Training material for extension advisors in irrigation water management

Volume 1: Main Report

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Report to the
Water Research Commission
and
Department of Agriculture, Forestry and Fisheries

WRC Report No. TT 539/12

OCTOBER 2012

University of Pretoria

WATER RESEARCH COMMISSION

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Department:
Agriculture, Forestry and Fisheries
REPUBLIC OF SOUTH AFRICA

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The publication of this report emanates from a project titled *Development of training material for extension in water irrigation management* (WRC Report No. K5/1649).

This report forms part of the following set of reports:
Volume 1: Main report
Volume 2: Technical learner guide
Volume 3: Extension learner guide

ISBN 978-1-4312-0335-2
Printed in the Republic of South Africa

Executive summary

Learning is an investment in capacity building that has and will continue to deliver rewards for primary agricultural producers and government officials in terms of increased production, profitability, exports, jobs and sustainable agricultural growth. This report concludes the solicited Water Research Commission (WRC) Project on “Development of training material for extension in irrigation water management” which was initiated in 2006.

In the Programme of Action of the Presidency announced in 2010, Outcome 7 strives to achieve vibrant, equitable and sustainable rural communities and food security for all. Furthermore, the National Development Plan released in 2011 elaborates on "trade-offs and risks for agricultural expansion". It recommends, amongst others, improving and extending skills development and training in the agricultural sector, including entrepreneurship training. This should include the training of a new corps of extension officers that will respond effectively to the needs of smallholder farmers and contribute to their successful integration into the food value chain. It is generally recognised that extensionists provide the link between research output and solving the perceived problems which farmer’s experience. All types of farmers, but specifically smallholder farmers, are dependent on extension services as a source of information and knowledge. Discussion forums organised by the Water Research Commission in all provinces between 2000 and 2003, in which a wide range of farmers participated, have highlighted that the extension link has deteriorated in recent years and become less effective.

In 2005 a consultancy project was undertaken for the WRC to establish a database of extensionists who are active on smallholder irrigation schemes in South Africa. In that process it was also determined that the current level of training presented by tertiary organisations to extension workers for the tasks they have to perform on irrigation schemes is inappropriate in the majority of cases. Extensionists therefore do not have the necessary knowledge base and skills to do their work. In many cases this results in a lack of confidence amongst extensionists, decline in their credibility and withdrawal from the community, which they must serve. There is an urgent need to restore the self-esteem of individuals and improve the service delivery of the extension profession. In view of this key deficiency, a start was made to define the “knowledge profile” for training of extensionists.

The outcomes of the consultancy formed the basis for this solicited research project. The aim for this project is to develop and interactively test learning material for the capacitating of extensionist in the promoting of efficient use of irrigation water by smallholder farmers.

The project team addressed the aims of this research through the following phases:

- Conducting of a baseline study to describe the current status of irrigation extensionists serving irrigation farmers on small scale irrigation schemes. This baseline study provides information about the current numbers of extensionists serving irrigation farmers, the current ratio between extension and farmers, competence level of the extension corps, experience in irrigation and training needs regarding irrigation water management;

- Overview of educational and training programs in irrigation water management for learners in agriculture at tertiary training organisations;

- Contextualisation of the irrigation farmer and extensionists’ environment;

- Developing of the learning material through interactive participation with various stakeholders which entails the development of landscapes, frameworks for the learning areas as well the drafting of learning modules;
- Testing and evaluation of learning material content and format interactively

The solicited project started in April 2006, subsequent to the consultancy project (WRC Report KV 178/07) which served to identify some of the training needs of the irrigation extensionists as well as to evaluate the occupational status of them. The extensive scope of the project as well as the focus on the development of outcomes-based training material necessitated a Participatory Curriculum Development (PCD) approach. This required new innovative thinking to the hierarchical curriculum development approaches. The purpose was to develop a curriculum from the interchanges of experience and information between the various stakeholders in the educational and irrigation management spheres. PCD seeks to identify the stakeholders, and to involve them in the construction of the curriculum – including not just subject matter being taught but also the experiences and activities which the learners engage in during the course. It seeks to explore with stakeholders, collectively or individually, their views about the desired learning objectives and the processes intended to bring about the achievement of those objectives.

The project activities included various field and office visits, consultation, discussions and interaction with role players from the private sector, academia from nearly all the agricultural colleges, universities of technology and universities offering training programs, extension workers from various provinces of South Africa including Limpopo, Eastern Cape, Mpumalanga, Northwest, Free State, and KwaZulu-Natal. The consultation and interaction with role-players in the industry was extensive and contributed to keep focused with the development of the learning material.

The main output of this research project was the development of the learning material for the eight learning areas that were identified to form the “knowledge profile” of the irrigation extensionist. The aim of the learning material is to support tertiary training organisations such as agricultural colleges and universities of technology offering agricultural programs on a NQF level 5, as well as the supporting of training providers offering short courses in irrigation management. The learning package consisting of nine parts is aimed to help build the necessary skills and competencies required of irrigation extensionists to assist irrigation farmers in the learning process they need to undergo regarding irrigation water management.

The learning material consists of 93 learning modules divided into technical and extension related modules. The learning package starts with a brief overview of the soil-plant-atmosphere continuum, which also forms the reference framework for deliberations and learning in the other seven technical learning areas.

Technical Learner Guide

Part 1: Soil-plant-atmosphere continuum
The soil-plant-atmosphere relationship recognizes that all components of the irrigation field (soil, plant and atmosphere) should be taken collectively into account when decisions are made regarding irrigation water management. This part serves as an introduction to the concepts like dynamic field balance of water and energy that is required for the flow of water and helps the learner to understand the whole picture.

Part 2: Assessing of soil resources
The objective with this technical guide in soil science is to provide learners with a comprehensive understanding (in depth) of the soil factors that is required for land suitability evaluation and land use planning for irrigated agriculture. This learning material comprises of 13 learning modules and specific attention in the development of the learning material was given to soil requirements (ideal conditions) and tolerances of crops grown under irrigation – with emphasis on the different crops.

Part 3: Agro-climatology
This learning material consists of 10 modules and the aim is to provide learners with a general overview (NQF level 5) of the agro-climatic factors that need to be taken into consideration for effective irrigation management. This will enable them to communicate effectively with subject matter specialists and farmers in this regard.

Part 4: Irrigation water management
The aim with this learning material is to acquaint learners with a comprehensive understanding of irrigation water management principles, introduce them to various irrigation systems that can be selected, an understanding of the layout and operation of an irrigation system and how to set benchmarks for efficient irrigation water management on the farm. This learning material comprises of nine learning modules.

Part 5: Irrigation engineering
The objective with this learning guide in irrigation engineering is to provide learners with an overview of irrigation engineering aspects required for effective management like evaluation and maintenance of irrigation systems. Three modules were identified for inclusion in this learning material. The knowledge and skills will enable the extension agent to communicate effectively with specialists like irrigation engineers after trouble shooting on the farm and to apprehend the ARC Irrigation Manual more effectively.

Part 6: Irrigation legislative context
The learning material aims at providing the basic knowledge and understanding required to apprehend the legal environment of an irrigation farmer. Four modules relating the agricultural policy of South Africa, National Water Act, National Water Resource Strategy and Irrigation Strategy were included.

Part 7: Irrigation economics
This learning material (12 modules) aims at providing a basic understanding of farm management with the various tools that can help the farmer to achieve his objectives. These tools and methods are divided into six sections which include production and resource planning, financial management, marketing, human resource management and risk management. All of these sections are then incorporated in the business plan which forms the road map for the farm, enabling the farmer to achieve his goals and objectives.

Part 8: Irrigated crop and fodder production
This learning material aims at providing an overview of sustainable cropping systems, basic understanding of the water uptake by plants, vegetative and reproductive growth of plants followed by a comprehensive overview of production practices with specific emphasis on the crop irrigation requirements of various crop types. This material comprises of 30 learning modules.

Extension Learner Guide

Part 9: Agricultural extension

The aim with the extension learning material is to address the identified skills and competencies as reflected in the newly developed units standards on NQF level 3 (7), NQF level 4 (6) and NQF level 5 (13) for agricultural extension. The extension learning material includes eleven modules on various extension related aspects such as communication for rural innovation, extension approaches for agriculture development, leadership and facilitation, group mobilising, holistic farm planning and land evaluation skills.

During the participatory development of the learning material valuable lessons were learned:

- It is important to involve the target group in planning. Wide consultation networks with stakeholders from the target learning group, industry organisations, technical and extension experts and other providers was required.

- Appropriate subject matter specialists (SMEs) and authenticators had to be identified who guided and informed the design and development of the learning material.

- Frameworks /landscapes helped with the contextualisation of the essential knowledge and skills required from irrigation extensionists.

- The checklist developed for the evaluation and testing of frameworks and landscapes of learning material helped to guide reviewers with a structured approach to test and evaluate learning material. Attention was given to the specific learning outcomes set for learning material in order to ensure that the training offered is on an appropriate level of complexity under various conditions and for different learners.

- Monitoring of impact of learning material through feedback from the learners on what part of the course was well received and what part could be improved after presenting a learning program. It is also important to take action on this feedback which was received.

- Special type of expertise is required for development of training material – one with both theoretical as well as practical knowledge of a specialised field.

It is recommended that the outcomes of this project should be marketed and disseminated to all relevant tertiary and private training organisations in the country for future practical training on various aspects of irrigation water management. This will ensure addressing the lack of competency amongst extensionists, and restore their credibility and self-esteem towards the rendering of a professional service to irrigation farmers.

Acknowledgements

The project team is grateful to the Water Research Commission (WRC) for initiating, funding and managing this very important solicited project. The co-funding by the Department of Agriculture, Forestry and Fisheries is also acknowledged. The following members of the Reference Committee are thanked for their valuable and significant guidance and support during the project:

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Prof SM Mtshali	University of Zululand
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The project team expresses its profound gratitude to:

- Extensionists of the provincial departments of Limpopo, Northwest, Mpumalanga, KwaZulu-Natal, Eastern Cape, Free State and Northern Cape
- Lecturers of agricultural colleges and universities of technology for participating in the discussion forums and testing of learning material
- *Advisors and technical/extension experts:*
  Mr Andre vd Merwe, Transvaal Suiker Beperk
  Mr Francois Marais, Elsenburg Agricultural College
  Prof Chris du Preez, University of the Free State
  Prof Sue Walker, University of the Free State
  Dr Baldur Koch, Private Consultant
  Mr Chris Barnard, Fertigation Academy
  Mr Francois vd Merwe, Department of Water Affairs
  Mr Abraham Bekker, GWK
  Mr Amos Montjane, Tompi Seleka Development Institute
  Mr Piet du Toit, Private Consultant
  Mr Gerhard de Kock, Private Consultant
  Mr Johan van Stryp, Loskop Irrigation Board
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Agricor	Agricultural Development Corporation of Bophuthatswana
AgriSETA	Agricultural Sector Education Training Authority
AIE	Institute for Agricultural Engineering
ARC	Agricultural Research Council
ARDC	Agricultural Rural Development Corporation
ARDRI	Agricultural Rural Development Research Institute
CAPS	Curriculum Assessment Policy Statement
CASP	Comprehensive Agricultural Support Program
CE@UP	Continuous Education @University of Pretoria
DAFF	Department of Agriculture, Forestry and Fisheries
DU	Distribution Efficiency
DWA	Department of Water Affairs
ESTA	Extension of Security of Tenure Act No 62 of 1997
FO	Farmer Organisation
GWK	Griqualand West Co-op
HSRC	Human Science Research Council
IDP	Integrated Development Planning
LDA	Limpopo Department of Agriculture
LTA	Land Reform Act No 3 of 1996
MAR	Mean Application Rate
MDA	Mpumalanga Department of Agriculture
MGK	Magaliesberg Graan Kooperasie
NDA	National Department of Agriculture
NEMA	National Environmental Act N0 107 of 1998
NGO	Non-Governmental Organisation
NQF	National Qualification Framework
NWA	National Water Act (No 36, 1998)
NWRS	National Water Resource Strategy
OBE	Outcomes-Based Education
OBET	Outcomes-Based Education Training
OQF	Occupational Qualification Framework
PCD	Participatory Curriculum Development
PRA	Participatory Rural Appraisal
QCTO	Qualification Council for Trades and Occupation
RESIS	Revitalisation of Small Scale Irrigation Schemes
RH	Relative Humidity
RNCS	Revised National Curriculum Statement
SAM	SA Malsters
SAQA	SA Qualification Authority
SASRI	South African Sugar Research Institute
SERTEC	Certification Council for Technikon Education

SGB	Standard Generating Body
SIS	Small scale irrigation schemes
SMEs	Subject Matter Experts
SUBTROP	Subtropical Growers' Association
TOR	Terms of Reference
TSB	Transvaal Suiker Beperk
US	Unit Standard

1. INTRODUCTION

Learning is an investment in capacity building that has and will continue to reap rewards for primary agriculture producers and government in terms of increased production, profitability, exports, jobs and sustainable agricultural growth. It has long been established that through learning new technical and personal skills are developed, old ones are upgraded and new attitudes and values develop as part of the change. This report concludes the solicited WRC Project on “Development of training material for extension in irrigation water management”.

In 2005 a consultancy project was undertaken for the WRC to establish a database of extensionist who is active on smallholder irrigation schemes in South Africa (Stevens & Van Heerden, 2007). In that process it was also determined that the current level of training presented by tertiary organisations to extension workers for the tasks they have to perform on irrigation schemes is inappropriate in the majority of cases. In view of this key deficiency, a start was made to define the “knowledge profile” for training of extensionists. The core content was also provided for training courses in order to present holistic and practically oriented training for extensionists in the future. The outcomes of this consultancy project formed the basis for this solicited project. It is envisaged that the outcomes of the project enable actions to develop a curriculum for future practical training of extensionists on various aspects of irrigation water management.

2. RATIONALE FOR THE DEVELOPMENT OF TRAINING MATERIAL FOR IRRIGATION EXTENSIONISTS

The revitalisation of irrigation schemes and irrigation management transfer is accepted policy in South Africa (Denison & Manona, 2007). Implementation of this policy can however not succeed without efficient extension support. In the process of integrated development planning (IDP), extension services are also the essential link between government and rural communities who are dependent on agriculture. In the Programme of Action of the Presidency announced in 2010, Outcome 7 strives to achieve vibrant, equitable and sustainable rural communities and food security for all. It is stated that water losses in the agricultural sector should be reduced with 10% by 2014. This implies an expectation from government that the sector should increase water use savings in order to ensure that enough water is available for other uses. In this endeavour irrigation extensionists perform an important function to promote agricultural development, and ensure the efficient use of water for food production.

Furthermore, the National Development Plan released in 2011 elaborates on "trade-offs and risks for agricultural expansion". It recommends, amongst others, improving and extending skills development and training in the agricultural sector, including entrepreneurship training. This should include the training of a new corps of extension officers that will respond effectively to the needs of smallholder farmers and contribute to their successful integration into the food value chain. It is generally recognized that extensionists provide the link between research output and solving the perceived problems which farmer’s experience. All types of farmers, but specifically smallholder farmers, are dependent on extension services as a source of information and knowledge. This has been confirmed by a survey amongst emerging irrigation farmers (Backeberg & Sanewe, 2006). Discussion forums organised by the Water Research Commission in all provinces between 2000 and 2003, in which a wide range of farmers participated, have highlighted that the extension link has deteriorated in recent years and become less effective. According to Mashego and Matshego (2005), small-scale farmers need in order of priority: land (16.5%), water (13.95%), financial loans and funding (12.62%) and skills (8.74%). This

emphasise the important role to be played by extension within the complex web of information sources used by irrigation farmers for decision making.

The science of irrigation management is complex and comprehensive, and therefore the irrigation extensionists need comprehensive technical knowledge and skills in irrigation management as well as appropriate knowledge and understanding regarding human behaviour (Stevens & Van Heerden, 2006a; Stevens & Van Heerden, 2006b). Presently information is available on various biophysical and socio-economic aspects of irrigation management. Various irrigation courses are offered at Universities of Technology and Agricultural Colleges. However, the general feeling amongst extensionists involved in irrigation is that this information is not presented in the required format and the courses do not prepare extensionists for the tasks they have to perform on the irrigation schemes. The training does not cover all the areas for which the extensionist is responsible and certainly is not practical, hands-on training (Stevens & Van Heerden, 2006a; Stevens & Van Heerden, 2006b; Stevens & Van Heerden, 2007).

Extensionists therefore do not have the appropriate knowledge base and skills to do their work. In many cases this results in a lack of confidence amongst extensionists, decline in their credibility and withdrawal from the community, which they must serve. There is an urgent need to restore the self-esteem of individuals and improve the service delivery of the extension profession. In view of this key deficiency, a start was made with the process to develop a "knowledge profile" for the training of extensionists involved in irrigation farming (Stevens & Van Heerden, 2006a; Stevens & Van Heerden, 2006b; Stevens & Van Heerden, 2007).

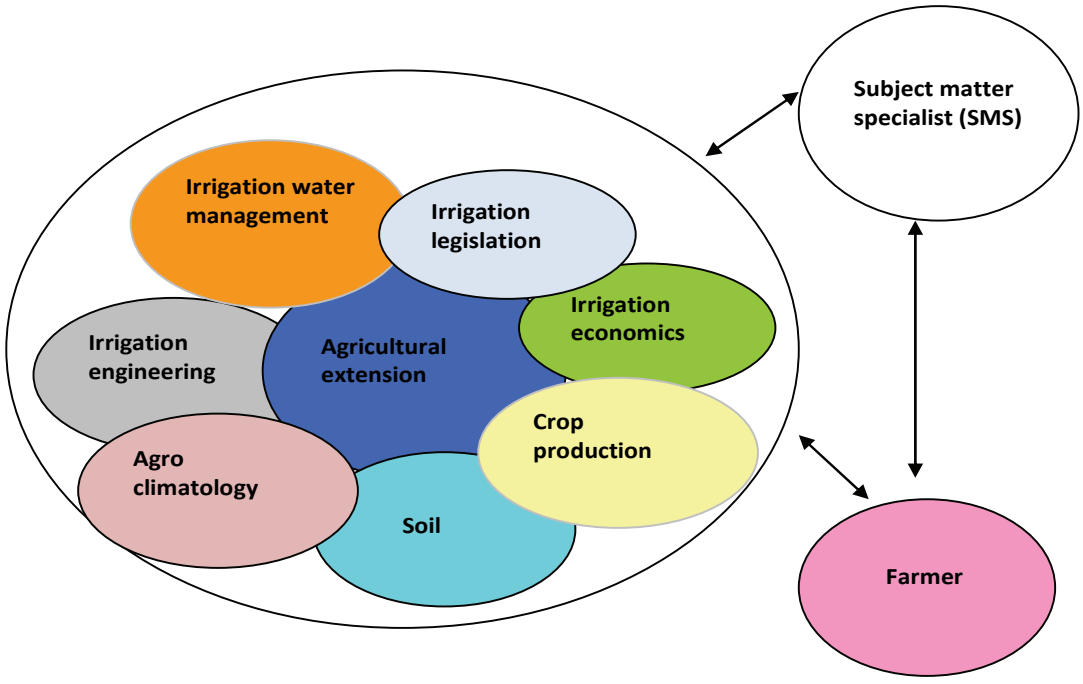

Figure 2.1. Conceptual framework of the "knowledge profile" of an irrigation extensionist (Stevens & Van Heerden, 2007)

This conceptual framework ('knowledge profile") of a possible curriculum for the training of extensionists and advisors in irrigation management was one of the outputs of the consultancy project undertaken for the Water Research Commission (Stevens & Van Heerden, 2007). This conceptual "knowledge profile" of the irrigation extensionists as illustrated in Figure 1, does not imply that extensionists should become experts in each of these identified technical learning areas, but rather that adequate technical knowledge and competence in each of these learning areas is a prerequisite for credible extension service delivery to irrigation farmers. The challenge to the project team and the Water Research Commission through consultation with stakeholders were to determine what this "adequate level" of training for each of these learning areas entails. This "knowledge profile" and core content of training formed the basis for this WRC project to develop training material on irrigation water management for extension officers.

3. TERMS OF REFERENCE AND OBJECTIVES FOR RESEARCH

The following aims and objectives were set in the project proposal to be addressed by the project activities.

3.1 Aim

To develop and interactively test comprehensive training material for capacitating of extensionists in the promotion of efficient irrigation water management by smallholder farmers.

3.2 Specific objectives

1. Determine on a sample basis a baseline of:
   - Who are the extensionists active in smallholder irrigation?
   - Their current training level.
   - Their training needs.
   - The current training available or offered to extensionists.
2. Refine the list of training modules (see objectives 4 and 5 below) based on the training needs assessment and add modules if necessary.
3. Workshop with stakeholders to clarify the modules to be developed and the interactive process to be followed to test the modules.
4. Develop Outcomes-Based Education Training (OBET) modules for training of extensionists with the focus on technical content in respect of:
   - Soil and soil-water.
   - Plants, water requirements, cultivation and production.
   - Atmosphere-climate (agro-meteorology).
   - Soil-plant-atmosphere continuum including scheduling.
   - Irrigation systems.
   - Crop and farm irrigation economics.
   - Scheme and on-farm storage and distribution.
   - Conservation and utilization of natural resources and natural environment (including health and safety issues).
   - Relevant support services (inputs and outputs), e.g. marketing, storage and processing.
   - Water user organizations (WUA, etc.) including individual and collective action for water management.
   - Institutional arrangements.
   - Water policy and legislation.
5. Develop Outcomes-Based Education (OBET) aligned training modules for training of extensionists with the focus on extension and training skills in respect of:

- Role of indigenous knowledge in communication for development.
- Social system within which farmers operate.
- Group formation and group dynamics.
- Leadership.
- Entrepreneurship.
- Sustainable rural livelihoods.
- Extension approaches.
- Training techniques and approaches/principles.
- Monitoring and evaluation of extension programs and their outcomes/impact.
- External factors.

6. Investigate appropriate formats (video, report, flipcharts, manual, etc.) for presentation of specific modules.
7. Test the training modules with a target group of extensionists on smallholder irrigation schemes and adapt if necessary.
8. Give feedback to stakeholders.

3.3 Overview of project content and timelines

The project was conducted according to the activity and timeline summary shown in Table 3.1 and extended over a period of 5 years.

Table 3.1. Project timeline and activities

Year 1 Apr 2006-Mar 2007	Development of framework. Literature survey Baseline report on current status of training of extensionist Stakeholder workshop Identifying of appropriate learning format Assess and analysis of available information: technical and extension
Year 2 Apr 2007-Mar 2008	Drafting of learning material according to the identified learning areas. Gap analysis between the needs and available information Outline of learning frameworks of material Initial testing and adaption of frameworks for development of training material (technical and extension)
Year 3 Apr 2008-Mar 2009	Drafting of learning material according to the identified learning areas. Outline of learning frameworks of material (technical and extension) Initial testing and adaption of frameworks for development of training material (technical and extension) Drafting of learning material (technical and extension) Authentication and testing of draft learning material
Year 4 Apr 2009-Mar 2010	Drafting of learning material according to the identified learning areas. Drafting of learning material (technical and extension) Testing of appropriate format and acceptability of draft learning material amongst potential users (technical and extension) Authentication and testing of outstanding draft learning material
Year 5 Apr 2010-Mar 2011	Revision and finalisation of draft learning material Revise learning material according to feedback and liaison with stakeholders Finalising the learning material

3.4 Project Deliverables

The aims of the project were addressed over the 5 year period through many hours of field work, consultation, discussion forums, writing of learning material and testing of the appropriateness of the learning material to learners, practitioners and authenticators. These analyses and products were presented to the WRC through 30 deliverable reports:

- Detailed work plan for the whole project and inaugural meeting with project team and interested parties
- Baseline report on current status of extensionists in South Africa (who are the extensionists active in small scale irrigation, their current training level, training needs and the training that is available)
- List of additional training modules to be developed based on training need assessment (Stakeholder Workshop)
- Proceedings of stakeholder workshop to obtain perceptions on the proposed list of training modules
- Interim report on appropriate formats for specific modules
- Interim reports on assessing and analysing of available information : technical modules and extension modules
- Interim reports on the development of frameworks and content for technical and extension training modules
- Progress reports on testing and evaluation of frameworks of training material (technical and extension)
- Interim report on testing of appropriate format and acceptability for presentation of developed training material amongst potential users
- Interim report on final adaptations and testing of amended training material in participation with stakeholders
- Interim report on feedback stakeholder workshop
- Popular /scientific article
- Annual progress report to WRC
- Final project report to WRC

3.5 Project activities

- *Baseline status report*
  This phase was used to describe the current status of irrigation extensionists serving irrigation farmers on small scale irrigation schemes. This baseline report provided important information regarding the following:
    - Current size of the extension corps and the number of extensionists responsible for serving small scale irrigation schemes (SIS)
    - Who their target audience is?
    - Gender and age structure of the corps
    - Competence level of the extension corps
    - Experience in irrigation and training (formal and non-formal) available to extension staff
    - Assessment of the “knowledge profile” of the irrigation extensionist
    - Identification of information sources used by extensionists and their training needs regarding irrigation water management

- *Overview of educational and training programs in irrigation water management for learners in agriculture.*
  Current training curricula used for the training of extensionists in irrigation water management by tertiary organisations on diploma (NQF 5) level and degree (NQF 6) level were assessed as well as training programs offered by private training organisations in South Africa. The information on training curricula offered mainly reflects the eight learning areas as been identified to compile the "knowledge profile" of the irrigation extensionist through the consultation with extensionists, various stakeholders and academia. The eight learning areas are as follow:
    - Crop production
    - Soil
    - Agro climatology
    - Irrigation management
    - Irrigation engineering
    - Irrigation economics
    - Legal aspects pertaining to irrigation
    - Agricultural extension

- *Contextualisation of the irrigation farmer and extensionists' environment*
  At the beginning of this phase of the development of the learning material the team together with the subject matter specialists involved in the process took the time to define the context of the irrigation extensionists in which he/she operates daily as well as that of the irrigation farmer. This step helped to contextualise essential skills, knowledge and elements required from irrigation extensionists. In other words, to ensure that everybody involved in the development of the learning material are familiar with the typical environment and the system in which irrigation extensionists and farmers operate and which could influence their behaviour and choices. This "context" refers to physical, emotional or the social nature of it. Information emanating from the defining of the context strongly influences and determines the activities a person engages in, as well as the skills and the knowledge a person requires interacting in a meaningful manner within his/her context.

- *Developing of the learning material*

    a. The first step in the process of the development of technical and extension training material was to do a reconnaissance of the learning material that exists which is appropriate regarding irrigation water management. This reconnaissance included three distinguished stages namely:
        i. Identification of existing learning material offered by private training organisations, tertiary organisations like agricultural colleges, *technikons, universities of technology and universities, and training and education governing bodies, i.e. South African Qualification Authority (SAQA), etc.
        (* *The majority of technicons during the duration of the project was converted to Universities of Technology)*
        ii. The second step was to "unpack" this available learning material and analyse it in terms of content, format and relevance.
        iii. The third step was to identify shortcomings with regards to:
            1. Identified needs expressed by learners (extensionists) and opinions expressed by subject matter experts as well as

2. Objectives set for this project as defined in the terms of reference (TOR)

b. The second part of the reconnaissance involved the identification and assessment of SAQA registered training material (technical and extension) on NQF levels 3-5 of AgriSETA with regard to primary and secondary agriculture subfields.
c. This phase also involves extensive consultation with a great number of stakeholders in the industry through stakeholder workshops, interviews, telephonic conversations, e mail correspondence and various discussion forums organised with extension officials and advisors from private organisations in several provinces of South Africa.
d. Development of objectives for the learning material in terms of learner behaviour through taking in consideration various learning theories and the outcome of consultation with stakeholders. The development of the learning material followed the principles of Outcome Base Education and Training (OBET) namely to focus on the following key elements namely:
    i. Outcomes: results of skills, knowledge, attitudes and attributes in place
    ii. Learning: formal and informal learning interventions that specifically lead to the achievement of outcomes
    iii. Assessment: gathering of evidence measuring competence specifically for the outcomes defined
e. Planning of appropriate learning material through the development and testing of landscapes and frameworks for the eight learning areas: soil, crop, agro-climatology, and legal aspects of irrigation management, irrigation water management, irrigation engineering, irrigation economics and agricultural extension.

- *Testing and evaluation of learning material content and format interactively*
  The testing of the learning material was done amongst extensionists attending short courses, facilitators of training, students and lecturing staff from agricultural colleges and universities of technology, and authenticators and specialists.

  The first phase of the testing of the learning material involved the evaluation by authenticators, specialists and academics of the learning content of the material. This project used an adapted matrix for determining whether the learning material is appropriate.

  The second phase of testing and evaluation involved the collection of feedback from learners on the whether they found the learning material understandable and how relevant it is with the current practising of extension. A separate matrix for evaluation was developed during the project to be used for this assessment. The third phase of testing and final alignment of learning material involved a stakeholder workshop that was held with irrigation practitioners and trainers from Transvaal Suiker Beperk, Agriwiz, Farm Secure, Akwandaze, FET Colleges, ARC and Department of Agriculture and Land Affairs Mpumalanga. Based on the feedback received the final fine tuning to the learning material (content and format) was made.

3.6 Products

The final report includes both the Main Report (Volume 1) where the baseline study and a comprehensive overview of the project activities regarding the developing of the learning material are given. Two volumes, one on the Technical Learning Material (Volume 2) and another on the Extension Learning Material (Volume 3), comprise the main product of the project. The learning material in technical learning areas as well as extension

learning area are aimed to assist learners to acquaint themselves regarding the obtaining of the following competences:

- *Foundational competence*: as demonstrated through the understanding of what an irrigation extensionists is doing and why he/she is doing it.
- *Reflexive competence*: as demonstrated through the ability to integrate or connect performances with the understanding of the irrigation extensionists so that he/she learns from his/her actions and is able to adapt to changes and unforeseen circumstances.
- *Practical competence:* as demonstrated through the ability to perform a set of tasks that refers to the psychomotor domain of human learning.

Technical learning material

The technical learning material includes various modules on the learning areas agro climatology, assessing of soil resources, irrigation water management, irrigation engineering, irrigation economics, and irrigation legislation context and irrigated crop and fodder production.

Soil-plant-atmosphere continuum

The soil-plant-atmosphere relationship recognizes that all components of the irrigation field (soil, plant and atmosphere) should be taken collectively into account when decisions are made regarding irrigation water management. This part serves as an introduction to the concepts like dynamic field balance of water and energy that is required for the flow of water and helps the learner to understand the whole picture.

Assessing of soil resources

The objective with this technical guide in soil science is to provide learners with a comprehensive understanding (in depth) of the soil factors that are required for land suitability evaluation and land use planning for irrigated agriculture. This learning material comprises of 13 learning modules and specific attention in the development of the learning material was given to soil requirements (ideal conditions) and tolerances of crops grown under irrigation – with emphasis on the different crops.

Agro climatology

This learning material consists of 10 modules and the aim is to provide learners with a general overview (NQF level 5) of the agro-climatic factors that need to be taken into consideration for effective irrigation management. This will enable them to communicate effectively with subject matter specialists and farmers in this regard.

Irrigation water management

The aim with this learning material is to acquaint learners with a comprehensive understanding of irrigation water management principles, introduce them to various irrigation systems that can be selected, an understanding of the layout and operation of an irrigation system and how to set benchmarks for efficient irrigation water management on the farm. This learning material comprises of nine learning modules.

Irrigation engineering

The objective with this learning guide in irrigation engineering is to provide learners with an overview of irrigation engineering aspects required for effective management like evaluation and maintenance of irrigation systems. Three modules regarding maintenance and evaluation of irrigation system were identified for inclusion in this learning material. The knowledge and skills will enable the extension agent to communicate effectively with specialists like irrigation engineers after trouble shooting on the farm and to apprehend the ARC Irrigation Manual more effectively.

Irrigation legislative context
The learning material aims at providing the basic knowledge and understanding required to apprehend the legal environment of an irrigation farmer. Four modules relating the agricultural policy of South Africa, National Water Act (No36, 1998), National Water Resource Strategy (2004) and Irrigation Strategy (2007) were included.

Irrigation economics
This learning material (12 modules) aims at providing a basic understanding of farm management with the various tools that can help the farmer to achieve his objectives. These tools and methods are divided into six sections which enclose production and resource planning, financial management, marketing, human resource management and risk management. All of these sections are then incorporated in the business plan which forms the road map for the farm, enabling the farmer to achieve his goals and objectives.

Irrigated crop and fodder production
This learning material aims at providing an overview of sustainable cropping systems, basic understanding of the water uptake by plants, vegetative and reproductive growth of plants followed by a comprehensive overview of production practices with specific emphasis on the crop irrigation requirements of various crop types. This material comprises of 30 learning modules.

Extension learning material

The aim with the extension learning material is to address the identified skills and competencies as been reflected in the newly developed units standards on NQF level 3 (7), NQF level 4 (6) and NQF level 5 (13) for agricultural extension. The extension learning material includes eleven modules on various extension related aspects:

- *Module 1: Principles of agricultural extension*
  Defines agricultural extension, and explains the role that agricultural extension plays as a knowledge system in agricultural development and in rural development, as well as the principles that apply in the practising of extension.
- *Module 2: The extensionists or extension agent*
  This module explains the role of the agricultural extensionist and the prerequisite knowledge and competencies required to earn the necessary credibility to intervene with a farming community effectively.
- *Module 3: Communication as the basis for extension*
  This module aims at providing an overview of the role that effective communication and active listening is playing in an extensionist's strategy for inducing change. It provides guidelines to help the extensionists to plan an effective communication strategy.
- *Module 4:Extension approaches*
  The learning module explains the different extension approaches that an extensionist can follow in his interaction with the farming community, which may varies from the traditional top-down approach to the more participatory extension approaches like the use of Farmer Field Schools, Participatory Technology Development, etc.
- *Module 5: Community development and mentorship*
  This module provides a brief overview of the principles and aspects to take into consideration with the development of a farming community. It elaborates on the identification of potential stakeholders and role-players and how to mobilise them in the development of a community. The role of the extensionist in this activity is defined as well as the role of the mentor in the development and support of farmers.
- *Module 6: Mobilising of farmer groups*
  This module deals with the mobilising of farmer groups. It starts of by defining group dynamics and the various farmer groups one will find in a farming community, and elaborates on the various roles

members can play in a farmer group. It continues with providing a brief overview of the various stages of development of a group and explains group dynamics (internal and external) through the discussion of a case study. It concludes with a checklist that can be used to ensure that farmer groups are functioning efficiently.

- *Module 7: Leadership and facilitation*
  Leadership is unquestionably the key factor to successful group functioning and to achieve the stated missions for successful agricultural development. This module provides a brief overview of what leadership is and explains the role of leadership in sustainable agricultural development. It elaborates on various leadership styles. The role of the extensionist as a facilitator is explained for effective group functioning. This module also provides an overview of how to deal with conflict in a farmer group.
- *Module 8: Situation analysis*
  Agricultural development needs to be undertaken from three main perspectives namely: ecological, economic and social perspective. It is therefore important that the extensionist should be able to analyse the current situation before he or she embarks on an agricultural development program. This module provides valuable information for the extensionists to take into consideration with the planning of an extension program and elaborates on the various activities and methods to apply in the analysing of the situation. The use of some of these methods is explained through the inclusion of a case study on Tugela Ferry.
- *Module 9: Project development and management for extensionists*
  Every extensionist manages projects from time to time, and this module provides the necessary building blocks for extensionists to understand what an agricultural project is about and how to manage it effectively.
- *Module 10: How to prepare a holistic farm plan for irrigation*
  Sustainable agriculture development includes economic viability, environmental stewardship and social responsibility. This module explains whole or holistic farm planning for irrigation. It provides clear guidelines and steps for the holistic planning of an irrigation farm.
- *Module 11: Land suitability evaluation for irrigation agriculture*
  The final module explains the basic principles to apply in the evaluation of land suitability for irrigation development. It explains what to take into consideration with preparatory investigations and data collection for the evaluation of land suitability.

4. STATUS OF IRRIGATION EXTENSIONISTS RESPONSIBLE FOR SMALL SCALE IRRIGATION SCHEMES (SIS)

4.1 Research methodology

Guided by the terms of reference the following objectives were set to determine the status of the extensionist corps serving the small scale irrigation farmers:

- Identify extension workers involved with small-scale irrigation farming
- Report on current status of training level of extensionists involved in supporting small-scale irrigation farmers.
- Identify the training needs of extensionists involved in supporting small-scale irrigation farmers
- Identify irrigation training program offered to extensionists by tertiary and other relevant institutions in South Africa

Partially, objectives set for this deliverable, were addressed by the use of a database compiled for the search for an appropriate extension approach for South Africa (Dűvel, 2002) conducted by the University of Pretoria as a baseline document. This database served as a reference framework for the identification of extension officers involved in small-scale irrigation that are employed by the Department of Agriculture in the various provinces. This database was followed by a field survey where extension officials were selected to participate. The field survey was done by means of structured interviews to identify and describe the current level of knowledge and competence profile of irrigation extension workers, as well as their training needs (Stevens & Van Heerden, 2006; Stevens & Van Heerden, 2007)

To accommodate the spectrum of knowledge, competency and needs of extension workers, respondents from small-scale irrigation schemes from five provinces, namely Eastern Cape, KwaZulu-Natal (Tugela Ferry), Limpopo (RESIS), Northwest (Taung Irrigation Scheme) and Mpumalanga were randomly selected. The reason for focusing on the above mentioned irrigation areas is because the relative size of small-scale irrigation schemes (SIS) in these provinces are substantial relevant to the size of SIS for the rest of the provinces as indicated in Table 4.1 .

Table 4.1. Small-scale irrigation schemes in South Africa (Stevens & Van Heerden, 2007)

Province	Number of small-scale irrigation schemes (n)	Area of irrigation (ha)	Number of irrigation farmers (n)
Eastern Cape	50	9 527	6 394
Limpopo	171	51 091	7 307
KwaZulu-Natal	18	6 923	5 903
Mpumalanga	15	8 109	1 191
Northwest	2	3 784	477
Free State & Northern Cape	18	1 680	294
Gauteng	1	827	35

A random sample of respondents from the Limpopo and Eastern Cape provinces were selected while stratified sampling was used for Mpumalanga (Nkomazi east irrigation scheme and Nelspruit area), Northwest (Taung Irrigation Scheme), and KwaZulu-Natal (Tugela Ferry and Makhatini) based on the size of irrigation and officers involved with extension support to small-scale irrigation farmers. The inclusion of these five selected irrigation areas was done to ensure that the various training programs offered by different tertiary education institutions in various provinces are included in the survey.

The draft questionnaire, which includes both open-ended and closed-ended questions, was tested with several project team members and extension specialists before it was employed in the field. The questionnaire was used in a face-to-face interview that was held with the random sample of extension workers, where the interviewer asked the questions and the respondents' answer was recorded *(Appendix A)*.

The main objectives of the questionnaire were:

- To assess the demographics of the respondents and present an overview of the training status regarding irrigation management.

- To assess the knowledge and competence level of extension workers regarding irrigation management.
- Identify the information and learning sources that irrigation extensionists usually use.
- Identify the training needs and preferred training methods. This training needs assessment was conducted to pinpoint the training needs of extension officers with the aim to develop and provide training relevant to the identified needs of extensionists. A systematic approach of needs assessment was used, which ensured that gaps in performance and competence were identified correctly. These gaps can then be addressed through appropriate training.

The face-to-face interviews with extension workers selected helped to establish close relationships with the extensionists servicing these irrigation communities and created an in-depth understanding of their aspirations, available resources, training levels and training needs. This baseline review of the current situation amongst extensionists enables the research team to identify target communities and to refine the research procedures.

4.2 Status of extension corps serving the small scale irrigation farmer

The first part of the baseline study focuses on identification of the extensionists responsible for serving small-scale irrigation farmers in South Africa, assessment of their level of knowledge and competence, and perceived training needs and preferred training methods.

4.2.1 Size of extension corps

The information was collected with the participation of various role players in the nine Provinces, i.e. the extensionists and as well as the extension managers. Group sessions were held throughout the country during 2002, and widespread involvement of extension staff in the interaction and feedback process was experienced (Dűvel, 2002). The degree, to which extension staff within the nine provinces was involved, is indicated in Table 4.2.

Table 4.2. Sample size of extension personnel involved in the group interviews

Province	Sample size
Eastern Cape	229
Free State	55
Gauteng	53
KwaZulu-Natal	193
Limpopo	324
Mpumalanga	129
Northern Cape	22
North West	173
Western Cape	21
TOTAL	**1199**

According to the Department of Agriculture, 387 extensionists are responsible for serving small-scale and commercial irrigation farmers on irrigation schemes. The frequency distribution of extensionists on according to the various provinces is illustrated in Table 4.3.

Table 4.3. Distribution of extensionists responsible for serving small scale and commercial irrigation farmers (N=387)

Province	Sample size
Eastern Cape	65
Free State	3
Gauteng	2
KwaZulu-Natal	67
Limpopo	192
Mpumalanga	36
Northern Cape	3
North West	8
Western Cape	11
Total	**387**

Developing the skills base of farmers is the primary objective of extension services. In terms of the Constitution, agriculture is a provincial competency, to be carried out within the framework of national policies set by the National Department of Agriculture. One of the main functions of the provincial departments of agriculture is the provision of farmer support services. The demand for extension services varies according to the nature of the farming practices (e.g. crop farming, livestock and irrigation farming) and farm size.

The following demand for skills development was identified by AgriSETA in 2008 targeted in the following areas:

- Commercial agriculture: special technical expertise is needed to assist the sector raise its productivity, better manage environmental factors and increase value-addition. Furthermore business management, marketing and supply chain management skills are also required to increase sector profitability to raise the overall productivity.
- Subsistence farmers: While the subsistence farmers face a number of challenges, developing and deepening subsistence farmer's knowledge and application of commercial production and farm management will contribute to expanding output and profitability and thereby facilitate greater equity in commercial agriculture as a whole.
- Small scale farmers: Access to basic agricultural production and risk management skills is urgently needed to increase the productivity of small scale agriculture.

The extension: farmer ratio that is proposed by the Department of Agriculture, Forestry and Fisheries (NDA, 2005), depends on the state of advancement of the farmers, and the intensity of the extension support programs. Communal farmers with a high number of producers on a household and subsistence level are currently serviced through a low extension: farmer ratio, while market oriented large scale farmers are serviced through a high ratio. The following extension: farmer ratios are recommend by the Department of Agriculture, but local conditions, circumstances and realities should dictate the final ratio.

Table 4.4. Proposed agricultural extensionist:farmer ratios (NDA, 2005)

Scale of operation	Nature of operation or farming		
	Crops	Livestock	Mixed
Subsistence or household level	1:400	1:500	1:500
Small scale level	1:250	1:250	1:300
Market oriented/large scale commercial	1:500	1:500	1:500

Taking into account the skills demanded for the various categories of farmers as been identified by AgriSETA (2008), the proposed extensionist: farmer ratio by the Department of Agriculture may even be too broad to ensure that the necessary capacity is build amongst small scale irrigation farmers.

4.2.2 Target audience

Since 1995 the change in policy has led to an increased priority focus on the subsistence, household food production and small-scale farmer as been outlined in the Comprehensive Agricultural Support Program (CASP) of the Department of Agriculture, Forestry and Fisheries (DAFF). This is reflected in respondents' indication of their primary focus regarding clients (Figure 4.1).

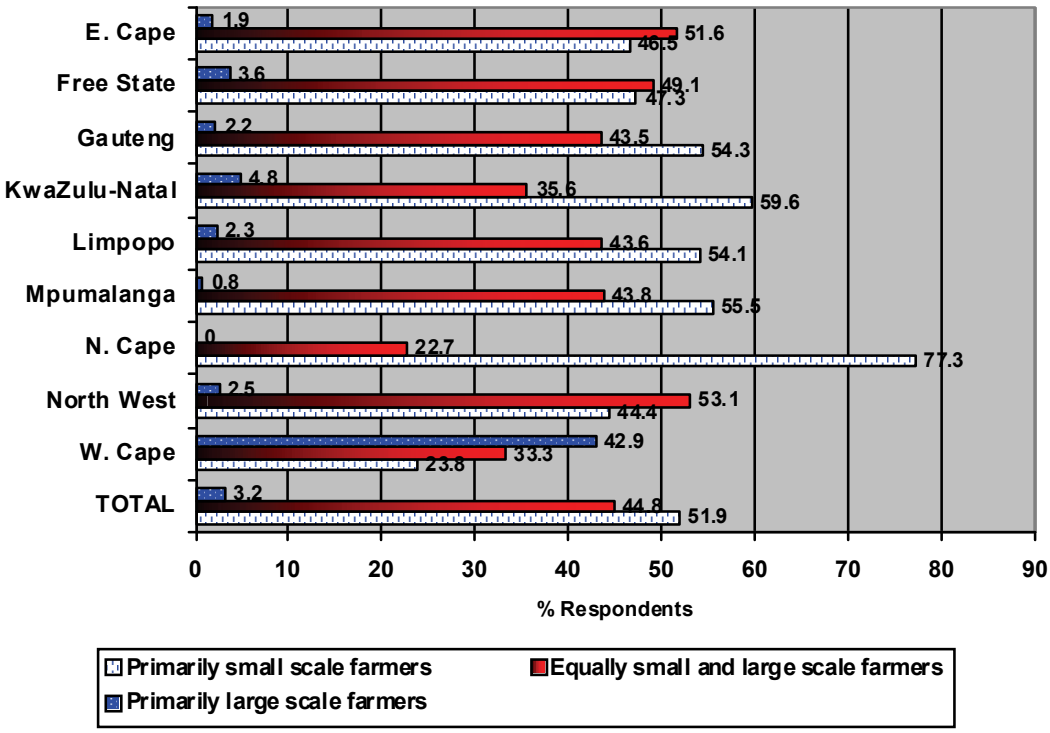

Figure 4.1. Percentage distribution of respondents according to their focus on small scale or commercial farmers (N=1199)

The overall focus on small-scale farming is clearly emphasised by the findings in Figure 4.1. Fifty two percent of the extension workers indicated that they primarily served the small-scale farmers and household food security clients. Even the 45 percent respondents classified as serving equally small-scale and commercial scale farmers must, according to clear evidence obtained, be seen as focusing primarily small-scale farmers. This would imply that 97 percent of extension workers in the Department of Agriculture, Forestry and Fisheries (DAFF) focus on the small-scale farmer. A clear exception in this regard is the Western Cape where about 43 percent, serve primarily the commercial farmer.

The focus of extension workers serving small scale irrigation schemes is illustrated in Figure 4.2. Fifty eight percent of the extensionists responsible for serving irrigation farmers indicated that they primarily focus on helping the small-scale farmers, while 42 percent, respectively classified as serving equally small-scale and commercial irrigation farmers. It is however clear from discussions held with several of the extensionists in the field, that many extensionists perceive a small-scale irrigation plot of 10 ha, as a semi-commercial farmer.

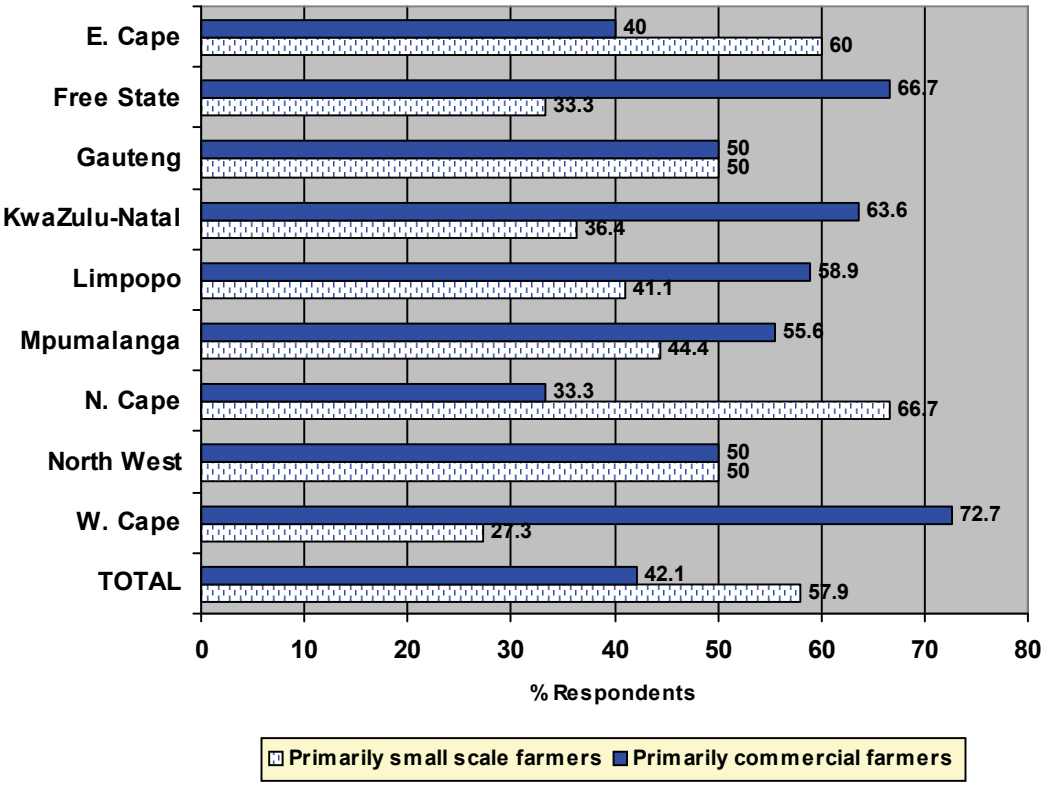

Figure 4.2. Percentage distribution of extensionists responsible for serving irrigation schemes according to their focus on small and commercial scale farmers (N=387)

Therefore the majority extensionists employed by the Department of Agriculture, Forestry and Fisheries (DAFF) primarily focus on serving the small-scale farmer with the exception of the Western Cape, where the focus is more oriented towards the commercial farmer.

4.2.3 Gender

The majority of extension workers involved in the survey was males (81%). This figure coincides with the actual distribution of gender amongst extension workers throughout the country in 2003, although a positive tendency occurs subsequently in that the ratio of female towards male extension workers.

4.2.4 Age structure

Figure 4.3 portrays that the majority of extension workers (82%) are younger than 50 years of age, which a promising fact is regarding the potential for further training in irrigation management. Younger people are in general more keen and eager to learn about “new technology” and to change their perceptions regarding the potential use of new technology for irrigation management.

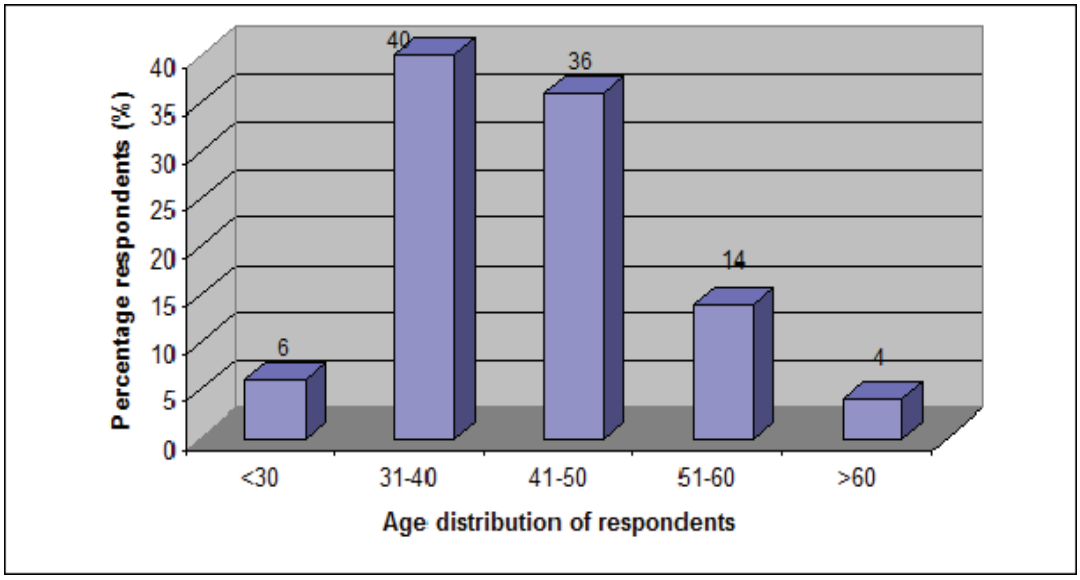

Figure 4.3. Percentage distribution of extensionists according to age (N=387)

4.2.5 Competence of extension personnel

In an increasingly broad and dynamic extension environment, extensionists may deliver services ranging from the transfer of technology to facilitative human development, performing in the roles of development, program or information extension and changing of perspectives. Small-scale farmers are mainly served by the Department of Agriculture, Forestry and Fisheries (DAFF) in the various provinces. The following services are rendered by the Department of Agriculture, Forestry and Fisheries (DAFF) to farmers (NDA, 2005):

- Facilitate access to extension and advisory services that lead to sustainable income generation by the specific clients
- Provide and facilitate access to agricultural information for improved planning and decision making
- Facilitate access to technology and, where possible , provide such technologies
- Provide and facilitate access to advice on sustainable agricultural production
- Provide and facilitate advice on skills development in agriculture

- Strengthen institutional arrangements (partnerships, restructuring, corporatisation, funding, establish new entities) for effective delivery of services.

The effectiveness and efficiency of extension is a direct function of the competency level of the extension staff. This is particularly the case in extension, which requires professional skills, which range from interpersonal and communication skills, to knowledge, planning, evaluation and ethical competence (Stevens & Van Heerden, 2006; Stevens, 2007; Stevens, 2008). In view of this, incorporation of such competencies in irrigation management into training course structures can be regarded as basic requirements or preconditions for effective extension delivery on irrigation schemes. All providers of agricultural extension and advisory services must at least be competent in the following areas (Stevens & Van Heerden, 2006; Stevens, 2007; Stevens, 2008):

- *Communication:* must be able to exchange information and ideas in a clear and concise manner appropriate to the audience in order to explain, persuade, convince and influence others to achieve desired outcomes.
- *Client orientation and customer focus:* must be willing and able to deliver services effectively and efficiently in order to put the spirit of customer service into practice.
- *Knowledge management:* Must be able to promote the generation and sharing of knowledge and learning in order to enhance the productivity of the farmers – this entails the competence in a particular specialised field of study as irrigation management.
- *Project management:* must be able to plan, manage, monitor and evaluate specific activities in order to deliver the desired outputs.

The field survey amongst *109 extension officers* from the following irrigation areas as depicted in Table 4.5 revealed interesting aspects of the competence and experience of extension workers in irrigation water management.

Table 4.5. Distribution of respondents involved in the survey as per province (N=109)

Province	Small scale irrigation scheme	n	%
KwaZulu-Natal	Tugela Ferry, Makhatini, , Mpangweni	5	5
Northwest	Taung, Brits	3	3
Eastern-Cape	Zanyokwe, Keiskammahoek, Qamata, Rainbow, Masinecedane	11	10
Limpopo	Tshiombo, Tshudulu, Dzindzi, Dingleydale, Diepkloof, Khumbe, Palmaryville, Mandiwana, Phadzima, Dopeni, Brakfontein	56	52
Mpumalanga	Nkomazi, Noordkaap, Suidkaap, Siyabuyela, Hazyview, Lydenburg,	34	30
Total		**109**	**100**

4.2.6 Formal education level

Efficient agricultural extension services require of extension workers to be qualified and competent in both the disciplines of agriculture and extension. The highest formal qualifications of extension staff, consisting of frontline extension workers and those associated with support services to small-scale irrigation schemes are summarised in Table 4.6.

The majority of frontline extension workers (75%) have obtained an agricultural diploma, which qualifies them as agricultural technicians but does not place them in the professional category of the scientist. What is positive is the significantly higher qualification of the supervisors and extension managers where 67% of them have an Advanced Diploma or higher qualification, while only 19.4% of the extension workers have this qualification. The significantly higher qualifications of the officers in the support service are to be expected, but the consequence of this is that they should be involved much more effectively in the extension process, particularly for knowledge support purposes.

Table 4.6. Frequency distribution of extensionists according to their extension position and highest tertiary qualification (N = 387)

Position	National Certificate/Diploma in Agriculture		Advanced Dipl/BTech/D-degree		BSc/BSc (Hons)		Masters/MSc/ PhD	
	n	%	n	%	n	%	n	%
Extension workers	276	80.5	53	15.5	7	2	7	2
Supervisors & Managers	5	33	4	27	3	20	3	20
Other support services	9	32	7	24	3	10	10	34
TOTAL	**290**	**75**	**64**	**17**	**13**	**3**	**20**	**5**

Table 4.7 compares the different provinces regarding the qualifications of the frontline extension workers. These findings show that extension staff in the provinces of Limpopo, Eastern Cape, Mpumalanga and KwaZulu-Natal has the lowest qualifications in agriculture.

Table 4.7. Distribution of frontline extension workers according to province and the highest qualification in agriculture (N=387)

Qualification	Certificate or Diploma		Advanced Dipl. BTech of B-degree		BSc, Hons. BSc(Hons)		Masters, MSc, PhD	
	n	%	n	%	n	%	n	%
Eastern Cape	55	85	8	12	0	0	2	3
Free State	0	0	0	0	2	67	1	33
Gauteng	1	50	1	50	0	0	0	0
KwaZulu-Natal	45	67	9	14	6	9	7	10
Limpopo	159	83	28	14	3	2	2	1
Mpumalanga	21	58	12	33	1	3	2	6
Northern Cape	3	100	0	0	0	0	0	0
North West	3	42	3	42	0	0	2	6
Western Cape	3	27	3	27	1	9	4	37
TOTAL	290		64		13		20	

4.2.7 Field of subject matter specialisation

It is expected of extensionists not to have only an adequate level of tertiary training in agriculture that will satisfy the requirements of their clients, but that subject matter specialisation in an appropriate field is often needed. The distribution of the fields of specialisation of extensionists responsible for the support of small-scale irrigation farmers is shown in Table 4.8.

Table 4.8. Frequency distribution of frontline extension workers according to their field of specialisation in agriculture (N=387)

Field of specialisation	n	%
Extension	184	47
General agriculture	75	19
Animal healthcare	26	7
Crop production	22	6
Home economics	19	5
Animal production	16	4
Rural development	15	4
Horticulture	6	1.5
Agricultural management	5	1.3
Agricultural economics	4	1
Communication	3	0.8
Land use planning	3	0.8
Soil conservation	2	0.8
Irrigation	*2*	*0.8*
Game /wildlife production	1	0.2
Public administration	1	0.2
Soil science	1	0.2
Aquaculture	1	0.2
Crop protection	1	0.2
Total	**387**	**100**

Forty seven percent of the extensionists perceive themselves specialised in the field of extension, while only 0.8% indicated any qualifications directly related to irrigation. Six percent of the extensionists are qualified in crop production, while two percent respectively are qualified in horticulture production. These findings clearly illustrate that the majority of extensionists working on small-scale irrigation schemes are not technically competent to render the necessary support expected by small-scale irrigation farmers with regard to intensive crop production and irrigation management.

4.2.8 Experience in Irrigation

The extension workers' experience in irrigation was assessed from the time that they have been employed in irrigation areas as well as their involvement with small-scale irrigation farmers (Figure 4.4).

Forty four percent of the extension workers are employed on irrigation schemes between six and ten years, with 25% extension workers serving irrigation farmers more than 10 years. With this vast experience amongst extension workers it was assumed that the majority of extensionists would have obtained extensive knowledge

of the agro-ecological conditions on the irrigation scheme. The fact however is during the interviews conducted with the 109 extension workers; it became clear that many of them lack basic knowledge and skills required for the support to farmers with regard to adapted farming practices. They also lack basic knowledge regarding the specific irrigation management preferences and dislikes of their clients. The reasons for this situation could be either that many extension officers lack the necessary aspiration or positive attitude to really become involve in the development of small-scale irrigation farmers, or it may also be because of the current policy adopted by the Department of Agriculture, Forestry and Fisheries (DAFF) where extensionists are mainly involved with the regulatory aspects regarding the implementation of development aid programs like CASP and Massive Food Project.

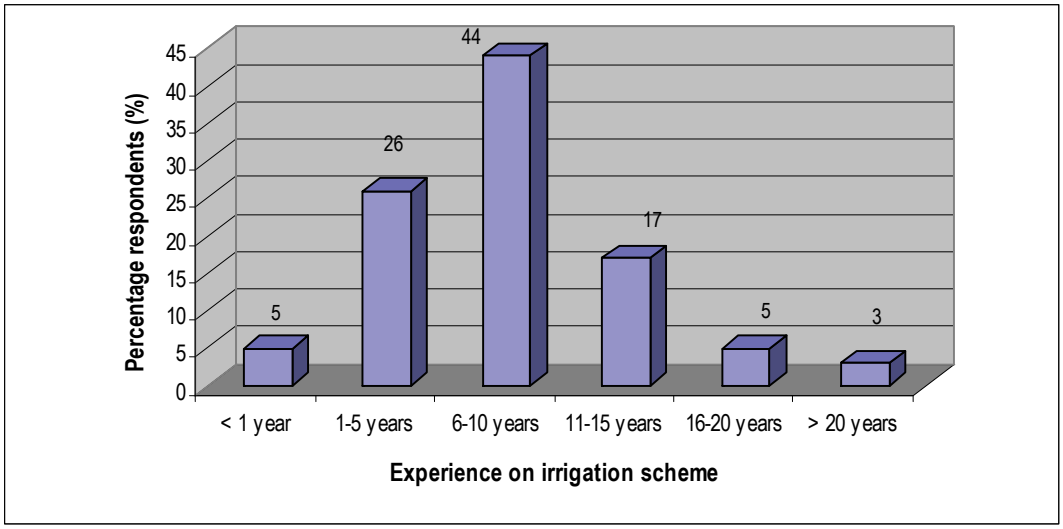

Figure 4.4. Percentage distribution of extension workers according to their experience in irrigation (N=109)

The full range of irrigation systems is found on small-scale irrigation schemes, viz. flood, sprinkler, centre pivot, micro and drip irrigation (Crosby, De Lange, Stimie, & Crosby, 2000). Short furrow irrigation is indigenous to many of the small-scale irrigation schemes in South Africa, and although it appears to be relatively simple, it is probably the more difficult irrigation system to plan and manage correctly. Forty eight percent of the extensionists are working on irrigation schemes where farmers make use of short furrow or flood irrigation (Table 4.9). For these extensionists it is important to have sufficient knowledge regarding the norms that apply for the designing of furrow irrigation and to be able to help farmers with decisions regarding the correct application and distribution of irrigation water (e.g. knowledge regarding water holding characteristics of soil).

Pressurized irrigation systems include irrigation systems like sprinkler, drip, micro and centre pivot. 52% of the extensionists are serving farmers that use pressurized irrigation systems, which once again require appropriate knowledge and competence to help farmers with decision making regarding how much water to apply and when to apply the irrigation water.

Table 4.9. Percentage distribution of respondents according to their experience with different irrigation systems (N=109)

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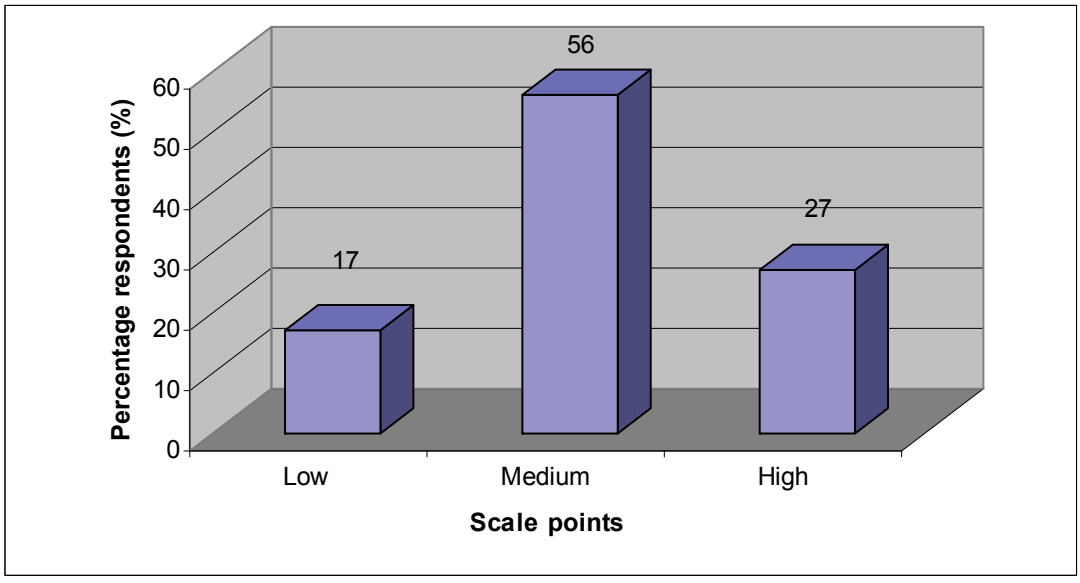
Irrigation method	n	%
Short furrow/flood	52	48
Hand shift sprinkler irrigation (Quick couple)	44	40
Stationery sprinkler irrigation- (Floppy)	9	8
Mobile irrigation systems (Centre pivot)	4	4
Total	**83**	**100**

The appearance of floppy sprinklers is a fairly new phenomenon, especially in the Limpopo Province, where it has been installed on new irrigation development or in irrigation areas that were revitalised since about 2004. Although modern irrigation technologies have the potential to improve water use efficiency of small-scale irrigation farmers, often the level of farm management and external support required can be difficult to sustain over the long term. Ninety two percent of the irrigation extension workers responsible for serving farmers involved with flood and furrow irrigation methods do not have any special training in either crop production or irrigation management.

4.2.9 Perceived competence in irrigation water management by extension workers

Because of the impracticability of obtaining reasonably objective indications of extensionists' competence within the limited timeframe allocated for this part of the study, the only alternative approach was to make use of subjective or perceived assessments using a semantic scale. Figure 4.5 shows the competency assessment of extensionists with regard to irrigation water management using a 10-point semantic scale (where 1= extremely incompetent and 10= highly competent).

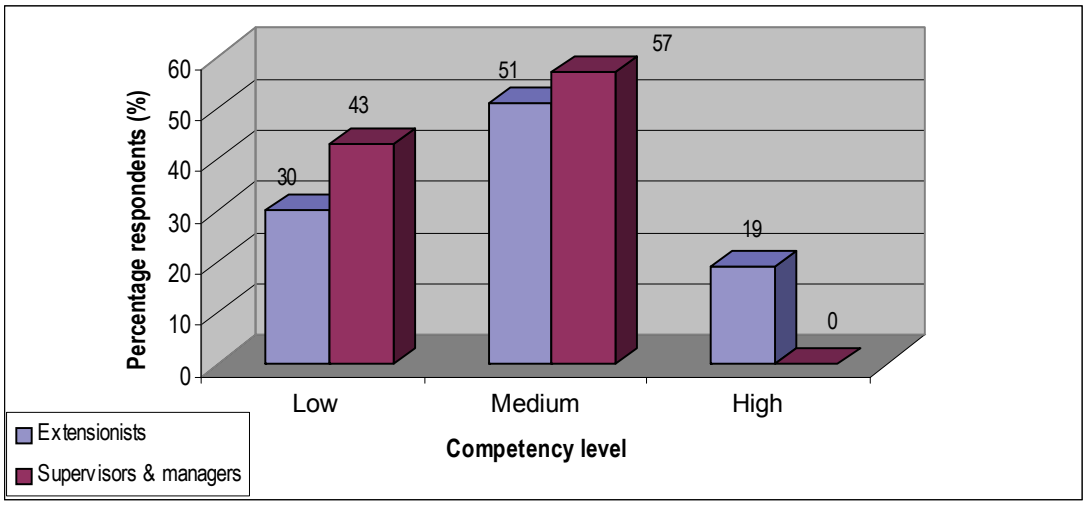


10 point semantic scale for competency in irrigation management with Low level = 1-3 scale points; medium level=4-6 scale points; High level = 7-10 scale points

Figure 4.5. Percentage distribution of extensionists according to their own competency assessments on irrigation management using a 10-point semantic scale (N=109)

This assessment of the competence of extensionists in irrigation water management indicates that 83 % of the respondents perceive themselves to be competent enough to be able to render effective support to irrigation farmers. Only 17% perceive themselves inadequate in terms of skills and knowledge regarding irrigation management. This confirms the general observation by the project team in the field, namely that many of the irrigation extension workers perhaps over estimate their current level of competence in irrigation management. Often it needs someone from "outside" to make a group aware of their current status of knowledge and skills, and through such an intervention the necessary aspiration and felt need for additional learning could be created.

The comparison between assessments of competence in irrigation management by frontline irrigation extension workers and by managers and/or supervisors in extension revealed that clear differences exist between these two groups (Figure 4.6).



10 point semantic scale for competency in irrigation management with low competency level: 1-3 scale points; medium competency level: 4-6 scale points and high competency level: 7-10 scale points

Figure 4.6. The percentage distribution of respondents according to their function and own competency assessment (N=109)

It is clear from Figure 4.6 that a tendency exists that frontline irrigation extension workers rate their own technical competency in irrigation management higher than which managers and supervisors rate their own competency, although no significant statistical evidence was found.

4.2.10 Formal and non-formal training of extensionists

Probably the factor that contributes the most to the competence of the irrigation extensionist is his knowledge and skills in both the disciplines of agriculture and extension. While there are opportunities for training and development, there is a requirement to better appreciate who the extension practitioners are, their skills and competencies, professional environment, performance and specific expectations of the clients and the employers. The distinctions between formal, informal, and non-formal training are only meaningful drawn in relation to a particular context and situation (Conner, 2004). For more on the clarity on the discussion that will follow, it is essential to differentiate between formal, non-formal training, informal training, intentionally and accidentally learning.

- **Formal learning** includes the hierarchically structured school system that runs from primary school through the university and organized school-like programs created in business for technical and professional training.
- **Non-formal learning** we define as any organized educational activity outside the established formal educational and training system whether operating separately or as an important feature of some broader activity intended to serve identifiable learning objectives.
- **Informal learning** describes a lifelong process whereby individuals acquire attitudes, values, skills and knowledge from daily experience and the educative influences and resources in his or her environment, from family, neighbours, the market place and mass media.
- **Intentional learning** is the process whereby an individual aims to learn something and goes about achieving that objective.
- **Accidental learning** happens when in everyday activities an individual learns something that he or she had not intended or expected.

Despite the differentiation between the various ways of learning, there is a range of important questions concerning training of extension practitioners that need to be answered:

- Who are these extension practitioners, and by who are they employed?
- What roles do they perform?
- What training and professional development is available?
- What training and competencies do they currently have?
- What competencies should they have?
- How are these skills and competencies recognised?
- What is the availability of this resource?

a. Formal training of extensionists in irrigation water management

For discussion purposes reference is made to formal training as any training that was received from universities, technicons (universities of technology) and agricultural colleges. Extension workers received the following formal training in irrigation water management, mainly offered on a full time basis, where students have to master all aspects of a prescribed curriculum.

Table 4.10. Percentage distribution of extension workers regarding formal training received in irrigation management (N=109)

Formal training categories	n	%
None	51	46
Agricultural Diploma	45	41
B Tech	6	6
B Agric / BSc Agric	7	7
Total	**109**	**100**

Table 4.10 shows that 46% of the respondents received no formal training in irrigation management, while 54% indicated formal training received in irrigation management on a diploma or degree level. This is a “rather poor show” if it is considered that South Africa is a water-scarce country, and that water resources used in irrigation should be used “wisely” and as efficiently as possible to ensure that wastage is reduced to an absolute minimum.

b. Non- formal training of extensionists in irrigation water management

Training applicable to irrigation management as mentioned above can either be formal, in-formal or non-formal. Non-formal education can contribute significantly to the development of quality staff, as it can train extension workers in a short time, is usually relative cheap and can be aimed at the needs of the specific group, e.g. irrigation extension workers.

Short courses do have an appropriate place in agricultural training, as part of the non-formal training outside the classroom or educational environment. When properly designed they can serve to augment the trained technical knowledge and skills of extension workers. The short courses can also introduce new techniques and skills to extensionists who already have a background to irrigation management and crop production under irrigation. Respondents were asked to indicate their attendance of short courses, training providers, themes of the training and the time lapse since the last training. Table 4.11 indicates the frequency distribution of respondents that have attended short courses in irrigation management.

Table 4.11. Percentage distribution of extension workers that attended short courses in irrigation management (N=109)

Short courses as source of knowledge support	n	%
Yes	31	28.5
No	77	71
No response	1	0.5
Total	**109**	**100**

Only 29% of the respondents have attended short courses in irrigation management that were offered. The respondents that have attended these courses consist of 53% female extension officers and 25% male extension officers. Thirty three percent of the extension supervisors /managers interviewed also attended some of the courses offered. There is also a tendency that extension officers involved with more sophisticated irrigation systems (36%) like sprinkler, centre pivot and floppy irrigation systems are more exposed to short courses in irrigation management than those involved in furrow irrigation (16%).

c. Training providers responsible for offering short courses in irrigation water management

Short courses can be provided by a number of different training providers. An assessment of organisations responsible for offering these short courses in irrigation management was made by asking respondents to name the organisation or trainer that offered the specific training in irrigation management as received. The findings are summarised in Figure 4.7.

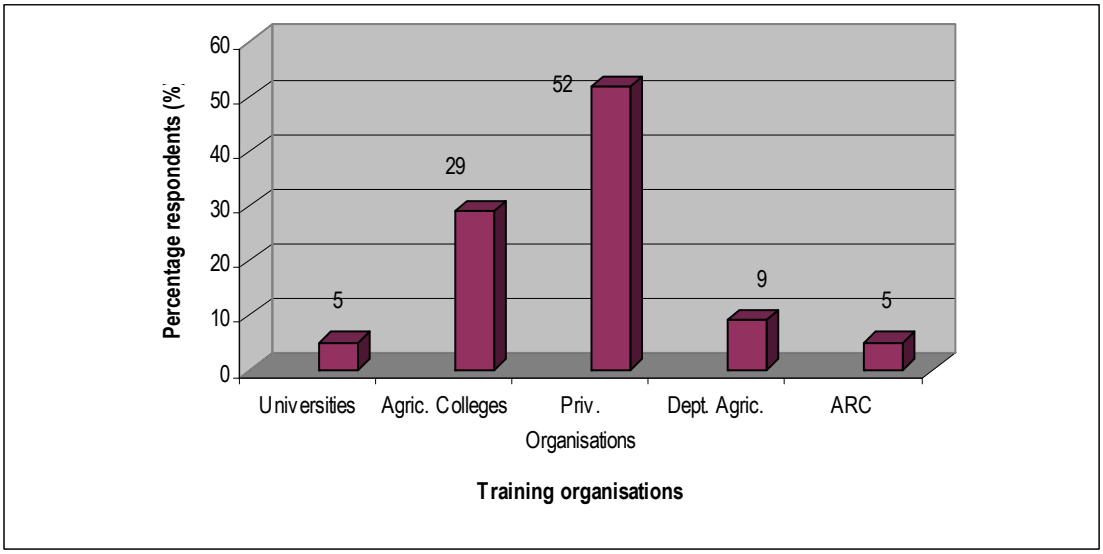


Figure 4.7. Percentage distribution of the organisations that offered short courses in irrigation management (N=31)

Figure 4.7 illustrates the major training providers of short courses in irrigation water management. Private organisations (52%) and agricultural colleges (29%) are the main role players in this regard in the various provinces. Table 4.12 provides a more detail picture of the training providers of informal training in the different provinces.

Table 4.12. Training providers as per province responsible for the offering of short courses in irrigation water management (N=31)

Province	Universities	Agric. colleges	Private organisations	ARC	Provincial Dept. of Agric.
Eastern Cape	Fort Hare	Fort Cox	Siyakholwa NGO Tshidiza NGO		
Northwest	University of Pretoria University of Northwest	Potchefstroom college Taung Agricultural College	SA Malsters	Small Grain Centre	
KwaZulu-Natal	University of Pretoria University of Free State	Cedara Agricultural college	Netafim Mzala/LUA		
Limpopo	University of Limpopo	Madzivhandila Tompi Seleka	GTZ LTGA ARDC (Veeplaats)	Inst. Agric. Eng (AIE)	Limpopo Dept of Agric (LDA)
Mpumalanga		Lowveld	Netafim Agrofert Irricon SASRI TSB	AIE	Mpumalanga Dept of Agric (MDA)

In Mpumalanga especially the sugar industry (South African Sugar Research Institute (SASRI) and Transvaal Suiker Beperk (TSB)) but also other mentioned private organisations viz. Agrofert, Irricon and Netafim play an important role to help extensionists in the support of technical knowledge and skills on irrigation management through appropriate training. Of great concern is the relative small role that universities, Department of Agriculture and research institutes play in the offering of non-formal training, although these institutions are generally recognised to be the hub of knowledge, which exists over subject matter specialists, appropriate infrastructure, and research and study facilities.

Content is a very important factor influencing learner participation in learning activities. If information or training is not seen as relevant and applicable learners are unlikely to use or access it. Table 4.13 provides an overview of the content of the training and information provided at the training courses attended.

Table 4.13. Frequency of the subject matter content of short courses offered in the different provinces (N=31)

Province	Subject matter content	n	%
Eastern Cape	Irrigation management and principles Crop production principles	4	13
Northwest	Irrigation management and scheduling	1	3
KwaZulu-Natal	Irrigation management Irrigation scheduling	5	16
Limpopo	Irrigation methods and maintenance of irrigation systems Irrigation management Tomato production under irrigation RESIS program	8	26
Mpumalanga	Nutrient monitoring and irrigation management Irrigation scheduling Irrigation methods and maintenance of irrigation systems Sugarcane production	13	42
Total		**31**	**100**

4.2.11 Assessment of irrigation knowledge profile by irrigation extensionists

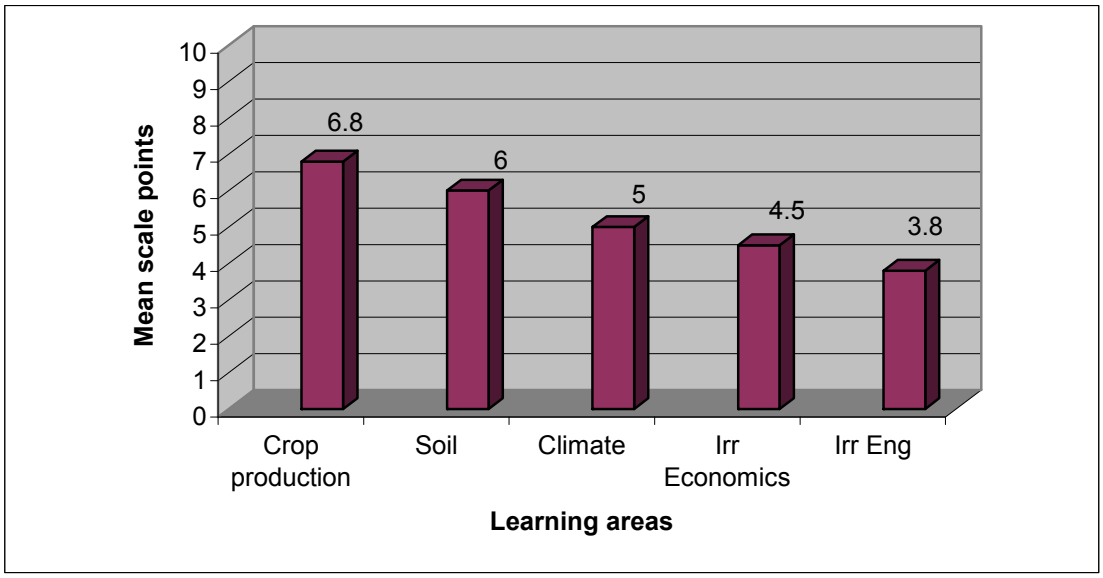
Extension is the line function of the Department of Agriculture and therefore has the purpose of providing appropriate knowledge for irrigation farmers towards improved, sustainable irrigation practices. However to be able to help farmers with the necessary information on irrigation management, a certain minimum technical knowledge of irrigation management aspects is needed.

The mean knowledge assessment of extension workers by themselves using a 10-point semantic scale (where 1 = extremely low knowledge level and 10= extremely high knowledge level) was used with regard to the following fields of irrigation management:

- Crop production or agronomy aspects (crop growth and crop water requirements, sensitivity of different crops, general crop management)
- Soil (cultivation practices, physical and chemical characteristics of soil, irrigation potential, water holding capacity, etc.) and topography of the farm

- Use of agro climate data (ETo, evaporation figures, rainfall, temperature, humidity, etc.) in crop production
- Irrigation economics (drafting and interpretation of enterprise budgets, compiling and preparing of business plan for irrigation farming, calculating and interpreting of irrigation operational costs, etc.)
- Irrigation engineering (maintenance of irrigation systems, delivery rate of water sources, monitoring of system efficiency, etc.)

The results of this assessment by extension officers of their knowledge level are illustrated in Figure 4.8.



10 point semantic scale for competency in various learning areas applicable for irrigation management with low competency level: 1-3 scale points; medium competency level: 4-6 scale points; and high competency level: 7-10 scale points

Figure 4.8. The mean knowledge assessment of extension workers by themselves of the different learning areas in irrigation management using a 10-point semantic scale (N=109)

The knowledge levels of extension officers as assessed by themselves with regard to crop production, soil science and agro climate are perceived to be adequate (with a mean score of 5 points and above). However it is also clear that with regard to irrigation economics and irrigation engineering, extension officers perceive their knowledge level to be inadequate, and therefore an indication of realisation among respondents that they require more knowledge.

Perhaps this is a modest indication and not necessarily a realistic indication of the shortfall of the knowledge required, and emphasise the need for an appropriate knowledge support system. The need for this knowledge support lies first of all in an understanding that the curricula that is offered to the majority of extensionists at agricultural colleges, focus to train students in general agricultural aspects which include crop and soil production aspects. However, with regard to irrigation engineering, irrigation economics and climate, more specialised training and knowledge is often needed. Therefore, the need for maximum knowledge support by specialists with regard to these three learning areas lies in the impossibility of the individual dealing on a specialist level with a wide variety of commodities or enterprises in a unique agro-ecological environment and socio-economic situation.

4.2.12 Perceived competence on rendering of extension support

The methods and strategies used in the delivering of extension are dependent on the understanding of extension and its underlying goals. Extension for some is a form of education being primarily pro-active in nature and focusing on future problems that the client may encounter, while for others extension is similar to that of an advice-giving nature. In its extreme form only the advice requested is given and consequently is usually of a recipe nature.

The irrigation extensionists that are responsible for agricultural development among small-scale farmers are fitting the educational approach of extension where the mobilisation of farmer groups, leadership development, needs assessment among clients and planning of communication strategies are some of the important functions and activities to be undertaken. The respondents assessed their ability and competence with regard to the following aspects of institutionalising and extension support:

- Group mobilisation: the mobilisation of farmers to organise themselves into farmer organisations and study groups was found to have positive effects on the adoption of new practices, since farmers do not operate in a vacuum but are influenced by values and perceptions of fellow farmers [12)].
- Need assessment: The needs of farmers include concepts like drives, motives, incentives and goals. It is important to determine the needs of irrigation farmers as this helps to explain the adoption-behaviour of farmers and to make sure those new recommended practices fits the farming style of the individual farmer.
- Leadership development: the desirables expected by a group rarely occur spontaneously and need to be encouraged through sensitive and responsible leadership, which often need to be developed.
- Planning of communication strategy: the extensionists play an important role in the planning of effective communication strategies between the farmer, research and extension. They play an important role in helping farmers to develop farmer networks as means for accessing information that is perhaps not readily available.
- Monitoring and evaluation of farmer group efficiency and the role that extension plays in the development of agricultural in the specific area. Periodically a farmer group needs to stop to examine how well it is functioning and how the effectiveness can be improved. Extensionist should have the necessary competency to play an important role with regard to these exercises.

The mean rating of the competency and knowledge level of extensionists on institutionalising and extension aspects are summarised in Figure 4.9.

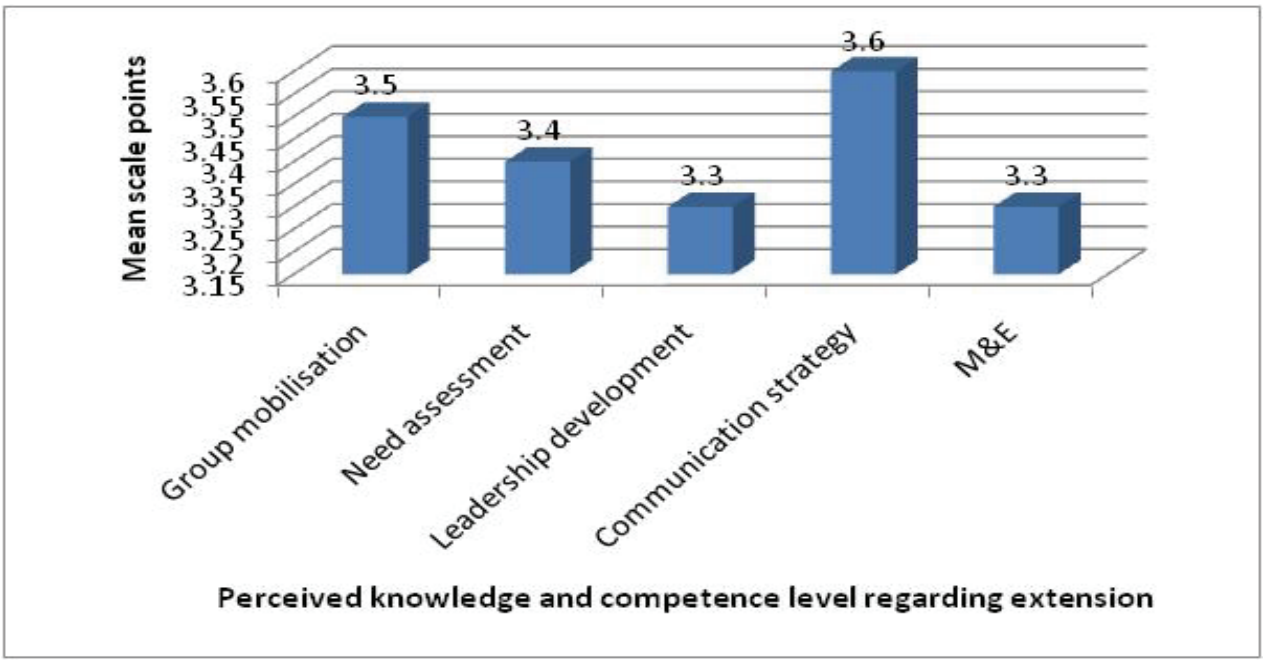


Figure 4.9. Perceived competence and knowledge level of irrigation extensionists regarding rendering of extension support (N=109)

The above findings illustrate that the respondents in general were satisfied with their ability and competence level regarding the rendering of extension support to irrigation farmers.

4.2.13 Sources of information and learning to support extensionists

Learning about irrigation management and extension almost always involve multiple learning sources, and training is rarely the only learning source used. There is an increasing recognition that in order to understand information seeking, we need to understand the context in which it takes place and which factors to some extent shape it (Chang & Lee, 2000; Cool, 2001; Solomon, 2002). Information seeking in it broader context is often termed “information behaviour”, which is defined by Wilson (1999) to include the activities a person engage in when identifying his or her own needs for information, searching for such information and using that information for decision-making.

Information support can be provided by a number of different sources. An assessment of the sources generally used by extension workers with regard to irrigation management was made by requesting respondents to identify and prioritise the potential contribution of different information sources regularly consulted.

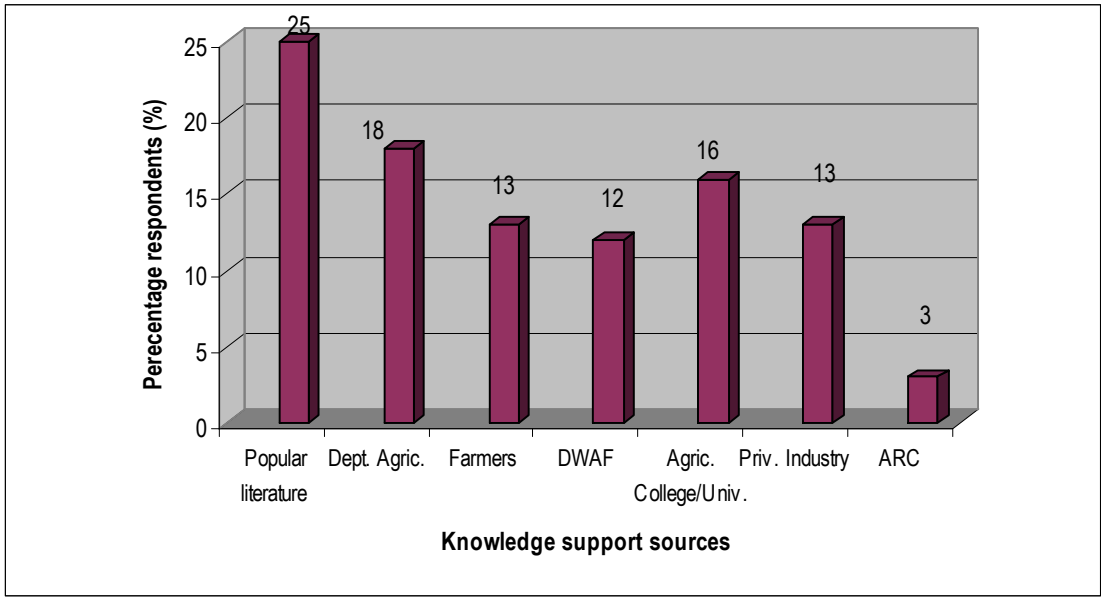


Figure 4.10. The perceived knowledge support provided by different sources and expressed as percentage distribution (N=109)

Extension practitioners rely much on the popular articles of magazines like Farmers Weekly and Nufarmer (25%) as well as on subject matter specialists of the Department of Agriculture, Forestry and Fisheries (DAFF) in the respective province (18%). The role of agricultural colleges like Fort Cox in the Eastern Cape, Lowveld in Mpumalanga and Tompi Seleka in Limpopo were mentioned, while ARDRI Research Institute at the University of Fort Hare and ARDC (Veeplaats) in the Limpopo also played an important role in the support of information on irrigation management. However, the role that Fort Cox plays in terms of the provision of information is mainly provision of infrastructure for training offered by government officials as well as non-governmental organisations like Siyakholwa Development Agent.

In provinces like Limpopo and KwaZulu-Natal, the role of Department of Water Affairs (DWA) and the traditional council were highlighted, since there is a tendency that for many of extension officers employed in these two provinces, their supportive role to irrigation farmers is perceived to entail aspects concerning water distribution and delivery to a specific irrigation block and field. They do not perceive their role to include support to farmers with regard to irrigation scheduling and irrigation management decisions taken at field level.

Private organisations like the South African Sugar Research Institute (SASRI), Transvaal Suiker Beperk (TSB), Siyakholwa Development Agent and SA Malsters (SAM) are playing an important role, especially with regard to the specific commodities they serve. Disappointing is the relative minor role that the ARC plays in the various provinces providing information to extension officers with regard to irrigation management.

4.2.14 Training needs of extensionists

Learning is an ‘economic tool” that works through social means, where new attitudes and values are essential ingredients (Burns, 1995). Learning can create new identities for individual learners, empowering them in a social as well as economic sense. The other side of the coin is that those who are not actively participating in learning throughout their lives are missing out. They are at risk not to keep pace with the changes of the

agriculture sector in South Africa. Extensionists are at the coalface of learning in the industry. They are uniquely placed to be a channel between the vast and complex mountain of information and ways of working that may be useful for the irrigation farmer (Burns, 1995).

Every adult learner is different and unique. Needs, perceptions and knowledge are very important determinants that influence the learning behaviour of people. Adults are motivated to learn in order to solve a problem or take advantage of an opportunity, or some event in their lives. Therefore, adults learning need to be meaningful and relevant. This part of the study determined the perception of their training needs and most appropriate method to acquaint themselves with the necessary knowledge and practical skills in irrigation management.

Burton and Merril (1977), as quoted by Van Dyk *et al*. (1998), defines a need as a "discrepancy or gap between the way things are and the way things ought to be". Nadler (1982) as quoted by Van Dyk *et al*. (1998), defines a need as the 'difference between a goal (and what was expected) and what actually exists." Van Dyk *et al.* (1998) differentiate between three levels of training needs:

- Macro level needs: These are the needs which have to address national and or even international issues and are usually driven by national and international political, economic and social perspectives.
- Meso-level needs: These are needs of a specific organisation, group of employees in a particular occupation, or members of a specific population group. These needs have to do with those factors that are necessary for the organisation as a whole to survive or to deliver its mandate.
- Micro-level needs: These are needs of an individual employee or a small group of employees. These needs are determined by comparing the individual employee's performance with the stated performance norms and standards for the job.

The needs that were expressed by extensionists mainly belong to the category meso-level needs as described by Van Dyk *et al*. (1998)). Training is among the most important factors that can contribute towards the improvement of extension workers' competence, which is potentially the most important component contributing to their credibility. Therefore through determining first of all the felt training needs (needs perceived by the individual as important to him/her) with regard to irrigation management and extensionists' preferred training method (formal, non-formal or self-directed and. informal) will ensure appropriate and adapted training programs. The following training needs with regard to irrigation management were identified and is summarised in Table 4.14.

Respondents perceive very strong felt training needs with regard to various aspects on irrigation management (34%) and irrigation engineering aspects (39%) in order to equip them with the necessary credibility to serve small-scale irrigation farmers. Several respondents from the Limpopo indicated a critical need to be trained with regard to the management and maintenance of the floppy irrigation system installed on small scale irrigation schemes in the province

A likely explanation for the relative low perceived level of need expressed for training on aspects of agro-climate can either be because of a lack of awareness of the importance of this learning area in irrigation management or lack of experience in the use of climate data. Three percent of the respondents indicated training on macro level needs like the legislation pertaining to agriculture with specific reference to the National Water Act (No 36, 1998).

Table 4.14. Percentage distribution of identified training needs of respondents with regard to irrigation management (N=109)

Training need	Number of respondents (n)	Percentage (%)
1.*Soil science:* classification, preparation, soil physics	7	6
2.*Irrigation management*: irrigation scheduling, different irrigation methods, water quality	37	34
3. *Irrigation engineering:* irrigation system management and maintenance, pumps, design and planning of irrigation systems	43	39
4.*Crop production/horticulture*:fertilisation, cultivation, crop factors, diseases and pests, crop rotation	12	11
5. Agro *Climatology:* (in general)	8	7
6. *Irrigation economics*: marketing; agricultural management: financial management, labour management	18	17
7. Agricultural policy and legislation	3	3

4.2.15 Perceived preferences with regard to learning

A closer analysis of the preferences with regard to the selection of learning methods is required. It is important to know and take cognisance of the preferences of learning expressed by extension practitioners for the development and planning of future learning opportunities. Adults are assumed to be voluntary learners, autonomous, independent and self-directed. "The highest professional and moral principle for adult educators is to involve learners in identifying of their needs" (Cervero & Wilson, 1999).

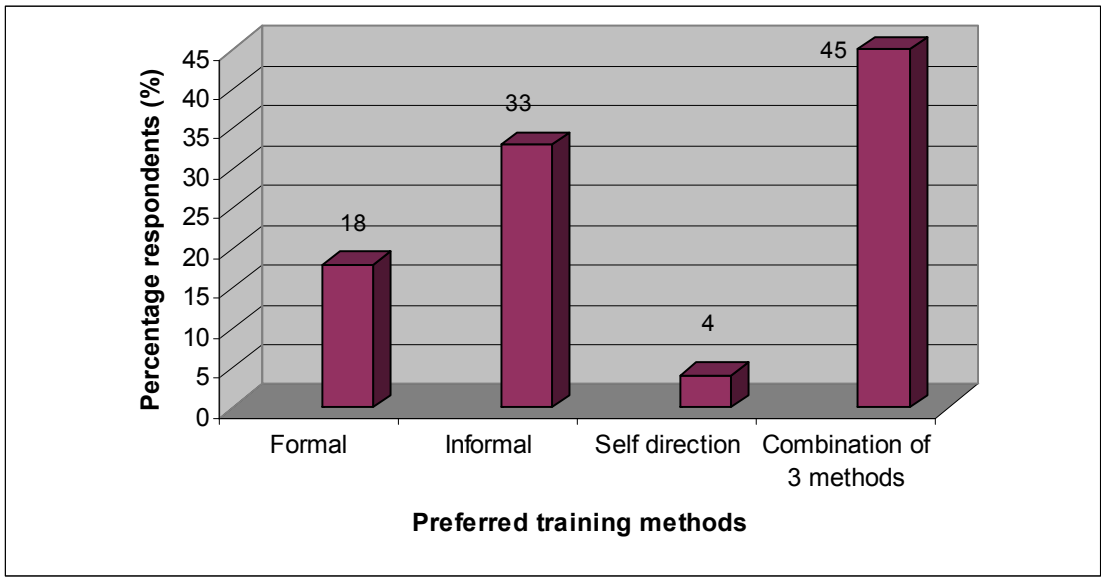


Figure 4.11. Percentage distribution of respondents' perceived preferences regarding training methods (N=109)

According to Blum (1996), self-directed learners are "responsible owners and managers of their own learning process". Such individuals have the skills to access and process the information they need for a specific purpose. Self-directed learning integrates self-management (management of the context, including social setting, resources, and actions) with self-monitoring (the process whereby learners monitor, evaluate, and regulate their cognitive learning strategies). The research indicates that being a self-directed learner is a trait or disposition a person should develop, and only 4 % respondents prefer self-directed learning in irrigation management. The majority of respondents prefer a combination of the three training methods namely: formal training in a classroom environment plus non-formal training outside the classroom where experiential learning and demonstrations form a major part of training plus self-directed learning or often referred to as in-formal training in the comfort of their home and with their family.

5. OVERVIEW OF EDUCATIONAL AND TRAINING PROGRAMS IN IRRIGATION WATER MANAGEMENT FOR LEARNERS IN AGRICULTURE

The agricultural extensionists serving irrigation farming areas should be able to analyse, plan and advise on most of the agricultural aspects of farming with crops under irrigation. In this regard Gulhati & Smith (1967) states that: "*For productive and permanent irrigated agriculture, attention must be given not only to providing water supply, irrigating efficiently, and draining land as necessary, but also to following sound soil management practices, selecting productive crop varieties, and utilizing all beneficial cultural practices. The history of irrigation clearly points to the need for giving greater attention to the agricultural phases of irrigation*". In the light of this statement, it is a prerequisite that agricultural extensionists should have a good theoretical background and "working knowledge" of soil science, agricultural meteorology, agronomy or horticulture or viticulture, irrigation management, irrigation engineering principles, irrigation economic principles, broad perspective on agricultural law and a deep knowledge of extension. Apart from the fact that it is necessary to gain deep knowledge of disciplines like agronomy, soil, irrigation management and extension, there is also a need to incorporate into it holistic concepts of irrigation engineering, economics, and agricultural law to be able serve the irrigation farmer (Stevens, 2007; Stevens, 2008).

An irrigation extensionist is expected to have a *multidisciplinary* background, and this part of the baseline report reflects on the educational programs and curricula offered by tertiary training organisations in South Africa (universities, agricultural colleges, technikons/universities of technology) and private training organizations during 2005. This assessment was used to identify possible shortcomings that exist regarding the training needs as been perceived by the extension officers. Current training curricula used for the training of extensionists in irrigation management by tertiary organisations on diploma (NQF 5) level and degree (NQF 6) level were assessed as well as training programs offered by private training organisations in South Africa (Stevens,2007).

At agricultural college and technikon/university of technology level a three-year national diploma in agriculture and related disciplines at tertiary level is offered. Courses usually consist of two years formal training (Higher Certificate in Agriculture) followed by one year of structured experiential training at an approved employer (National Diploma in Agriculture). Prospective farmers, extension officers, animal health and engineering technicians are trained at the colleges of agriculture of the various Provincial Departments of Agriculture and the National Department of Agriculture, Forestry and Fisheries. Practical training takes up about half the student's time. The balance is devoted to lectures and demonstrations. Apart from agricultural and related scientific subjects, attention is also paid to training in farm economics and management. In addition to the diploma course, short courses are also offered by colleges and technicons/universities of technology. All training at colleges of

agriculture and universities should fulfill the minimum quality standards set by the Higher Education Quality Committee (HEQC). Any higher education organization offering training programs in South Africa should fulfill the minimum criteria for program accreditation along with the additional benchmarks which an organization might set for itself. The HEQC uses the criteria, a self-evaluation report and supporting evidence provided by the organization , in the evaluation of applications for program accreditation (new programs) or re-accreditation (existing programs). This means that training at all colleges of agriculture attain the same status and formal recognition as training at technikons.

Several universities in the country have faculties, departments or schools of agriculture, *viz*. Fort Hare, KwaZulu-Natal, Northwest, Free State, Pretoria, Stellenbosch, Venda, Zululand and Limpopo. The duration of a BSc (Agric.) course is four years while that of a B Agric course is three years. Using data from 2004 (the latest available) Table 5.1 provides an indication of graduates and skills opportunities the agricultural training system is able to supply (AgriSETA, 2006).

Table 5.1. Organisations offering agricultural training in South Africa (2004) (AgriSETA, 2006)

Offering agricultural training	Enrolment 2004	Graduates 2004	Issues/comments around performances
Universities (8 organisations)	5300	900	Universities have the capacity to meet the demand for higher education within the agriculture sector, although a need exists to re-direct students into study fields that will address scarce and critical skills experienced within the industry.
Universities of Technology (6 organisations)	2763	783	Are able to address the upstream and downstream skills need of the sector and are responsive to the requirements of the industry – offering an increase range of specialization. Concern regarding the quality output (especially from certain organizations) and the ability of students to be assimilated into a workplace without the need for substantial in-service training.
Agricultural colleges (11 organisations)	1500	668	All qualifications offered are registered on NQF. However only 25% of the colleges evaluated in 2004 were awarded full accreditation. The main reasons for this situation was: • Offering of programs that do not fully address the skills shortages in the sector (e.g. the need for science, engineering and technology) • Provide too little or no practical or workplace training • Employ under-qualified staff • Experience severe budget constraints
Accredited training providers serving the agricultural sector (120 registered on AgriSETA database) Capacity of 25 000 learners p.a.			Majority is small enterprises (5-10 employees) and thus makes extensive use of contracted instructors/facilitators for larger and more specialized training interventions. The majority are geared towards rendering services framing enterprises and focus mainly on lower NQF levels.

Table 5.1 portrays clear concern regarding the level of agricultural training, especially at college level.
The information that follow mainly reflect the current *status quo* with regard to formal education and training organisations as collected from ten South African universities, twelve agricultural colleges associated with the various Provincial Departments of Agriculture and five technikons or universities of technology.

Apart from the formal training offered by tertiary organisations, various private and parastatal training organisations are involved in presenting short courses to extension workers and farmers. A brief overview of some of these short courses is portrayed.

5.1 Research methodology

This evaluation of training curricula offered to students in irrigation management is the result of mainly a consultative process where various academic staff, officials from various departments and private training institutions participated. The study entailed a comprehensive desktop study of existing courses and training programs offered to students at various training institutions through the studying of recent yearbooks and prospectus. However, since all information of the various tertiary institutions was not electronically available, the survey also included the use of electronic (e-mail) and telephonic interviews as well as face-to- face interview with key informants. The interviews with academic staff and trainers helped the team to identify various training methods and approaches used as well as to clarify the content of courses where necessary.

The information on training curricula offered mainly reflects the eight learning areas as been identified through the consultation with extensionist, various stakeholders and academia. The eight learning areas are as follow:

- Crop production
- Soil science
- Agro climatology
- Irrigation water management
- Irrigation engineering
- Irrigation economics
- Legal aspects of irrigation
- Agricultural Extension

5.2 Tertiary training in irrigation management

5.2.1 Universities

University	Overview of training curricula presented in irrigation management
University of the Free State	• Comprehensive irrigation water management training that includes courses related to soil science, agronomy, agro-meteorology and irrigation engineering on NQF level 6. Two study programs are offered, namely a B Agric course (Specialisation in Irrigation Management) and a BSc Agric program (Specialisation in Irrigation Science and Agronomy). • The first program does not enable the student to post graduate studies in this field of study, while the second program can lead to master or doctorate in irrigation management. • Various tailor made short courses available to the industry on request .

University	Overview of training curricula presented in irrigation management
University of Fort Hare	• Two study programs are offered, namely B Agric and BSc Agric programs. Irrigation management is offered as part of courses offered in the Crop Science on NQF level 6. • B Agric program includes courses like Elements of Agricultural Meteorology and *Elementary Irrigation*. • BSc Agric program includes courses on *Principles in irrigation management and Water Relations.*
University of Stellenbosch	• The BSc Agric program covers training in the production of agricultural crops, pasture crops, vegetable crops, deciduous fruit, citrus and vines. For each crop, various subjects, such as crop production, biochemistry, soil science, *agricultural water science*, agricultural economics, genetics, entomology, nematology, plant pathology and biometry, are integrated into a meaningful whole. • There are three fields of study within the undergraduate program, namely Crop Production, Crop Protection and Breeding, and Soil and Water Management. o Crop Production: emphasis falls on the training of crop production managers for, amongst others, agronomy, deciduous fruit, citrus and vines. This program includes subjects in agronomy, horticulture, viticulture, soil science and agricultural economy. o Crop Protection and Breeding students are trained to become specialists in crop protection (the control of entomological and nematological pests and plant diseases) and genetic crop improvement. o Soil and Water Management students are trained to become specialists who understand the nature, importance and management of soil and water in crop production. This program includes courses in agronomy, crop protection, horticulture, viticulture, and soil and water management. *The course in soil and water management is comprehensive and attends to the main aspects of irrigation management*. o Various tailor-made short courses on offer to the industry on request.
University of KwaZulu-Natal	• Undergraduate and post graduate programs in Agribusiness, Crop Science and Horticulture. The four year BSc Agric programs are found in Agric Economics, Agribusiness (Crop Science and Horticulture), Plant Production and Soil Science. In addition to the BSc Agric program a three year B Agric and B Agric Management are offered. • As part of the B Agric (Agric/Rur Dev stream) and BSc Agric (Plant Science the course *Irrigation design and management* is included. This together with courses in crop production, resource assessment, agricultural policy analysis and agricultural economy courses offers comprehensive training to students.
University of Zululand	The Department offers undergraduate qualifications: • BSc Agriculture (Agronomy) • BSc Agriculture (Animal Production) • BSc Agriculture (Economics – Agribusiness Management) The Department also offers postgraduate studies in agronomy, and the program includes: • Biometery • Plant production • Crop Physiology • Soil fertility • Crop production • Horticulture Science • *Irrigation and water management* • Weed control • Plant Propagation

University	Overview of training curricula presented in irrigation management
University of Limpopo	• The Faculty of Agriculture offers undergraduate and postgraduate training in Agricultural Economics, Animal Production, Plant Production and Soil Science. Degree programs include a three-year Bachelor of Agricultural Management and a four-year Bachelor of Science in Agriculture. • A four-year BSc program in Plant Production, Animal Production, Agricultural Economics, Horticulture, Pasture Science or Soil Science is offered to undergraduate students while a three-year Bachelor of Agric Management (B Agric Admin.) with major courses Plant Production, Animal Production and Agricultural Economics is also offered. Postgraduate students can enroll for honours and masters in B Agric Management. Students can also enroll for master degree programs in the following disciplines: Agricultural Economics, Animal production, Horticulture, Crop Science, Pasture Science, Plant protection, Soil Science, Remote sensing, and Agricultural Extension. • Agricultural Extension is offered to undergraduate students as part of the courses followed to complete a BSc Agric degree program in Agric Economics, Animal Production, Plant Production and Soil Science. A taught master's degree is offered in Agricultural Extension. • Soil science, agriculture economics, crop production, farm management and cropping systems are some of the courses offered in the B Agric program. *Soil, plant water relationships and irrigation management* are inclusive to the BSc Agric Plant Production and Soil Science programs.
University of Venda	• The School of Agriculture, Rural Development and Forestry of the University of Venda for Science and Technology offers three-year B Agric and four-year BSc Agric. degrees programs. • The three-year B Agric program offers majors in general Agriculture, Family Ecology and Consumer Science and Agribusiness Management. • The four-year BSc program offers majors in Agricultural Animal Science, Crop Science, Horticultural Sciences, Food Science and Technology, Forestry Science and Soil Science. • In addition, there is postgraduate Diploma in Agricultural and Rural Engineering, as well as a host of postgraduate programs in the above disciplines and Rural Development.
University of Pretoria	• The University of Pretoria offers various four year programs in agriculture namely BSc Agric and B Inst Agrar in Plant Production, Soil Science, Plant Protection, Rural Development Management, Land Use Planning, Horticulture and Agriculture Engineering. • Courses in agronomy, farm management, financial accounting, agricultural economics, communication, *soil water and irrigation management*, soil science are included in both the BSc Plant Production as well the B Inst Agrar Plant Production programs. • Various tailor made short courses available to the industry on request.
UNISA (University of South Africa)	• After the amalgamation with Technicon South Africa the Department of Agriculture, Animal Health and Human Ecology at UNISA offers various programs in agriculture on both a diploma and degree level. • The National Diploma in Agricultural Management program comprises courses in soil science, plant production, soil classification, pasture science, agricultural law and agricultural engineering. • The BSc(Agricultural Science) program offers a combination of theoretical and practical training over a period of three years and comprises courses: Soil science (soil chemistry, soil pedology and classification, soil fertility and plant nutrition); Agricultural meteorology; Bio resource ecology; land use planning; Plant production science (pasture management, vegetable science, weed management, crop physiology, fruit production, plant pests and diseases, food and fodder crops) ;Production economics and financial management (agricultural marketing, financial analysis and budgets, developing agricultural production);*Irrigation and water management;* Practical modules in fruit, crop, pasture, weed management and *irrigation management* are also offered to students. • The B Tech Agricultural Management and Bachelor of Science in Agricultural Science include courses in plant production, financial management, soil science, *agricultural engineering (irrigation drainage, irrigation scheduling)* and leadership development.

University	Overview of training curricula presented in irrigation management
University of Northwest	The Faculty of Agriculture, Science and Technology of the University of the North West offers: • A four-year BSc (Crop Science, Animal Science, Agric. Economics, Animal Health and Land Management). The following courses are included in the BSc Crop science program: crop production, soil science, agricultural economics, *elements of irrigation, principles of irrigation,* soil conservation. • A three-year Diploma in Agric (Crop Science or Animal Health) is also offered. The Diploma in Agric comprises the following courses: crop production, soil science, agricultural economics, agricultural extension, farm management and accounting, *elementary irrigation.* • Other programs are the Advanced Diploma in Animal Health, Postgraduate Diploma in Agricultural Economics and Management and the Postgraduate Diploma in Agricultural Extension.

5.2.2 Agricultural colleges

The training curricula of twelve Agricultural Colleges associated with Provincial Departments of Agricultural were assessed regarding the offering of training, especially with regard to the "knowledge profile" of the irrigation extensionist. At NQF 5 level the majority of the agricultural colleges offer training in irrigation management as one or two modules, which usually forms part of the fundamental training provided in crop production. The exception is the Lowveld Agricultural College, where a student can specialise in irrigation management with regard to either agronomy or horticulture. At this College, it was found that a student must successfully complete irrigation management as one of the core courses, before the student will be promoted to the final year of study.

A brief overview of training programs and courses include in the curricula for the twelve agricultural colleges follows:

1. Tsolo Agriculture and Rural Development Institute

Programs
Tsolo Agriculture and Rural Development Institute lost their accreditation with the Higher Education Quality committee (HEQC), and since 2005 no diploma programs were offered. In the past this Institute offered four diplomas, viz. Animal Health and Production, Agriculture, Home Economics, Crop Production and Agricultural Education. The course *Introduction to irrigation management* formed part of the training offered in the diploma program in crop production.

2. Elsenburg College of Agriculture (Cape Institute for Agricultural Training)

Programs
In 1995 Elsenburg and Kromme Rhee colleges of agriculture amalgamated. The amalgamation placed a great responsibility on the Department of Agriculture to continue and expand the training offered, and a Centre for Further Education and Training was created to address the need for short, practical courses for especially farm workers and

developing farmers. The relationship with the University of Stellenbosch has been re-established and since 2004 Elsenburg offers a B. Agric course in association with the University of Stellenbosch's Faculty for Agriculture and Forestry. Since 1 April 2004, Elsenburg College of Agriculture is known as the Cape Institute for Agricultural Training.

Cape Institute for Agricultural Training is offering a three-year B Agric degree since 2004. The qualification is aimed at those who wish to follow a career in farming or in the agricultural sector. The student is equipped with production, technical and management skills. For their B Agric program a course in *agricultural engineering is included which comprises of the following modules: irrigation and drainage as well as scheduling of irrigation.* The aim is to provide the student with enough knowledge to understand and manage irrigation on his/her farm. The curriculum content is based on the SABI Irrigation Design manual, but does not take the student to the designer level.

A two-year Higher Certificate in Agriculture is currently being offered, which can lead to a National Agricultural Diploma. The Diploma in Agriculture Cellar Technology is a specialist program aimed at winemakers and those interested in pursuing a related career in the wine industry. Agricultural engineering (which includes a module on irrigation), agribusiness management, extension, natural resource management, agronomy, pomology, viticulture and *irrigation* forms part of the instructional program during the two-year Higher Certificate training. The National Diploma in Agriculture is offered as modules regarding production, agricultural management, and natural resource management.

3. Taung Agricultural College

Programs
Since 1994 the college is evaluated and accredited by SERTEC, offering a three-year National Diploma in Agriculture. Four different academic departments are responsible for education and training of students in the agricultural field, i.e. Departments of Animal Production, Crop Production, Farm Management and Farm Machinery and Works. The college has its own intensive farm enterprise, which is managed by both lecturing staff and a farm manager, consisting of the following sections: - • Dairy (Frieslands) • Beef cattle (Bonsmara) • Piggery - Poultry (Layers and Broilers) • Small Stock (Dorpers and Boergoats) • Feedlot • Horticulture • Irrigated crop production section (Corsica and pivot) On the Diploma level one of the specialized fields is Crop Production, which includes modules like: fruit production, industrial crop production, vine production and a basic crop production *where students are introduced to irrigation management.* Taung Agriculture College offers agricultural training in the form of a N3 certificate in Agriculture, N4, N5 and N6 certificates in Farming Management.

4. Potchefstroom College of Agriculture

Programs

The Potchefstroom College of Agriculture (Northwest Province) offers the following:
• Higher Certificate in Agriculture: Mixed Farming (two years full-time) which includes courses like crop production, soil science and agricultural engineering
• National Diploma in Agriculture (one year additional experiential training on a farm)
• B.Tech (Agricultural Management) degree is offered in conjunction with Pretoria University of Technology. The curriculum is developed to provide academic and practical training to meet the needs of prospective commercial farmers in the mixed farming areas of the Highveld area of South Africa. The program comprises four main divisions:
  • Animal production (dairying, beef cattle, small stock, pigs and poultry)
  • Plant production (crop production and horticulture) where irrigation is offered as small part of the course.
  • Agricultural management
  • Agricultural engineering
• *Syllabus on the course Agricultural Engineering includes modules on soil conservation, drainage and irrigation.*

5. Cedara Agricultural College

Programs
Cedara College has been undergoing a re-curriculation process, whereby the entire curriculum is being revised. The main aim of this re-curriculation was to realign the theory and practical aspects of the courses more closely. This has also gone together with the development of a more consolidated College farm, where practical work is more accessible. As from 2005 students are exposed to specific skill and experiential training on College Farm. This includes basic work required on any farm through to management of enterprises. The new curriculum is being phased from 2005. It was implemented with first year students in 2005 and will follow with second and third year. Two programs are currently presented at the Cedara College of Agriculture (KwaZulu-Natal Province): • A Higher Certificate in Agriculture. This is a two-year program, in which students get a solid grounding in general agricultural principles and may select to specialise in Animal Production or Crop Production. A Senior Certificate or equivalent is the minimum requirement for admission. This program will be phased out. • A Diploma in Agriculture. This is a three-year course with the Higher Certificate constituting the first two years of study. *In both programs irrigation is offered as a part of a module in Agronomy 1 and Agronomy 2.*

6. Owen Sithole Agricultural College

Programs
The Owen Sithole Agricultural College offers two programs namely: a two-year Higher Certificate or a three-year Diploma in Agriculture; and a two-year Higher Certificate or three-year Diploma in Home Economics and Agriculture. Both programs have been accredited by the Certification Council for Technikon Education (SERTEC) and are recognised nationally. In the agriculture program students have the option to specialise in at least one of three production fields, namely ▪ Crop Production, ▪ Ruminant Production, and ▪ Non-ruminant Production. Courses are offered in a modular format. • Higher Certificate in Crop Production: include courses like crop production, soil science, agricultural engineering, and farm business management (accounting and agricultural economics). • National Diploma in Agriculture (Crop Production): include courses like soil science, farm business management, land use planning, extension, and agronomy. *Irrigation management aspects like sourcing and provision of water, conservation of agricultural resources act, NWA, and irrigation is included as modules in the Agricultural Engineering course.*

7. Tompi Seleka Development Institute

Programs
The College farm of Tompi Seleka Development Institute (Limpopo Province) is 1 470 ha in extent. About 100 ha are under irrigation. Seventy ha are for field crop production and 30 ha are under artificial pastures for the dairy herd. The rest is shared between residential areas, natural pasture camps and wildlife camps. The Tompi Seleka's School of Agricultural Sciences in the past offered Diplomas in Agriculture: Plant Production, Agriculture: Resource Utilisation and Agriculture and Animal Production until 2004. It's School of Food and Textile Sciences offered a National Diploma in Agriculture: Community Extension. Irrigation was offered as a module of the course on crop production. The duration of the programs was three years, which included formal training (four semesters) and two semesters practical training. Since 20042005, after losing its accreditation with HEQC, the College offers skills programs (mainly to small scale farmers) in the production of the following: Vegetable Production, Cotton Production, Sunflower Production, Maize Production, Soil Fertility and Management, Entrepreneurship, Project Management and Food Preservation. *Specific skills program is offered in irrigation management which forms part of the RESIS.*

8. Madzinvhandila Agricultural Training Centre

Programs
A three year Diploma in Agricultural Production course was offered at the College till 2005. All students were required to take more or less the same modules during the 1st – 3rd term. As from the 4th term, each student was required to take specialized courses in any of the qualification programs offered at the college, i.e. Crop Production and Horticulture. This program included courses like production economics, sociology, farm accounting, plant production, soil science, agricultural marketing, human resource management, land use planning, *and irrigation and water management offered in the second year of the program.* Since 2005/2006, after losing its accreditation with HEQC, the Training Centre undergone changes with regards to the mandate from the Limpopo Department of Agriculture. The main changes have been the facing out of the Higher Education Diploma Program, and training was since then aimed at building capacity of previously disadvantaged farmers through short courses and skills programs. The main clientele for training became farmers from poverty alleviation projects, land reform beneficiaries, subsistence farmers, farm workers as well as departmental staff like extension officers. The skills programs entail the following: Participatory Extension Approaches, "train the trainer" programs, small and medium enterprise management, maize Production, soil fertility management, seed production, laboratory services (soil analysis) to farmers. *Specific skills program is offered in irrigation management which forms part of the RESIS program.*

9. Lowveld College of Agriculture

Programs
The College specializes in Water Management and two production farming enterprises viz.: Agronomy and Horticulture, specializing in tobacco, cotton, sugar, vegetables, subtropical crop production, citrus and short courses are offered in table grape production. The college offers an integrated course and therefore Farm Management forms an important part of the training program. The compulsive courses are: soil science, water management, basic plant propagation, computer practices, plant protection, botany and agricultural engineering. The duration of the training program is three years of which two years are done in full time study at the college and one year of practical experience through experiential training on a farm. After the successful completion of a two-year study, a higher certificate in Plant Production is awarded and after successful completion of the experiential training year, the student is awarded a Diploma in Plant Production. This diploma entitles a student to later follow a B Tech degree. *Irrigation or water management forms part of the curriculum offered during the first and second semester as indicated (Water Management 1A and 1B). Modules like irrigation systems, hydrodynamics, scheduling chemistry in irrigation, principles in irrigation planning and design and dam safety are included.*

10. Glen Agricultural College

Programs
The Glen Agricultural College offers besides a number of short courses, two formal qualifications namely: • Higher Certificate in Agriculture: The prospective student will after successful completion of two years of studies, qualify for receiving a Higher Certificate, which is approved by HEQC. A prospective student may choose to specialise in one of the following agricultural fields: Agri-business Crop production Animal Production • National Diploma in Agriculture is offered since 1994, and is mainly management orientated. Applicants who hold a two year Higher Certificate or equivalent qualification at any tertiary agricultural institution in South Africa will be considered for the course. The course concentrates on the management of a farming enterprise, the integrating of different subjects and the practical application of accumulated knowledge. Courses in crop production, agricultural engineering, farm management, soil science and agricultural production economics are included in the program. *Irrigation management and irrigation principles are some of the modules that are included in Agricultural Engineering.*

11. Fort Cox Agricultural College

Programs
Fort Cox Agricultural College offers two qualifications in agriculture namely: • The National Diploma in Agriculture offered over a period of three years where students have a choice to select from three learning programs namely: Agribusiness, Animal Production and Crop Production. • Pre-Diploma Certificate offered over a period of one year where students receive the opportunity to upgrade their matric subjects. This program prepares students to eligible for admission to technical programs in various colleges, technikon and universities. The curriculum of the National Diploma in Agriculture (Crop Production)includes courses like soil science, crop production, financial management, production economics, land use planning, soil classification, soil and water conservation, agricultural engineering (2&3), and i*rrigation principles.*

12. Grootfontein Development Institute

Programs
The formal training program offered at the college is a three year full-time program, leading to a Diploma in Agriculture. Provision is made for an exit-level after successful completion of two years of training when a Higher Certificate in Agriculture is awarded. The general aim of the college training program is to provide broadly-based training in the principles, techniques and practical skills of animal production and farm management with special emphasis on the specific needs of the small stock farming sector in the extensive sheep farming areas. The fields of study in the instruction programs include the principles and practices of small stock production, agricultural management, environmental management, and crop production, agricultural engineering practices on the farm and agricultural organisation and agricultural extension. • Higher Certificate in Agriculture: courses include in the training program – agricultural engineering, soil science, agricultural management, and agricultural law studies. • Diploma in Agriculture: courses include in training program – agricultural extension, agricultural management and environmental management. *Irrigation management is included as part of the Crop Production IIB –the following modules are included: The suitability of soil and water irrigation. The different irrigation systems. Crop factors and crop water requirements for scheduling. The principles and practices of sustainable irrigation of saline and alkaline soils.*

5.2.3 Universities of technology and technicons

1. Mangosuthu Technikon**

Programs
Mangosuthu Technikon offers two programs namely a National Diploma: Agriculture, which prepares students with a broad base of theoretical knowledge and practical experience in Animal and Plant Production. The second program is National Diploma in Community Extension will enable graduates to improve the standard of living in rural areas. • National Diploma in Agriculture: courses include agricultural extension, agricultural marketing, soil science, agricultural production management, farm planning and crop production • National Diploma in Community Extension: encompasses courses like extension (with modules: communication, group dynamics and program planning), land use planning, farm management economics, and human ecology. *Although no specific reference is made in the syllabus to a module regarding irrigation management as part of crop production, it is assumed that it will be offered as part of the modules regarding the cultivation of crops like vegetables, fruit and cereals.*

*** The Mongosuthu Technikon's name changed since 2005 to the Mongosuthu University of Technology*

2. Central University of Technology

Programs
The School for Agriculture and Environmental Science offers three programs namely: Environmental Health, Agriculture and Fire Service Technology. The University offers two programs in Agriculture namely, a three year National Diploma: Agricultural Management and a four-year B Tech degree in Agricultural Management. Training encompasses subject disciplines of the human and natural science and specific emphasise management practices of farmers. • National Diploma: Agricultural Management: encompasses courses like agricultural management, agricultural soil science, plant production, agricultural production management, agricultural engineering, and agricultural law. • BTech Agricultural Management: financial management, strategic management, plant production and leadership development. *Irrigation design and planning are modules that are offered as part of the course: Agricultural Engineering.*

3. Worcester Community College

Programs
Worcester Community College offers a National Diploma in Farming Management. The main instructional offerings are: marketing, business, financial management, human resource management, and Farming Management. The period of instruction at the College (full time) is two years with a compulsory period of 18 months' practical work on a farm in order to obtain the National Diploma (NQF Level 5). This program forms part of the programs offered by Cape Peninsula University of Technology (Cape Technicon). *No mention is made of any irrigation management modules as part of this training program.*

4. Cape Peninsula University of Technology (Cape Technicon)

Programs
The Department of Agriculture of the Cape Peninsula University of Technology presents the following programs in Agriculture and Horticulture: • National Diploma in Agriculture and Agricultural Management • B Tech: Agriculture. Agricultural Extension III is required for admission and a pass mark of 60% in the major subjects of the National Diploma is recommended. • National Diploma: Agriculture (Animal Production) or (Crop Production) • National Diploma in Horticulture National Diploma in Agriculture: encompasses courses like agricultural management, agricultural soil science, plant production, soil classification, agricultural law, agricultural engineering. B Tech Agriculture: encompasses courses like agricultural extension, agricultural communication, and crop production. National Diploma: Agriculture (Crop Production): encompasses courses like agricultural economics, agricultural soil science, crop production, soil surveys, agricultural marketing, agronomy, agricultural extension, and agricultural production management. National Diploma: Horticulture: includes courses like horticulture, horticulture management, and environmental studies. *Irrigation principles and design is offered as modules within the courses crop production and horticulture*

5. Tshwane University of Technology

Programs

Tshwane University of Technology presents programs in agriculture, as well as in horticulture, nature conservation and equine studies. The following three-year diploma programs were offered until 2009, after which it were phased out of the training program:

- National Diploma : Agricultural Management
- National Diploma : Agriculture
- National Diploma : Crop Production
- National Diploma : Agriculture Mixed Farming
- National Diploma : Agriculture Rural Development and Extension
- National Diploma : Agriculture
  - Subgroup 1: Crop Production
  - Subgroup 2: Commercial Mixed Farming
  - Subgroup 3: Development and Extension

The following four-year B Tech programs are offered:

- B Tech Agric
  - Subgroup 1: Crop Production
  - Subgroup 2: Development and Extension
- B Tech Agric: Agric Mgt

- National Diplomas in Agriculture: Crop Production, Agricultural Management and Mixed Farming encompass the following courses: agricultural extension, agricultural economics, crop production, soil surveys, agricultural marketing, agricultural engineering, fruit production, crop protection, agricultural production, and vegetable production.

- National Diploma: Development and Extension encompasses courses like extension, agricultural marketing, agronomy, fruit production, and farm planning.

- BTech Agric (Crop production): agricultural communication, crop production, project management, agricultural extension, and agricultural communication.

- BTech Agricultural Management: encompasses courses like financial management, leadership development, strategic management, crop production and animal production.

Irrigation scheduling, soil water relationships, classification of soil water, measurement of water content, infiltration of water movement in soils, evapotranspiration, plant-water relationships are includes as part of one of the modules that is presented in the soil science course. It is also addressed in fruit production and plant production courses.

6. Nelson Mandela Metropolitan University (Port Elizabeth Technicon)

Programs
Nelson Mandela Metropolitan University in Port Elizabeth offers a three-year National Diploma in Agricultural Management, as well as the degree B.Tech: Agricultural Management. The National Diploma: Agricultural Management is a three year qualification of which two years are spent at the NMMU and one year in practice undergoing experiential training. This program encompasses courses like: agricultural management, agricultural soil science, plant production, soil classification, agricultural engineering, agricultural law, and agricultural production management. The B Tech requires an applicable three-year tertiary qualification or equivalent for admission. The Baccalaureus Technologiae: Agricultural Management is offered on a block release basis. It encompasses courses like plant and animal production, leadership development, strategic management and financial management. *Irrigation and land utilization practices are some of the modules offered as part of the course agricultural engineering which forms part of the training curricula for the National Diploma; Agricultural Management.*

The assessment of the education programs offered by the various tertiary organizations revealed that in general a fairly small portion of lecturing time and credits are allocated for training on irrigation management with the exception of a few organisations. At NQF level 5, the majority of agricultural colleges offer irrigation management as only one or two modules, which usually forms part of the fundamental training provided in crop production.

5.3 Short courses in irrigation management

Several short courses that could impact on irrigation management are presented by the Agricultural Colleges, Agricultural Research Council and private training organisations (Table 5.2).

Table 5.2. Brief overview of short courses offered by various training providers

Training organisation	Courses related to irrigation management
1. Agricultural colleges	
1. Tompi Seleka Development Institute (Skills Program)	Vegetable production Sunflower production Cotton production Maize production Soil fertility management Entrepreneurship Project management Food preservation
2. Potchefstroom College of Agriculture	Financial management Horticulture
3. Madzivhandila Agriculture Training Centre	Irrigation practices Safe use of chemicals Soil sampling and fertilisation application Basics of fertilisation application Vegetable production Running a small farming business Agricultural finance Compost making Small Medium and Micro Enterprise management
4. Grootfontein Agricultural Development Institute	Resource Poor Farming
5. Fort Cox College of Agriculture	Land based entrepreneurship Value adding technology Technology of producing field crops Technology of producing vegetables Leadership skills Conflict resolution Management of group dynamics Basic use of farm implements
6. Cedara College of Agriculture	Vegetable production Effective public speaking Crop production Soil fertility Bio resource program: Land assessment support system Training poster module Marketing Farm record keeping Soil classification and land capability Cultivated pastures Farm business management Map reading Soybean processing Farming system approach Entrepreneurship course Irrigation Barley and wheat production Agricultural extension Research methodology Alien plant control

Training organisation	Courses related to irrigation management
7. Owen Sithole College of Agriculture	Fruit Production Business Skills Vegetable production
8. Lowveld College of Agriculture	Cotton Production Table grape production Irrigation operation and maintenance
9. Glen College of Agriculture	Extension programming and evaluation Group dynamics Rural Community need identification and analysis Agricultural technology transfer strategy Cultivation of cultivated pastures Cultivation of lucerne Soil classification Disease control Calculation of plants density and yield Handling of pesticides and herbicides Calibration of implements: boom sprayer Wheat, potato and maize planters Cultivation of potatoes Farm management Marketing
2. Agricultural Research Council	Wheat production Crop production Maize and bean production Project management Farm agricultural management
3. *Private training institutions*	
Fertigation Academy	Introduction course to irrigation management and fertilisation Intermediary course 1: Irrigation and fertigation Intermediary course 2: Follow up on first intermediary course Specialist course: Irrigation and fertigation
SABI	Introduction to irrigation design: The accredited course complies with the AgriSETA accredited unit standard "Develop suitable irrigation systems" (Nr 116414), which forms part of the curriculums of the National Diploma in Plant Production and National Diploma in Agricultural Extension. Accreditation is done through the College for Sustainable Agriculture, and the following additional course outcomes will be achieved: • To apply efficient and cost effective management of irrigation systems by compiling and implementing operational, monitoring and maintenance plans for: ▪ Resource management ▪ Water quality management ▪ Scheduling ▪ Fertigation ▪ Hygiene management ▪ Asset management ▪ Safety management ▪ Environmental management

6. PROCESS IN DEVELOPING OF LEARNING MATERIAL

The following describe the process that was followed in the developing of the learning material through consultation and active participation of all relevant stakeholders.

6.1 Stakeholder consultation and discussion forums

i. Key stakeholder workshop

In order to critically assess and identify shortcomings in the preliminary list of training modules compiled on the TOR of this project and the training need assessment as included in the baseline survey, a key stakeholder workshop was arranged on 5 December 2006, ARC Agriculture Engineering (ARC-AIE), Silverton. Thirty-four delegates from the ARC, Provincial Departments of Agriculture, Agricultural Colleges, Universities of Technology, Universities and various private training institutions attended this occasion (*Appendix B*). The research findings derived from these two surveys among extension officers, subject matter specialists, commercial farmers and irrigation consultants serving the irrigation industry were highlighted and used to collate inputs and comments on the development of training material for extension in irrigation water management. The workshop served to critically assess and identify shortcomings in the preliminary list of training modules compiled and identify appropriate formats for specific training modules in irrigation water management. During the workshop subject matter experts and authenticators were identified.

From the outset of the workshop, delegates emphasized the pivotal role that agricultural extension should play in the capacity development of irrigated agriculture. Although farmers are encouraged to take responsibility for the on- farm irrigation management decisions, the demand for informed support services with regard to new irrigation technologies, technical advice, finance, water management regulations and management information needed for sound water management increase daily. The role of extension is to supply farmers with the necessary support where needed as well as to deliver this information for decision-making in an understandable and effective way, taking into consideration the various learning styles of farmers. Extension also plays a fundamental role in the feedback mechanism of research problems as faced by farmers on the farm. However, it was in general accepted that only a few farmers benefit from new irrigation technology, since current agricultural knowledge systems often failed to be responsive enough in addressing farmers' problems and opportunities.

The scene for the general discussion of the technical issues at hand was set, by giving a brief introduction to the current state of the "human" side or morale of extensionists in the field, as generally perceived by several similar projects conducted. The general lack of motivation, low morale and low self-esteem of extension workers in agriculture, can be, amongst others, contributed to a general lack of experiential training and foundational technical knowledge among the extensionists.

It was further stressed that the fact that should be emphasized and not forgotten along the way, is although the issue at hand is the development of training material for irrigation management (which in essence is a very technical and sometimes abstract process), the aim of the project is to develop this material for extensionists – and ultimately, farmers who are served by these extensionists. Therefore, although we are developing training material (or rather "learning" material), we are actually working with *people* – extensionists and farmers, who are the actual target group of this research project. Their inputs and needs throughout the duration of this project should be the guiding force behind what we as research team members do decide and develop.
Three main issues were discussed during this workshop:

i. Who and what are extensionists and what is generally perceived to be their role / function?
ii. Critically assess and identify shortcomings in the preliminary list of training modules compiled, based on the findings of the baseline study.
iii. Identify appropriate formats for specific training modules in irrigation management (technical and extension).

The workshop delegates were then divided into five smaller workgroups who were requested to discuss these issues within the smaller groups and note their findings and/or ideas on 'post-it' notes in order to provide feedback in the form of an informal log-frame structure. The overall findings of the five groups were summarised.

a. Feedback session

The following is a summary of the feedback received from the five focus groups:

1. What is the perceived role or function of Extension / Extensionists?

- Extension means both social and economical/technical assistance extended or at least facilitated;
- An extensionist is someone who can "translate" technical knowledge to make it understandable to a group of people in a practical way;
- Extensionists are the link between farmers and the technical / science experts and other stakeholders; extension is information transfer – training;
- An extensionist is a facilitator who brings knowledge to the people to help them to be able to help themselves;
- An extensionist is a facilitator, a sociologist (social scientist) and an agriculturalist;
- There are two levels of extension – commercial farming extension and emerging farming extension;
- An extensionist should be the link between the farmer and the researcher/subject matter specialist – at the moment they are only a "general cook and bottle washer";
- An extensionist should not be too young, needs to have self-confidence and has to have a certain level of education / qualification;
- An extensionist is not an encyclopaedia, but the index;
- Extension is an informal education process facilitated by an extensionist who has general knowledge of agricultural development – the role of the extensionist is to share knowledge and experience with farmers, particularly on technical, economic and social aspects;
- Currently, Extensionists lack basic knowledge of Agricultural Water Management – they usually know where to source information, though;
- An extensionist should be an advisor, guide, knowledgeable about specific issues, i.e. crops but know where to source information and expertise. For Irrigation Water Management they need to have a basic knowledge and understanding of Agricultural Water Management.

2. Identified shortcomings or "gaps" in list of training modules as listed in the Terms of Reference of the project and the list of modules identified based on findings of baseline study

- Project / event management
- Practical skills and application
- Basic knowledge assumed to be in place
- Support services – own departmental staff and subject matter experts
- Basic knowledge of soils and interpretation thereof within an irrigation environment
- Soil erosion and siltation
- Basic soil / water relationships
- How soil relates to an irrigation system
- Soil fertility
- Irrigation system quality – i.e. droplet size
- Utilisation of "grey water" (water harvesting)
- Water quality
- Water requirement estimates
- Diagnosis of problems in an irrigation system
- Extension in terms of HIV/AIDS and the impact thereof on agriculture and irrigation water management within a community
- Application of climatic data
- Appropriate use of Agrochemicals
- The role of communication in extension
- Participatory approaches and methods
- Gender and generation relations (youth participation)
- Gender roles – time allocation, household chores, production time use, labour availability in the field
- Culture and gender sensitivity – use of language, images, icons
- Stakeholder analysis – institutional support
- Planning, implementation, monitoring and evaluation
- Recognition of indigenous knowledge
- Policies on extension, water resource management, food security, Water Users' Associations
- Basic science numeracy, specific to agriculture
- Basic practical literacy
- In-service programs specific to extensionists' scope
- How to source and access information
- Not all the identified subjects need to be on NQF level 5 – they have different levels of importance in terms of Extension. With reference to the list of training modules discussed (Annexure B of this document), the following applies:
  - Crop science (A) and soil science (B) on the list of learning areas identified are closely related and need only be included up to NQF level 4;
  - Weed, disease control (C) and Agro-meteorology (D) are related and need only be included up to NQF level 3;
  - Irrigation engineering (E) – level 4
  - Agricultural extension (F) – level 5
  - Legal aspects (G) – level 3

- Effective water use (H) – level 4; and
- Irrigation economics (I) – level 3

3. Suggestions for appropriate formats for specific modules

- Learner Guide more important than Facilitator Guide
- Hard copy in book form
- Electronic version in CD/DVD format (PDF)
- Video material/clip on DVD
- Poster modules / pamphlet format (flyers, hand-outs)
- Short courses
- Thin, manageable files
- Easy referencing
- Three parts: Learner Guide, Learner Workbook, Facilitator Guide
- Multimedia, posters, overhead projector transparencies (if and where applicable)
- Use of interactive activities and real life, practical experiences as well as role-play and demonstrations are very important in terms of OBE-learning material.

4. General comments received during feedback session

- During the feedback session, the project team was urged to reconsider the original title – and therefore aim of the project, that is: "Development of Training Material for *Extension in Irrigation Water Management*". The team should guard against losing focus and trying to cover too much, or too wide a spectrum of issues within the training material they are going to develop, but rather concentrate on the development of high quality training material on Extension in Irrigation Water Management only.

- Not all the identified subjects need to be on NQF level 5 – they have different levels of importance in terms of Extension. With reference to the list of training modules discussed during the Stakeholder Workshop, the following applies:
    - Crop production and Soil science on the list of learning areas identified are closely related and need only be included up to NQF level 4;
    - Weed, disease control and Agro-meteorology are related and need only be included up to NQF level 3;
    - Irrigation engineering – NQF level 4
    - Agricultural extension – NQF level 5
    - Legal aspects – NQF level 3
    - Irrigation management – NQF level 4; and
    - Irrigation economics – NQF level 3
- It was also suggested that the new training material to be developed, should include as much detail as possible of learning on all the lower levels, from NQF level 1 up to NQF level 5, as there are generally very little knowledge or learning which can be "assumed to be in place" among extensionists within this field. This field has never before enjoyed specific, focused attention and definitely not in terms of the development of OBE-training material. In order to ensure that the newly developed training material are as thorough and effective as it can be, as much foundational knowledge on the lower NQF levels as possible, should be included in all modules – even if it results in material which is slightly more bulky than originally anticipated.

b. Conceptualisation of a possible curriculum for training of extensionists in irrigation management

The following learning areas were identified to be included in a possible curriculum for the training of extensionists in irrigation management.

Table 6.1. Learning areas identified for inclusion in proposed framework of curricula for training of extensionists in irrigation management

Technical learning areas	Minimum required knowledge and practical skills
Soil	Soil genesis: interpretation in terms of topography Interpret soil profile for irrigability by using relevant parameters Interpret texture in terms of water holding capacities Observe visible signs of problems (water logging, salinity, crusting, restrictive layers) Identification of potential water-logging problems and drainage potential Basic interpretation of chemical and physical parameters Basic soil mapping/profile interpretations/soil sampling Interpretation of soil topography Interpretation of Landsat/ aerial maps Maintenance of soil fertility Basic skills in soil preparation/cultivation
Irrigation legislative context	Interpretation and understanding of water use right and allocation for irrigation Basic understanding of water availability and licensing for water use right Determination of water reliability
Crops and fodder	Basic understanding of water quality and its influence on crop production and quality maintenance Insight and knowledge with regard to the selection of adapted crops Ability to help with appropriate cultivars selection Determining of crop water requirements Interpretation of satellite/Landsat/infra-red photos or maps Calculation of production potential or the production level of crops Basic understanding of principles applicable with the implementation of integrated crop/pest/diseases management Basic understanding of fertigation Basic understanding of principles applicable with sustainable crop production practices Basic understanding of principles applicable with the implementation of crop rotation
Agro Climatology	Basic understanding to select crops appropriate to specific climate-soil-market environment Basic understanding of the influence of climate on irrigation requirement

Technical learning areas	Minimum required knowledge and practical skills
Irrigation economics	Basic understanding of cost analyses (long-term and short term) Basic understanding and skills to prepare enterprise budgets Basic understanding and skills to prepare whole farm/partial budget Basic understanding and skills to prepare an appropriate marketing strategy for specific farm Basic understanding and skills to help with the selection of appropriate financing alternatives Basic understanding and skills to prepare a risk analysis Basic understanding of cost saving options (e.g. Ruraflex)
Irrigation engineering	Basic understanding and ability to determine area, peak demand and water availability Basic understanding to provide appropriate advice on the location in terms of distance/height/cost Appropriate knowledge and skills to help with the selection of adapted irrigation systems Basic understanding of the principles applicable with the evaluation and maintenance requirements of the selected irrigation system Basic understanding and skills needed to determine the application and distribution efficiency of an irrigation system Basic understanding with regard to different irrigation systems and irrigation in general Basic understanding of the principles applicable with the implementation of small scale water harvesting Basic understanding of the principles applicable with the implementation of on-farm conservation practices
Agricultural extension	Basic understanding and skills required for socio-economic analysis Basic understanding and skills required for institutional organisation and capacity building (WUA, FO, etc.) Basic understanding and skills required for leadership development Basic understanding of principles applicable for effective communication Basic understanding and skills required for effective mobilising of groups Basic understanding of the principles applicable for gaining the necessary credibility for efficient extension delivery Basic understanding of the concept holistic/whole farm approach
Irrigation water management	Basic understanding of the different tools and approaches to select from with regard to irrigation scheduling Basic understanding of principles applicable with regard soil-crop-atmosphere interaction Basic understanding of the soil water balance principles Basic understanding of the consequences of over- and under irrigation Basic knowledge and skills to help a farmer to calculate on-farm water use efficiencies Basic understanding of the principles that apply with scheme management

c. Identification of authenticators and subject matter specialists

The feedback session was followed with the identification and nomination of Subject Matter Experts (SME's) and Authenticators who will participate in the development of possible new training material.

The Proceedings of the Stakeholder Workshop held during December 2006 at ARC-AIE in Pretoria was compiled into a minute format and distributed to the 34 delegates that attended the workshop as well as to the 33 delegates which apologise and who could not attend the event. A copy of the Proceedings of the Stakeholder Workshop was submitted to the WRC.

A copy of the Proceedings was also submitted to the editor of SA Irrigation, who attended the Stakeholder Workshop. An article with the heading "*Extending farming assistance*" was published in the Apr/May 2007 edition of the SA Irrigation.

ii. Discussion forums

Six one-day discussion forums were arranged in various provinces during February and March 2007. Forty-two extension officers from Provincial Departments of Agriculture in Mpumalanga, Northwest, Free State, Limpopo and Eastern Cape participated in these discussions. Unfortunately the discussion forums arranged for KwaZulu-Natal (Tugela Ferry, Msinga district) and in Limpopo (Marble Hall District) were cancelled at a very late stage, and these inputs were incorporated at a later stage of the project after the necessary consultation and discussions took place.

Research findings derived from the baseline survey among extension officers, subject matter specialists, commercial farmers and irrigation consultants serving the irrigation industry were highlighted. These research findings together with the findings of discussions held during the Stakeholder Workshop conducted in December 2006 were used to gather input and comments on the development of training material for extension in irrigation water management from extension officers responsible for irrigation.

The discussion forums served to critically identify shortcomings in the preliminary list of training modules identified during the baseline study conducted. It also served to prioritise the importance of the eight learning areas identified for inclusion in the proposed framework of curricula for training of extensionists in irrigation management or the "knowledge profile" as indicated in Figure 1. In the third place extension officers were requested to help identify appropriate learning material formats to be taken into consideration with the development of envisaged training material.

a. General group discussion and feedback

The first objective of the discussion forum set was to identify the training level and needs of extension officers, and was addressed among participants of discussion forums who were not yet included into the existing databases. In Nelspruit, a couple of extension officers from the Lydenburg extension district were identified to complete the questionnaire, while a few officers at the Lady Frere office completed the questionnaire.

The discussion forum participants were divided into appropriate smaller groups and were asked to discuss the three issues within the smaller groups and note their findings and/or ideas on the distributed list of learning areas in order to provide feedback. Three main issues were discussed during this session:

- Critically assess and identify shortcomings in the preliminary list of training modules compiled, based on the findings of the baseline study and the feedback received from the stakeholder workshop.
- Prioritise the learning areas with regard to the inclusion in the proposed framework of curricula for training of extensionists in irrigation management (technical and extension).
- Identify appropriate formats for specific training modules

The following is a summary of the feedback received from the five focus groups:

1. Identified "gaps" in proposed list of training modules as listed

The following shortcomings were identified in the list of training modules provided to stakeholders during the Stakeholder Workshop as related to the eight learning areas.

a. *Soil*

Technical learning area	List of possible modules
Soil	1.Soil genesis: interpretation in terms of topography 2.Interpret soil profile for irrigability by using relevant parameters 3.Interpret texture in terms of water holding capacities 4.Observe visible signs of problems (water logging, salinity, crusting, restrictive layers) 5.Identification of potential water-logging problems and drainage potential 6.Basic interpretation of chemical and physical parameters 7.Basic soil mapping/profile interpretations/soil sampling 8.Interpretation of soil topography 9.Interpretation of Landsat/ aerial maps 10.Maintenance of soil fertility 11. Basic skills in soil preparation/cultivation

Shortcomings and proposals:

- ✓ Basic terms and calculations (volume, area, flow rate, graphs)
- ✓ Change module 1 on soil genesis to: *Soil genesis: soil forming process, soil composition, and soil classification.*
- ✓ Suggest combining of modules 2 and 3 into a single module.
- ✓ Module 6: add Chemistry of important plant nutrients
- ✓ Module 10: include principles of fertilisation
- ✓ Add new modules on:
  - Soil compaction
  - Soil management
  - Rehabilitation of irrigation fields
  - Principles of Land care/soil conservation
  - Land use planning:
    - Steps to take into consideration with planning of land use
    - Critical aspects and principles to take into consideration

b. *Irrigation legislative context*

Technical learning area	List of possible modules
Legal aspects regarding irrigation	1.Interpretation and understanding of water use right and allocation for irrigation 2.Basic understanding of water availability and licensing for water use right 3.Determination of water reliability 4. Basic understanding of water quality and its influence on crop production and quality maintenance (ecology)

Shortcomings and proposals:

Add the following modules to the list:

- ✓ Water tariff structures
- ✓ Resource and ecology management principles and legislation (water management)
- ✓ Environmental impact assessment: introduction to assessment techniques
- ✓ Environmental management principles (run-off, etc.)
- ✓ Pollution control and legislation
- ✓ Implication of rezoning

c. *Crop production*

Technical learning area	List of possible modules
Crops and fodder	1.Insight and knowledge with regard to the selection of adapted crops 2.Ability to help with appropriate cultivars selection 3.Determining of crop water requirements 4.Interpretation of satellite/Landsat/infra-red photos or maps 5.Calculation of production potential or the production level of crops 6.Basic understanding of principles applicable with the implementation of integrated crop/pest/diseases management 7.Basic understanding of principles applicable with the implementation of integrated weed management 8.Basic understanding of fertigation 9.Basic understanding of principles applicable with sustainable crop production practices 10.Basic understanding of principles applicable with the implementation of crop rotation

Shortcomings and proposals:

- ✓ Change module 1 as follow: *Insight and knowledge with regard to the selection of suitable crops*
- ✓ Change module 2 as follow: *Ability to help with appropriate cultivars selection, planting dates and planting depths*
- ✓ Module 3 – respondents of opinion that this is not necessary to be addressed as very few extensionists make use of this technique-something identified for use by specialists.

- ✓ Add estimation of yield (techniques) to module 4.
- ✓ Module 8 is not fitting; this specific learning area-must be included as a module within learning area 8: Water management.

d. *Agro climatology*

Technical learning area	List of possible modules
Agro climatology	1.Basic understanding to select crops appropriate to specific climate-soil-market environment 2.Basic understanding of the influence of climate on irrigation requirement (interpretation of weather data, basic skills and knowledge to make use of weather stations)

Shortcomings and proposals:

- ✓ Change the name of the learning area to: *Agro climatology*
- ✓ Change module 1 as follow: *Basic understanding to climate and the influence on crop production.*
- ✓ Change module 2 as follow: *Basic understanding of the influence of climate on irrigation management.*
- ✓ Add the following modules:
  - o Introductory on certain concepts and the influence of climate on crop production (frost control, etc.) and irrigation management
  - o Introduction to hydrological cycle
  - o Measuring of evaporation, radiation, humidity and wind
  - o Interpretation of climate data

e. *Irrigation economics*

Technical learning area	List of possible modules
Irrigation economics	1.Basic understanding of cost analyses (long-term and short term) 2.Basic understanding and skills to prepare enterprise budgets 3.Basic understanding and skills to prepare whole farm/partial budget 4.Basic understanding and skills to prepare an appropriate marketing strategy for specific farm 5.Basic understanding and skills to help with the selection of appropriate financing alternatives 6.Basic understanding and skills to prepare a risk analysis 7.Basic understanding of cost saving options (e.g. Ruraflex)

Shortcomings and proposals:

- ✓ The general feeling of extension officers is that the learning area should be called Irrigation Economics
- ✓ Module 2 add: break-even budgets, income statement
- ✓ Modules 4 add: aspects like marketing plan, market analysis, and distribution channels for agriculture commodities.
- ✓ Add to the list of modules the following:
  - o Basic understanding of irrigation systems with regard to running and maintenance costs
  - o Introduction of financial management a- record keeping

- Entrepreneurship principles
- Principles of irrigation farm management.
- Feasibility studies

✓ The use of the Departmental Manual on Machinery Costs

f. *Irrigation engineering*

Technical learning area	List of possible modules
Irrigation engineering	1.Basic understanding and ability to determine area, peak demand and water availability 2.Basic understanding to provide appropriate advice on the location in terms of distance/height/cost 3.Appropriate knowledge and skills to help with the selection of adapted irrigation systems 4.Basic understanding of the principles applicable with the evaluation and maintenance requirements of the selected irrigation system 5.Basic understanding and skills needed to determine the application and distribution efficiency of an irrigation system 6.Basic understanding with regard to different irrigation systems and irrigation in general 7.Basic understanding of the principles applicable with the implementation of small-scale water harvesting 8.Basic understanding of the principles applicable with the implementation of on-farm conservation practices (drainage)

Shortcomings and proposals:

- ✓ The general feeling of extension officers is that the learning area should be called Irrigation Engineering
- ✓ The order of modules should be rearranged to the following order namely: 6, 1,3,4,5,2,7 and 8
- ✓ Module 6 should read: B*asic understanding with regard to different irrigation systems and the principles that apply*.
- ✓ Add to module 2: Basic understanding to provide appropriate advice on the location in terms of distance/height/cost **of irrigation system**
- ✓ Add to module 7: **Principles of on farm water storage, storage dam capacities**
- ✓ The opinion of many extension officers aware of the SABI Irrigation Manual this manual should be incorporated into this learning material.
- ✓ Add to the list of modules:
  - Introduction to soil and water conservation principles
  - Management and maintenance of different irrigation systems
  - Factors to take into consideration during “troubleshooting”

g. *Agricultural extension*

Extension learning area	List of possible modules
Agricultural Extension	1.Basic understanding and skills required for socio-economic analysis 2. Basic understanding and skills required for institutional organisation and capacity building (WUA, FO, etc.) 3.Basic understanding and skills required for leadership development 4.Basic understanding of principles applicable for effective communication 5.Basic understanding and skills required for effective mobilising of groups 6.Basic understanding of the principles applicable for gaining the necessary credibility for efficient extension delivery 7.Basic understanding of the concept holistic/whole farm approach

Shortcomings and proposals:

- ✓ Respondents of opinion that the requirement for this knowledge is not "a basic understanding" but rather "comprehensive understanding" of the learning area, since extension forms the core of the irrigation extensionists knowledge profile.
- ✓ Also the necessary skills to mobilize and assess the efficiency of group functioning are identified as a huge need amongst extension officers.
- ✓ Add to the list of modules:
    - o Group dynamics, group formation and cohesiveness
    - o Effect of culture diversity on group functioning and dynamics

h. *Irrigation water management*

Technical learning area	List of possible modules
Irrigation water management	1.Basic understanding of the different tools and approaches to select from with regard to irrigation scheduling 2.Basic understanding of principles applicable with regard soil-crop-atmosphere interaction 3.Basic understanding of the soil water balance principles 4.Basic understanding of the consequences of over- and under irrigation 5.Basic knowledge and skills to help a farmer to calculate on-farm water use efficiencies 6.Basic understanding of the principles that apply with scheme management

Shortcomings and proposals:

- ✓ Recommendation to change the name of learning area to **Irrigation and Water Management**
- ✓ Add to module 2: Basic understanding of principles applicable with regard soil-crop-atmosphere interaction **and plant water consumption**.
- ✓ Add the following modules:
    - o Basic knowledge of water measurement concepts (units, method, dam capacity, stream flow, etc.)

- Basic principles on fertigation
- Basic principles in the managing of poor quality irrigation water
- Basic understanding and skills for the planning of irrigation: irrigation cycle, stand time, sets per day, sprinkler spacing, etc.
- Management principles applicable to ensure water sustainability

2. Prioritise the learning areas with regard to the inclusion in the proposed framework of curricula for training of extensionists in irrigation management (technical and extension)

With the second objective as set for the discussion forums, extension officers were asked to rate the importance of the eight learning areas for inclusion in the training material to be developed on a semantic scale. This prioritizing will help the team to decide what learning areas is priority for development, and will receive prior attention, energy and time.

Table 6.2. Prioritising of the importance of the eight learning areas for possible inclusion in the curricula of training material on a semantic scale (1= Not important and 10= Very important) by extensionists

Learning areas	Mzinti training centre	Nelspruit	Eastern Cape	Brits(NW)	Limpopo	Average score
Soil	8	8	10	9	8	9
Legal aspects regarding irrigation	2	8	8	5	8	6
Irrigated Crop production	8	8	10	8	8	9
Agro Climatology	2	9	9	6	10	7
Irrigation economics	5	9	10	7	9	8
Irrigation engineering	6	9	10	6	10	8
Agricultural extension	10	7	5	9	9	8
Irrigation and water management	8	9	10	9	9	9

The prioritising indicated in Table 6.2 clearly indicates that priority by the team should be given to the development of training modules for three learning areas, namely:

- Soil science
- Crop production
- Irrigation and water management

This assessment of priority was compared with the general outcome expressed at the Stakeholder Workshop during December 2006.

3. Suggestions for appropriate formats for training modules

Effective learning requires carefully combining content with various formats of presenting the learning material to take advantage of each formats' unique characteristics. The most effective learning formats provide experiences mirror the real world experiences and let learners apply the content in various contexts.

- Extension officers from Brits identify the need for the development of a Facilitator and/or Field Guide rather than another Learner Guide. This was in contrast with the general feeling of the discussion groups in Limpopo and Eastern Cape where the development of a Learner Guide was favoured.
    - The discussion group in Nelspruit also favoured the idea of Learner Guide, while the group of extension officers at Mzinti Training Centre felt strongly about the development of a Field Guide (Operational Manual) – a guide that can be used by extension officers in the field to help them with assisting the irrigation farmers and also for use in their training activities like the Field Guide that was developed for extension officers in the past. The examples of the Field Guide used by Agricor (Agricultural Development Corporation of Bophuthatswana) and the guide used by KZN extension officers were mentioned as effective guides for extension.
- The group at Lady Frere identified the storytelling methods and format used by Johan Adendorf to be included.
- The discussion groups in Nelspruit, Limpopo, Brits and Eastern Cape identified the need for the inclusion of relevant case studies to illustrate certain concepts and the application of these concepts in practice.
- Need for visual material inclusion strongly emphasised.
- Development of modules in the format of pamphlets like the existing Departmental information leaflet series
- The use of storytelling to make certain concepts more clear and acceptable to the potential learners.
- Easy referencing of manual
- Preparation of learning material with the intention to offer short courses – people does not read as readily as been accepted by educators.
- Use of experiential learning principles and as well as role-play.
- Material that could be used for demonstration purposes.

6.2 Appropriate learning format

What is the difference between the learning theories in terms of the practice of learning material design? Is one approach more easily achieved than another? Is one approach more relevant or more successful than another? Should the newly designed learning material of this WRC-project be in written text book format, in multimedia or electronic format, or should it be presented in short, individual modules each standing on its own as a "brochure", but still forming part of a bigger, integrated collection?

The interviews and discussions held with various key informants during the Stakeholder Workshop held in December 2006 and discussions held with extension officers during February and March 2007 clearly indicated differential needs with regard to the appropriate learning format. To address the differential learning needs various approaches for the design and development of learning material could be applied:

- Attain information, ideas or concepts
- Learn through demonstration and observation
- Practice skills, techniques and thinking process

- Increase in-depth understanding
- Meet a variety of learning objectives

6.2.1 Principles of adult learning

Adults are assumed to be voluntary learners, and every adult is different. They come to a learning experience with a unique set of past experiences, knowledge, skills, values, attitudes and aspirations. Theories of adult learning suggest these are rich resources to be drawn upon in learning; however existing knowledge, skill, values, attitudes and aspirations can also be barriers to learning from new experiences. Lieb (1991) identified the following characteristics of adult learning:

- Adults are *autonomous* and *self-directed.* They need to be free to direct themselves. The teachers or facilitators must actively involve adult participants in the learning process and serve as facilitators for them. Specifically, they must get participants' perspectives about what topics to cover and let them work on projects that reflect their interests. They have to be sure to act as facilitators, guiding participants to their own knowledge rather than supplying them with facts.
- Adults have accumulated a foundation of *life experiences* and *knowledge* that may include work-related activities, family responsibilities, and previous education. They need to connect learning to this knowledge/experience base. To help them do so, facilitators should draw out participants' experience and knowledge, which is relevant to the topic. They must relate theories and concepts to the participants and recognize the value of experience in learning.
- Adults are *goal-oriented*. Facilitators should help potential learners to attain their goals by offering a learning program that is organized and has clearly defined elements.
- Adults are *relevancy-oriented*. They must see a reason for learning something. Learning has to be applicable to their work or other responsibilities to be of value to them. This implies that theories and concepts must be related to a setting familiar to participants.
- Adults are *practical*, focusing on the aspects of a lesson most useful to them in their work. They may not be interested in knowledge for its own sake.
- As do all learners, adults need to be shown *respect*. Facilitators and instructors must acknowledge the wealth of experiences that adult participants bring to the classroom. These adults should be treated as equals in experience and knowledge and allowed to voice their opinions freely in class.

Extensionists, trainers and facilitators need to be aware of not only how adults learn, but also what motivates them to learn. Adults are motivated to learn in order to solve a problem or take advantage of an opportunity. Therefore adults need learning to be meaningful and relevant, and relatively few adults learn for the love of learning. These characteristics should be kept in mind with the developing of the learning material and especially with facilitating of learning.

6.2.2 Learning Theories: Behaviourism, Cognitivism and Constructivism – The Basics

In the design and development of learning material one may consider that cognitive theory is the dominant theory in learning material design and many of the instructional strategies advocated and utilized by behaviourists are also used by cognitivists, but for different reasons. For example, behaviourists assess learners to determine a starting point for instruction, while cognitivists look at the learner to determine their predisposition to learning (Ertmer & Newby, 1993). With this in mind, the practice of learning material design can be viewed from a behaviourist/cognitivist approach as opposed to a constructivist approach.

When designing from a behaviourist / cognitivist stance, the designer analyses the situation and sets a goal. Individual tasks are broken down and learning objectives are developed. Evaluation consists of determining whether the criteria for the objectives have been met. In this approach the designer decides what is important for the learner to know and attempts to transfer that knowledge to the learner (Outcomes-Based Education – OBE). The learning package is somewhat of a closed system, since although it may allow for some branching and remediation; the learner is still confined to the designer's "world" – usually pre-determined by the relevant Unit Standards and their Specific Outcomes.

To design from a constructivist approach requires that the designer produces a product that is much more facilitative in nature than prescriptive. The content is not pre-specified, direction is determined by the learner and assessment is much more subjective because it does not depend on specific quantitative criteria, but rather the process and self-evaluation of the learner. The standard pencil-and-paper tests of mastery learning are not used in constructive design; instead, evaluation is based on notes, early drafts, final products and journals.

Because of the divergent, subjective nature of constructive learning, it is easier for a designer to work from the systems, and thus the objective approach to learning material design. That is not to say that classical learning material design techniques are better than constructive design, but it is easier, less time consuming and most likely less expensive to design within a "closed system" rather than an "open" one. Perhaps there is some truth in the statement that "Constructivism is a 'learning theory', more than a 'teaching approach'(Wilkinson, 1995).

6.2.3 Is there one “best” learning theory for learning material design?

A solid foundation in learning theory is an essential element in the preparation of learning material because it permeates all dimensions of learning material design (Schiffman, 1995). Depending on the learners and situation, different learning theories may apply. The learning material designer must understand the strengths and weaknesses of each learning theory to optimize their use in appropriate learning material design strategy. *Theories are useful because they open our eyes to other possibilities and ways of seeing the world. Whether we realize it or not, the best design decisions are most certainly based on our knowledge of learning theories. Behaviourism, cognitivism and constructivism – what works where and how do we knit everything together to at least give ourselves some focus in our approach to learning material design?*

Jonassen (1991)) identified the following types of learning and matched them with what he believes to be appropriate learning theory approaches.

1. *Introductory Learning* – learners have very little directly transferable prior knowledge about a skill or content area. They are at the initial stages of schema assembly and integration. At this stage classical learning material design is most suitable because it is predetermined, constrained, sequential and criterion-referenced. The learner can develop some anchors for further exploration.
2. *Advanced Knowledge Acquisition* – follows introductory knowledge and precedes expert knowledge. At this point *constructivist approaches may be introduced*.
3. *Expertise* is the final stage of knowledge acquisition. In this stage the learner is able to make intelligent decisions within the learning environment. A constructivist approach would work well in this case.

With the different learning theories in mind, the challenge to the project team was to make the best use of the knowledge gained and incorporate it with the needs identified among stakeholders and extensionists into a format appropriate for the target learners. Another consideration is the distinction between "training" and "education". In today's competitive business world, the learning material designer may be required to establish and meet the objectives of that business. On the other hand, in a school setting, the designer may be challenged

to provide material that fosters an individual to find divergent approaches to problem solving. Whichever situation a learning material designer finds him/herself in, they will require a thorough understanding of learning theories to enable them to provide the appropriate learning environment.

The following summarise the comments gathered from Extension Personnel, Trainers, Facilitators and key participants of the Stakeholder Workshop.

Stakeholder Workshop 2006

- Learner Guide more important than Facilitator Guide. The challenges to the development of a Learner Guide are: to move from a traditional teaching approach to learning and student-centred one; infusing cross-curricular links and higher-order learning in individual subject areas, and determining how student achievement of outcomes is assessed.
- Hard copy in book form, as well as;
    - Electronic version in CD/DVD format (PDF)
    - Video material/clip on DVD
    - Poster modules / pamphlet format (flyers, hand-outs)
    - Short courses
    - Thin, manageable books – rather box several books together than have one, bulky book or file
    - Easy referencing
- Three parts: Learner Guide, Learner Workbook, Facilitator Guide
- Multimedia learning where both text and graphics are used for learning: posters, overhead projector transparencies (if and where applicable).
- Use of interactive activities and real life, practical experiences as well as role-play and demonstrations are very important in terms of OBE-learning material.
- Should include as much detail as possible of learning on all the lower levels, from NQF level 1 up to NQF level 5, as there are generally very little knowledge or learning which can be "assumed to be in place" among extensionists within this field.
- "As agriculture people we just learn too many technical things – we need facilitation skills in Adult Education, we do not need any more technical knowledge!"
- "There needs to be more support material to use while we are training. (pictures, posters – toolbox)
- People skills – training of trainers/facilitators in training methodology and adult learning / education techniques.
- Practical demonstrations, hands-on.
- Success stories must be included as examples.
- Successful farmers must be used in illustrations.
- There is a need to address a basic lack of facilitation skills:

Discussion forums held with extension personnel, 2007

The interviews and discussion forums held with extension officers in several provinces during February and March 2007 revealed the following needs with regard to appropriate format for the developing of learning material:

- Extension officers identified the need for the development of a Facilitator and/or Field Guide to be more important than a Learner Guide. The primary purpose of a Field Guide is to help extension personnel with advice on important irrigation management objectives with implementation practices for each objective. A manual of this format educates as well as presents daily information for efficient irrigation management.

- The Johan Adendorf-model of storytelling and use of narratives was identified during the discussion forums as an approach for learning. Narrative and storytelling help the learners to associate the topic under discussion with their real world[25)].
- The inclusion of relevant case studies to illustrate certain concepts and the application of these concepts in practice. Case studies are experiential learning methods, like simulation and demonstration. This method of learning helps learners to bridge the gap between theory and experience. It draws on the real-world examples to illustrate concepts taught by reading or lecturing. Adult learners seek usually relevance and immediacy, and case studies offers actual or credible examples of situations they seek to understand and master.
- Inclusion of visual material that could be used for demonstration and simulation purposes. Demonstrations allow learners quickly to understand complex information, compared to reading and lecturing. Demonstrations engage several senses at once, and provide a variety for learners. The human memory is strengthened by the visual presentation of information and by repetition. We remember:

  10% of what we read
  20% of what we hear
  30% of what we see
  50% of what we see and hear
  80% of what we experience
- Development of modules in the format of pamphlets like the existing Departmental information leaflet series with photo slides and graphs to illustrate certain concepts.
- Easy referencing of manual
- Preparation of learning material with the intention to offer short courses – *people does not read as readily as been accepted by educators.*
- Use of experiential learning principles and as well as role-play. It is important to develop critical thinking. The inclusion of experiential learning where adult students draw on their own experiences or select their own case studies can increase the effectiveness of learning[29)].

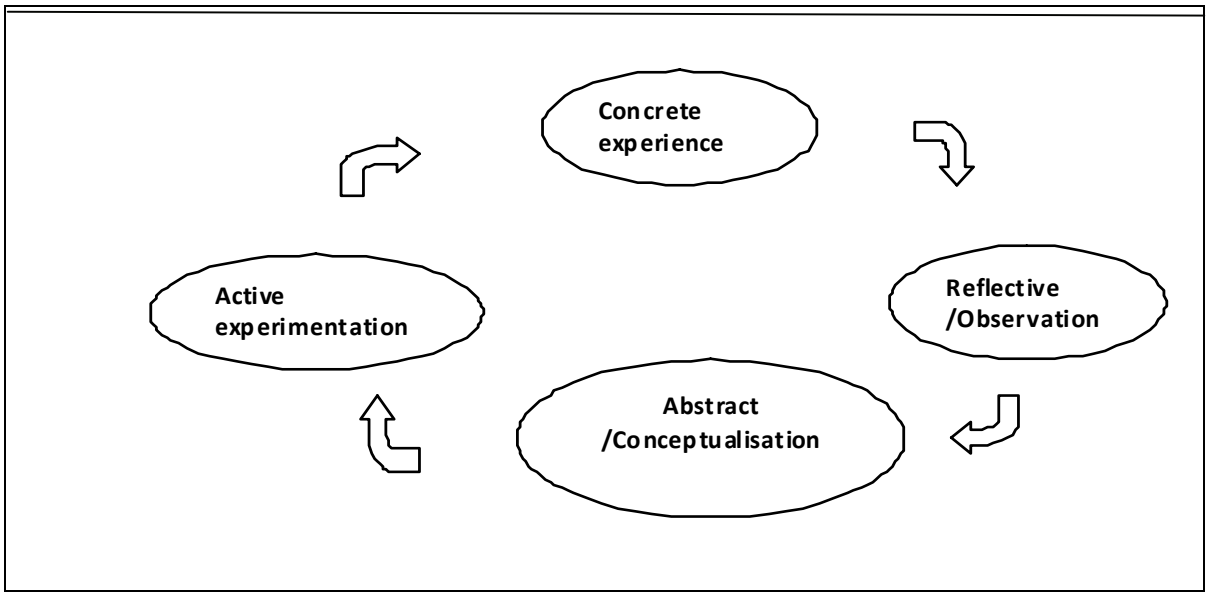


Figure 6.1. Experiential learning cycle (Kolb, 1984)

6.3 Process of assessing and analysing available technical and extension learning material

The first step in the process of the development of technical and extension training material was to do a reconnaissance of the learning material that exists which is appropriate regarding irrigation water management. This reconnaissance included three distinguished stages namely:

- Identification of existing learning material offered by private training institutions, tertiary institutions like agricultural colleges, technikons and universities, and training and education governing bodies, i.e. SAQA, Education and Training Seta like the AgriSETA, and Umalusi*.
- The second step was to "unpack" this available learning material and analyse it in terms of content, format and relevance.
- The third step was to identify shortcomings with regards to:
    - Identified needs expressed by learners (extensionists) and opinions expressed by subject matter experts as well as
    - Objectives set for this project as defined in the terms of reference (TOR)

**Umalusi: accredits private providers of education and training as well as private assessment bodies (like FET colleges)*

6.3.1 Fact finding and unpacking of learning material

The emphasis of the first step of the reconnaissance was to gather as much information on existing training and learning programs which address irrigation water management. The preliminary list of training modules compiled based on the TOR of the project was tailored after interaction with extensionists, subject matter specialists, educators and trainers of learning material. Eight learning areas were identified to be relevant to the knowledge profile of irrigation extensionists. These eight learning areas were used to define the unit of analysis in the process of identifying and collating of information on existing learning material in use by tertiary and private training institutions as well as unit standards registered with SAQA and AGRISETA.

The *first part of the reconnaissance* study focussed on the assessment of training curricula and material offered to students in irrigation management by tertiary institutions. These training curricula were collected from ten South African universities, twelve agricultural colleges associated within the various Provincial Departments of Agriculture and five technikons and universities of technology. The assessment of training curricula involved the unpacking with regard to content, format and relevance to the targeted learners. The assessment also includes training material offered by private training institutions and short courses.

The following highlights some of these findings:

- Several universities in South Africa have faculties and departments or schools of Agriculture, which also offer training in irrigation water management. The duration of a BSc Agric course is four years while that of a B Agric course is three years. After the amalgamation of technikons like SA Technikon and others with universities, many universities also offer national diplomas in agriculture.
- The twelve agricultural colleges in the country under the auspices of Provincial Departments of Agriculture offer training which include a three year National Diploma in Agriculture, and related disciplines. Elsenburg College for Agriculture (Cape Institute for Agricultural Training) is offering a B

Agric degree in collaboration of Stellenbosch University while Potchefstroom College of Agriculture offers a B Tech Agric Mgt in collaboration with Tshwane University of Technology.

- Technikons and Universities of Technology offer a three year National Diploma and a four year B Tech degree in agriculture and related disciplines.
- Various private training institutions, agricultural colleges and development institutes, the Agricultural Research Council and universities offer short courses in irrigation management and relevant learning areas. These courses are offered on various levels from NQF level 1 up to NQF level 6. Apart from the fact that very few of these short courses were SAQA accredited at the time of investigation, analyses and evaluation of the content and format of training material used revealed the following:
    - The content of training material is of a general and introductory nature, but interesting aspects from the training material were identified for possible use with the development of the envisaged training material for the project.
    - The format of the training material is still mainly content-based education and partially addresses the principles of OBE.

It seems from this investigation into the offering of tertiary agriculture training to extensionists in irrigation management that the majority of tertiary agricultural institutions tend to concentrate on single disciplines and the agricultural scientist or technician is usually found to be thoroughly trained in only one of the above required disciplines, whilst other required learning areas like irrigation management and irrigation economics are usually included as part of a curriculum to a limited extent, if at all.

The *second part of the reconnaissance* involved the identification and assessment of SAQA registered training material (technical and extension) on NQF levels 3-5 of AgriSETA with regard to primary and secondary agriculture subfields. The South African Government accepted the South African Qualification Authority Act No58 of 1995 (SAQA, 1995), introducing a new National Qualification Framework (NQF). The NQF makes provision for an outcomes-based education (OBE) system. One of the main objectives of the NQF is to create an integrated framework for learning achievements and to facilitate access and progression in education, training and development. Outcomes-Based Education and Training (OBET) are based on outcomes.

OBE FORMAT

Outcomes-Based Education (OBE) identifies critical cross-field and specific outcomes as revealed in Box 1. Critical cross-field outcomes are outcomes to achieve in every learning situation while specific outcomes are content-related outcomes. To determine whether learners are successful, i.e. whether learners know they have learnt well, the learner must be assessed using assessment criteria of the outcome (Van der Horst & McDonald, 1997, Lategan & Van Rooyen, 1998; HSRC, 1995)). Assessment forms therefore an integral part of outcomes-based education and used to determine whether or not the qualification has been achieved. Outcomes-based training is also referred to as competency-based training since learning is goal oriented and personal responsibility for learning is emphasised.

❑ *Critical cross field outcomes*

The intended outcomes are a starting point when new training material is developed and are divided into three categories of outcomes namely:

- *Knowledge outcomes:* suggest how farmers will demonstrate the knowledge gained form the learning
- *Skills outcomes:* how the learner applies the knowledge gained
- *Attitude outcomes* refer to attitude, beliefs and characteristics that learners can develop as a result of the learning experience.

Box 1: Unit Standard Format prescribed by SAQA (SAQA, 1997)

TITLE	
LEVEL	
CREDITS	
PURPOSE	
The learner achieving this unit standard will be able to…… (e.g. apply agrochemical products in a safe, effective and responsible manner with consideration to the environment In addition they will be well positioned to extend their learning and practice into other areas of …….. How will the profession in general benefit from this?	
LEARNING ASSUMED TO BE IN PLACE	
(What must the learner know before attempting this US)	
SPECIFIC OUTCOME	
Formula: Verb + noun + qualifying phrase, e.g. Mix correct pest control products at correct dose	
RANGE	
Example: Pest control products refer to but are not limited to chemical, organic, mechanical products	
ASSESSMENT CRITERIA	**RANGE**
Form: noun + verb + criteria	
CRITICAL CROSS-FIELD OUTCOMES	
Problem solving relates to specific outcomes …….	
Team work relates to specific outcomes …….	
Self-organisation and management relates to specific outcomes …….	
Information evaluation relates to specific outcomes …….	
Communication relates to specific outcomes …….	
Use of science and technology relates to specific outcomes …….	
Inter-relatedness of systems relates to specific outcomes …….	
Professional development relates to specific outcomes …….	
ESSENTIAL EMBEDDED KNOWLEDGE	

Learning outcomes should be clearly stated that both facilitators and learners could be held accountable for the learner's achievement of outcomes (HSRC, 1995; Botha & De Lange, 2005). Therefore with the design of learning material it is important to clearly state what learners should achieve at the end of the learning event. It is recommended that the list of learning outcomes should be kept short to prevent confusion amongst the learners.

Developmental outcomes support the critical outcomes, and are used towards the professional development of the learner. The developmental outcomes are as follow:

- Reflect and explore a variety of strategies to learn more effectively
- Participate as reasonable citizens in the life of local, national global communities
- Be culturally and aesthetically sensitive across a range of social contexts
- Explore education and career opportunities
- Develop entrepreneurial opportunities

- ***Assessment***

Traditional forms of assessment like tests and written assignments are helpful to assess a person's knowledge and even to a certain extent the skills they may have. But competency is more than this. Competency is about whether a person can apply their knowledge and skills effectively in various contexts.

"Assessment of learning is an essential element of outcome-based education. Without valid and reliable assessment procedures you will simply not know whether or not your learners have achieved the learning outcomes that were the

focus of the program, unit or lesson, and neither will learners know whether they have learnt well" (Van der Horst & McDonald, 1997).

Assessment can be (Cabeton Training and Development, 2005):

- *Formative assessment:* This type of assessment should be included to provide the learner with feedback on their performance and to provide guidance to the learner on how to improve.
- *Summative assessment* should assess every outcome and is used to judge the learner's achievement of the learning outcomes. It includes instruments like projects and performance tasks. Both communicative and instrumental learning are encouraged, and therefore the learner should be assessed by observing the carrying out of activities or on the final product produced by the learner, or the learner could be asked questions to establish evidence of a learner's underpinning knowledge and understanding.
- *Self assessment:* a form of diagnostic or formative assessment performed by the learner to determine their own level of progress and readiness to proceed with the summative assessment.
- *Peer assessment:* a form of diagnostic assessment performed by other learners on the same learner level to help the learner to determine their own level of progress and readiness to proceed with the final summative assessment.

❑ *Assessment criteria*

Assessment of learning must be workplace related and the learner must perform authentic tasks to be assessed against for competence. Assessment criteria are directly derived from the specific learning outcomes. It states what evidence is required to ascertain that the learners have achieved a specific learning outcome. It indicates in broad terms the observable process and products of the learning which serves as demonstration of the learner's achievement.

Blooms taxonomy model provides more light on what is expected of each outcome from the learner (Cabeton Training and Development, 2005). Blooms taxonomy model consists of three parts, or "overlapping domains":

- Cognitive domain (intellectual capability, i.e. knowledge or think)
- Affective domain (feelings, emotions and behaviour, i.e. attitude or feel)
- Psychomotor domain (manual and physical skills, i.e. skills or do)

❑ *Content*

The content of the learning material should support the achievement of the outcomes. Content should cover the following areas:

- Knowledge: the ideas that learners will learn and remember
- Skills: the practical capabilities that form the core of most of the learning program
- Values and attitude: the underlying ideas behind the skills and knowledge

Content of training module is guided by the learning outcomes set. Therefore content should be relevant to the learner's needs. Inclusion of too much content should be guarded against and content should be sequenced from simple to more complex. Content should be aligned according the amount of time allocated for learners to cope with the specific topic. Overload of information jeopardise effective learning.

❑ *Format of training*

The physical environment for training of irrigation extensionists will change from a lecturing room to the real-life experiences. It is envisaged that the more the learners are exposed to the authentic problems, the better they will relate to the real world of the workplace of the future. To ensure that the training is learning centred, the methods for learning should include the use of the following three senses:

- Visual- the learners learn through seeing the material
- Auditory: learner learns through hearing the material
- Kinaesthetic; learners learn by doing and experiencing

Learning is an active process and participation in the training process provides learners with the opportunity to learn by doing. The planned format for training will be based on participatory training methods, which will include:

- Small group discussions
- Project methods or assignments
- Brainstorming sessions
- Role-play and simulation
- Case studies and examples
- Presentation by learners (feedback on experiences)
- Story telling

Subsequent to the start of the project in 2005, when the original Curriculum 2005 came into effect, a Revised National Curriculum Statements (RNCS) of 2003 were implemented at school level. This revised curriculum in general was a huge improvement, producing a relevant and more challenging curriculum, which focuses explicitly on exposing learners to higher-order thinking skills essential for effective national development and competitiveness in the global economy of the 21st century. In 2010 government has decided that the term 'OBE' will be scrapped in the revision of the RNCS. Government has clarified that "…outcomes-based education as a broad framework for education and training in South Africa remains our approach and… the core values of outcomes-based education, such as encouraging critical engagement with knowledge instead of rote learning" (SAPA, 07/07/2010). The problems are not so much with the underlying philosophy of OBE, but in the level of disciplinary and pedagogical understanding that the RNCS requires, and its implementation and assessment. The OBE terminology was also found to be very sophisticated and unfamiliar for most teachers. To compound matters, the RNCS was implemented without enough targeted teacher training that was subject-specific or enough resources for teachers and learners in most schools. In addition, it over-emphasizes assessment and associated administration, and so overloads teachers with tasks that are not related to their teaching.

The key change with the implementation of CAPS is that the curriculum will no longer be framed in terms of learning outcomes and assessment standards, so as to strengthen content specification. To make it more accessible to teachers, the curriculum will be repackaged: every subject in each grade will have a single, comprehensive, concise Curriculum and Assessment Policy Statement (CAPS) that will provide details on what teachers ought to teach and assess. In this way, outcomes will be absorbed into more accessible aims, and content will be specified in subject topics and the assessments to be covered per term. The terminology will thus be familiar – aims, topics and subjects – and the burdensome assessment load have already been reduced. These changes in the education policy will definitely also impact in how learning material in future will be repacked and offered to learners.

Technical unit standards

The unit standards that are registered with SAQA on irrigation and related learning areas were identified and analysed with regard to what is available and what needs to be developed. 74 technical unit standards are registered with SAQA and AGRISETA on NQF levels 3, 4 and 5. The evaluation of these unit standards during 2006 reveal the following frequency distribution as reflected in Table 6.3.

Table 6.3. Frequency distribution of registered unit standards according to the seven technical learning areas and three different NQF levels

Learning area	NQF level			Total
	3	4	5	
Irrigation Engineering	0	1	2	3
Irrigation. Economics	6	6	11	23
Irrigation Water. Management	2	2	4	8
Legislation : irrigation	2	2	3	7
Crop production	4	9	16	29
Soil	0	1	1	2
Agro climatology	0	0	0	0

The evaluation of the technical unit standards reveals that a great number of the unit standards currently registered with SAQA on these three level descriptors are registered in crop production (40%) and irrigation economics (31%), while only a few are registered in the other learning areas. No unit standards are currently registered for agro climatology.

Extension unit standards

The third part of the reconnaissance involved the collating and assessing of agricultural unit standard qualifications in Agricultural Extension developed by the Standard Generating Body (SGB) of Agricultural Extension.

At the start of the project no unit standard base qualifications in Agricultural Extension were registered with SAQA. Twenty one extension related unit standards registered on NQF level descriptors 3-5 were identified as revealed in Table 6.4.

Table 6.4. Extension related unit standards registered with SAQA

Qualification	NQF level	Number of US
National Certificate: Land care production	5	8
National Certificate: Plant Production	5	7
National Certificate Plant Production	4	3
National Certificate Plant Production	3	1
National Certificate Animal Production	5	2

The South African Society for Agricultural Extension took initiative during 2001 with the establishing of a SGB for Agricultural Extension to develop unit standard qualifications in Agricultural Extension. In 2005 the SGB for Extension started with a process to develop Unit Standards and qualifications for Extension. Approximately 55 extensionists participated in the program and in October 2006 the SGB submitted the following qualifications to SAQA for registration:

- National Certificate: Agricultural Extension Level 3
- National Certificate: Agricultural Extension Level 4
- National Certificate: Agricultural Extension Level 5

- Diploma: Agricultural Extension Animal Production Level 5
- Diploma: Agricultural Extension Plant Production Level 5
- Diploma: Agricultural Extension Land Use Management Level 5
- Advanced Diploma: Agricultural Extension Level 6
- Honours degree: Agricultural Extension Level 7

Since the learning material was in the process of development and not yet registered and available from SAQA or AGRISETA during this phase of the project, the information was collected through face-to-face interviews, telephonic and electronic correspondence with subject matter specialist involved in the developing of the learning material. Table 6.5 reveals the unit standards (NQF level 3, 4, and 5) developed by extension specialists since 2005.

Table 6.5. Summary of extension unit standards to be registered on NQF levels 3-4 of AgriSETA as related to irrigation water management

SAQA Qualification ID	Qualification Title	US title	NQF level outcome
	National Certificate: Extension	Demonstrate an understanding of extension program planning	**3**
		Understand the principles of extension evaluation	**3**
		Demonstrate an understanding of networking principles	**3**
		Demonstrate an understanding of agricultural decision-making	**3**
		Demonstrate an understanding of community development issues	**3**
		Assist in the organisation and functioning of groups	**3**
		Demonstrate a basic understanding in the transfer of appropriate information, skills and technology within an extension environment	**3**
SAQA Qualification ID	**Qualification Title**	**US title**	**NQF level outcome**
	National Certificate Extension	Contribute to the evaluation of an extension program	4
		Implement an intervention plan to transfer appropriate technology	4
		Identify, interact with and support structures in a community	4
		Identify, interact with and support structures in a community	4
		Implement plans for behavioural change and innovation	4
		Monitor group according to principles of group dynamics	4

Table 6.6. Summary of extension unit standards to be registered on NQF level 5 of AgriSETA as related to irrigation management

SAQA Qualification ID	Qualification Title	US title	NQF level outcome
	National Diploma Extension	Develop and implement an extension program plan	5
		Evaluate an extension program in a simple setting	5
		Demonstrate an understanding of the fundamentals and practice of agric extension as a profession	5
		Establish sustainable structures in a community	5
		Explain how to manage diversity in the workplace	5
		Demonstrate an understanding of extension management	5
		Facilitate a group to achieve a stated objective or solve a problem	5
		Display cultural awareness in dealing with farmers and extensionists	5
		Manage volunteers in agric project or event	5
		Plan and implement interventions and opportunities for transfer of technology	5
		Implement strategies for behaviour change in agric extension	5
		Apply group dynamic principles in order to guide a group towards independence and sustainability	5
		Guide and support farmers and communities to make sound agric decisions	5
		Apply principles and functions of extension in practice	5
		Develop and update networks	5

The training material (NQF 6 level) on agricultural extension is comprehensive and addresses the majority of requirements expressed by the subject matter experts during the Stakeholder Workshop and the needs expressed by extension practitioners during the discussion forums held with them. The unit standards on a NQF level 5 that were registered before 2005 with regard to agricultural extension were found to be insufficient to address all the learning needs of extensionists, in that it was mainly addressing aspects like communication at the work place, leading a team, aspects of community development, integrated farm layout and site selection and the designing and implementation of a resource management plan. Therefore to address the need to acquaint extension workers with the necessary skills and competencies in agricultural extension, the new unit standards have been developed by the Agricultural Extension SGB, which need to be implemented by the tertiary institutions.

7. DEVELOPMENT OF TECHNICAL AND EXTENSION FRAMEWORKS

The following part of the report describes the development of technical and extension frameworks, which are reflected in the development of the learning guides (Technical Learning Guide: Volume 2; Extension Learning Guide: Volume 3).

7.1 Contextual analysis of irrigation farmers and irrigation extensionists

At the beginning of this phase of the development of the learning material the team together with the subject matter specialists involved in the process took the time to define the context of the irrigation extensionists in which he/she operates daily as well as that of the irrigation farmer. This step helped to contextualise essential skills, knowledge and elements required from irrigation extensionists. In other words, to ensure that everybody involved in the development of the learning material are familiar with the typical environment and the system in which irrigation extensionists and farmers operate and which could influence their behaviour and choices.

Table 7.1. Contextual analysis of an irrigation extensionist*

Elements	Interaction	Skills
Farming community	Need analysis Advice Training Vision building Capacity building Irrigation technology transfer Group mobilization Project management Build a bond or trust	*SOFT SKILLS:* Understanding human behaviour Networking ability Group mobilization and leadership development Organizational development Participatory techniques and methods Adult/experiential learning Effective communication
Mainstream market	Identify Facilitate process	
Niche market	Identify Facilitate process	
Natural resources	Establish database Resource conservation Participatory action research	*HARD SKILLS:* Computer skills On farm trial management Basic irrigation financial planning and management Marketing Business insight
Financial services	Help to compile a business plan	
Technical support system		
Social environment		
Data		
Information		
Other notes: inputs supply; technology development on the farm; master farmer		

* *Characteristics, communicator, openness, practical farmer, leader*

This “context” refers to physical, emotional or the social nature of it. Information emanating from the defining of the context strongly influences and determines the activities a person engages in, as well as the skills and the knowledge a person requires interacting in a meaningful manner within his/her context.

The following contextual analysis was developed for an irrigation extensionist and farmer, according to the following headings:

- The elements of the context.
- Ways in which the irrigation farmer will interact or interface with the elements.
- The skills needed by the farmer to be proficient in the interactions.

Table 7.2. Contextual analysis of an irrigation farmer

Elements	Interaction	Skills
Soil	Soil sampling	Seedbed preparation Soil sampling methods
Irrigation	Planning and budgeting of irrigation system Irrigation management Irrigation scheduling Fertigation	Determine water availability and quality Maintaining of irrigation system Implementation of basic irrigation scheduling plan Implement a fertigation plan
Finance	Choice and selection of creditors Appropriate financing	Budgeting (interim and long term budgets) Preparation of business plan Prepare operational plan
Crop	Choice of crop and /or cultivar	Establish crop
Weeds	Identify and control	Weed control methods Calibration
Pest and diseases	Identify and control	Pest and disease control methods Calibration
Fertilization	Fertilization management and liming	Fertiliser application Calibration
Product	Harvest Grading Packaging	Harvesting method Grading and packaging Tractor driving Operate and maintenance of equipment

7.2 Pathway in the accreditation of learning material

The accreditation frameworks in South Africa are currently undergoing major revision. There is a general perception that the Unit Standards framework is outdated to meet the needs of commerce, agriculture and industry. For this reason the Quality Council for Trades and Occupation (QCTO) has been structured and will aim to develop skills using a more workplace oriented skills development approach. According to the Department of Labour (2008) an occupational qualification represents the achievement of a planned combination of learning outcomes which is intended to provide qualifying learners with the applied competence to practice an occupation, to perform occupationally related skills sets and to provide a basis for further learning. Occupational qualifications develop under the auspices will contain three components:

- Knowledge and theory component
- Practical skills component
- Work experience component

According to the draft policy of 2008 by the Department of Labour, the Occupational Qualification Framework (OQF) will cover all NQF levels. The level at which occupational qualifications will be registered on the NQF will be determined by NQF level descriptors as determined by SAQA.

After attending the workshop on 17 June 2008 where the Department of Labour and representatives of the Department of Agriculture were met, it was clear that the legislative process of establishing the Quality Council for Trades and Occupations is still in process and that various elements of uncertainty prevail.

The project team took the decision that it will proceed with the development of the learning material according to the current Unit Standards framework (OBE Format) on a NQF level 5 that is required for the training on a diploma or advanced certificate level. The fact that the development of the learning material was approached from the occupational view of the irrigation extensionists and contextual requirements of the irrigation farmer will address the labour market needs as been stipulated in the new proposed policy of the Department of Labour. The learning material will provide occupational competence and meaningful knowledge and skills sets related to the occupation (Figure 7.1).

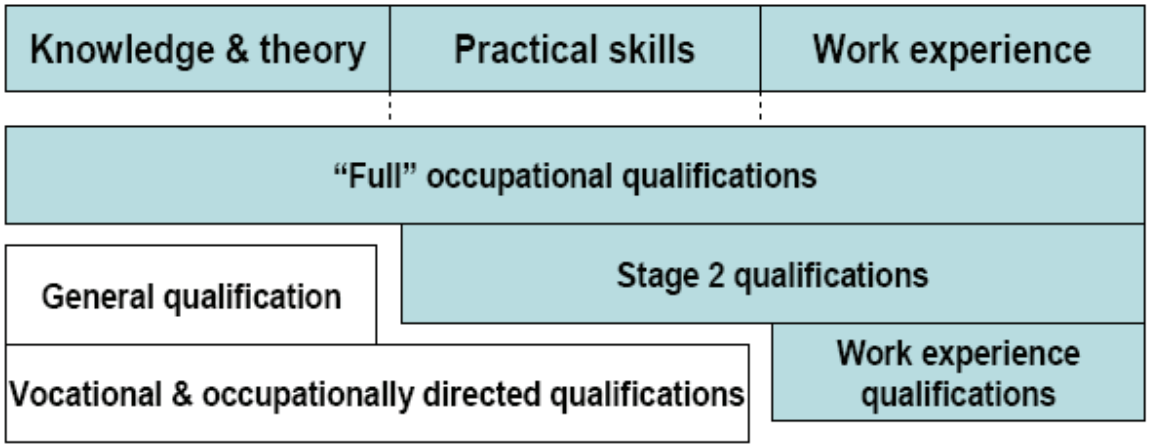


Figure 7.1. Scope of occupational qualifications

According to the policy document of Department of Labour (2008), this will provide greater consistency and coherence in the development and implementation of learning programs linked to occupations and occupational qualifications.

7.3 Identifying of SMEs and authenticators

Subject matter experts and authenticators were identified who guided and informed the design and development of the learning material. The subject matter experts (SMEs) were grouped in terms of the "topics" or learning areas that fit their expertise best. They were asked to develop technical and extension frameworks that will address the specific competencies required from irrigation extensionists. The biggest challenge experienced by developers of these frameworks was to take the contextual environment of the irrigation extensionists and farmer into consideration and develop frameworks that will address the practical needs of the irrigation extensionist on a NQF 5 level. It was important with the development of frameworks to develop material by taking into account the different levels of competencies required from the irrigation extensionists:

- ✓ *Foundational competence*: as demonstrated through the understanding of what an irrigation extensionists is doing and why he/she is doing it.
- ✓ *Reflexive competence*: as demonstrated through the ability to integrate or connect performances with the understanding of the irrigation extensionists so that he/she learns from his/her actions and is able to adapt to changes and unforeseen circumstances.
- ✓ *Practical competence:* as demonstrated through the ability to perform a set of tasks that refers to the psychomotor domain of human learning.

7.4 Checklist use for testing of learning outcomes

The following checklist was taken into account with the development of frameworks and content for the technical and extension learning material to ensure that it will comply with the principles of OBE (Table 7.3). Reviewers were asked to complete this checklist with evaluation of technical and extension learning material.

Table 7.3. Checklist for writing learning outcomes (Moodie, 2002)

Does the learning outcome clearly and concisely state the learning that is expected to take place?	Yes	No
Is the learning outcome specifically written in terms of specific knowledge, exact skills and attitudes?	Yes	No
Does the learning outcome provide direction and a target for the learners and the educators to aim for?	Yes	No
Can the content and assessment be developed using the learning outcomes?	Yes	No
Does the level of complexity of the learning outcome achieve a certain standard? (The level of complexity should be determined in the assessment of the training agent's needs, the task analysis, and the learning needs assessment).	Yes	No
Will the learners be able to be assessed on the demonstration of the knowledge, skills and attitudes that are stated in the learning outcome? Are the learning outcomes quantifiable and verifiable?	Yes	No
Can the learning outcomes be used when choosing the most appropriate instructional tools and developing learning activities or tasks?	Yes	No
Are the learning outcomes achievable within the constraints of the learning program?	Yes	No
Can the learning outcomes be achieved in the allotted time?	Yes	No
Is each learning outcome linked to other learning outcomes? It should not be a stand-alone statement.	Yes	No
Are the learning outcomes sequenced from simple to complex so that each learning outcome is reinforced by sequent learning outcomes?	Yes	No
Can the learners use the learning outcomes to organise their work schedules?	Yes	No
Can the learners use the learning outcomes to monitor their progress?	Yes	No

During the drafting and testing of frameworks for the relevant learning material the following questions have to be addressed by the developers and based on the outcome certain adjustments were required:

- Who are the learners?
- What is the scope and aim with the module?
- What is the prior knowledge that a learner should acquire?

- What are the outcomes of this training module?
- What is the order in which the learning will take place?
- What methods will be used for training? (Visual and practical hands on training methods)
- What materials are required for training?
- When and how will the assessment of learning be done?
- What is the time frame for learning?

7.5 Development of technical frameworks

As been reflected earlier in this report, 74 agricultural technical unit standards were found to be registered with SAQA and AgriSETA on NQF levels 3, 4 and 5. The majority of these unit standards are registered in crop production (40%), while only a few are registered in soil, agricultural law and legal aspects, irrigation management, irrigation engineering aspects and agricultural economics. No unit standard was found registered in agro-climatology. This assessment and evaluation of the available technical learning material guided the project team in giving priority to the development of training material in agro-climatology and irrigation management.

7.5.1 Selection of subject matter specialist and drafting of landscape

The participants in the development of the technical training modules represent the irrigation industry and the related subject matter disciplines identified like crop, soil, agro climatology, agricultural economics specialists, etc. The process of designing of frameworks started with the identification of subject matter specialists for the technical learning areas as well as team members with appropriate skills and knowledge to steer the process. The desired outcomes and format of the training material were discussed to ensure consensus in the final product envisaged.

7.5.2 Drafting of a landscape for each technical learning area

The initial step was to do a contextualization of the essential skills, knowledge and elements required from irrigation extensionists. A *landscape* was drafted for each of the learning areas identified during the Stakeholder workshop and the discussion forms held with extension workers. The main sketches of the learning and content areas were used for the development of landscapes for each of the training modules. In the development of landscapes for each learning area, the essential knowledge and skills required from an irrigation extensionists were sketched together with the “building blocks” or main learning outcomes required to address these requirements.

7.5.2.1 Landscape for agro climatology

The following skills and minimum understanding was used as reference framework for the development of the framework on agro-climatology.

Technical learning area	List of possible modules
Agro climatology	1.Basic understanding to climate and the influence on crop production 2.Basic understanding of the influence of climate on irrigation management (interpretation of weather data, basic skills and knowledge to make use of weather stations) 3. Introductory on concepts and influence of climate on crop production and irrigation management 4. Introduction to hydrological cycle 5. Introduction and basic understanding of the concepts evaporation, radiation, relative humidity, wind, evapotranspiration 6. Interpretation of climate data (SAPWAT, etc.)

The envisaged training in agro climatology will not be offered on a level which will enable learners to make complicated calculations and recommendations in agro climatology. The aim is rather to provide learners with a general overview (NQF level 5) of the agro-climatic factors that need to be taken into consideration for effective irrigation management. This will enable them to communicate effectively with subject matter specialists and farmers in this regard.

Landscape for agro climatology

The initial framework drafted for the compiling of the draft learning material on agro climatology was reworked after extensive consultation with extensionists and subject matter specialists in an effort to steer and help the writer of these modules to be focused.

Elements	Interactions	Essential knowledge/skill areas required from irrigation extensionists
1. Introduction to climate and weather	• What is weather? • What is climate? • Difference between macro, meso and microclimate	• Define climate and weather • Distinct ate between macro, meso and micro climate
2. Seasonal influence on climate	Four seasons influence on climate, radiation energy and duration of radiation according to season	• Understand the effect of seasons on climate
3. Hydrological cycle	• Hydrological cycle • Processes of water storage and movement in the hydrological cycle: o Precipitation o Evaporation o Condensation: concept, factors affecting condensation like topography, fronts and convergence o Evapotranspiration o Transpiration: concept, rate of transpiration, how measured o Runoff: precipitation, flooding, overview of the situation in SA o Infiltration o Groundwater flow o Melting (snow)	• Basic understanding of hydrological cycle and the processes of water movement and storage • What factors control the rate of evaporation and transpiration • What is potential evapotranspiration and how does it differ from actual evapotranspiration? • Identify factors that influence evaporation, transpiration and evapotranspiration

Elements	Interactions	Essential knowledge/skill areas required from irrigation extensionists
4. Evaporation, transpiration and evapotranspiration	• Factors effecting transpiration, role in irrigation efficiency, stomatal control, importance of differences between different crops and cultivars regarding stomatal control • Factors affecting evaporation: effect on suitability of irrigation systems (evaporation map?) • Actual and potential evapotranspiration. Potential evapotranspiration map of SA • Water budgets for SA different regions	• Understand concepts evaporation, evapotranspiration and crop factors • Basic knowledge of factors influencing evaporation • Ability to interpret potential evaporation map • Understand principles of water budgets and ability to interpret data on water budgets
5.Climatic factors that influence irrigation management		Basic understanding and conceptualization of factors that influence climate and irrigation cropping systems and the management
5.1. Temperature	• Introduction to temperature, heat units, cold units • Max, min and mean temperatures • Factors affecting temperature: altitude, latitude, slope/aspect, etc. • Seasonal maps for max, min, and mean temp • Heat units: heat unit map of SA • Cold units: cold unit map of SA • Ehlers temperature map	
5.2. Atmospheric humidity	• Concepts precipitation and atmospheric humidity • Vapour pressure • Dew point temperature • Relative humidity (RH): seasonal patterns in different parts of SA • + or – impact of RH (high or low) on some important crops in different parts of SA	
5.3. Precipitation: 5.3.1 Rainfall/mist/fog/ dew/snow	• Types of rainfall • Factors affecting rainfall: • effect of topography on rainfall • seasonality of rainfall • Rainfall map of SA: average rainfall, rainfall decadel figures • Rainfall seasonality: winter/summer-peaks and drought periods (mid-summer droughts) • Variability, reliability, efficiency • Contribution of dew, frost, mist and snow to amount of plant-available water	
5.3.2 Hail	• Frequency, severity and seasonality of hail in different parts of SA • “Hail belts” at micro level • Impact of hail on crop production management	
5.3.3 Frost	• Factors affecting incidence and severity of frost • Entry and exit dates of frost for various areas in SA (Maps) • Differences in incidence of frost at meso and micro level: • Effect of wind breaks • Effect of local topography	

Elements	Interactions	Essential knowledge/skill areas required from irrigation extensionists
	• Sensitivity or tolerance of different crops to frost (sensitivity to growth stages of crop) • Measures and technologies to combat frost damage in high value crops (table grapes, deciduous and pome fruit)	
5.4. Wind	• Strength/velocity, frequency , direction and seasonality distribution of prevailing wind • Characteristics and impacts of different types of winds: e.g. " bergwind" • Effect of topography: exposure of certain slopes to wind, effect on irrigation management • Sensitivity/tolerance of crops to wind • Effect of wind on irrigation-overhead irrigation • Wind breaks	
5.5. Day length and radiation	• Variations in day length and radiation with latitude • Effect of misbelts on light intensity • Response of different crops to different day length • Role of aspect, slope inclination and topography on radiation	
6. How do we monitor climate?	• Automatic and mechanical weather stations • Use of degree days • Köppen Geiger climate map or system	• Basic ability to interpret data from automatic weather station • Ability to interpret information from the Köppen Geiger climate map of SA • Ability to apply weather data in the planning of a cropping system and irrigation management plan
UPSTREAM	1. Agric. & Extension Research	i) New innovations (5-10 years in advance) ii) Adaptation and transformation of technology to be applicable to the specific farm & farmer situation – sustainability.
	2. Technical skills & knowledge in Agriculture	i) NQF Level 5 Qualification in Agriculture (Nat. Diploma) ii Specific agric. Skills programs (short courses) – certificates SAQA accredited.
	3. Knowledge Support Service (SMS)	i) Subject matter specialists to support extensionists.
	4. Soft skills	i) Understanding human behaviour ii) Networking ability iii) Organisational development iv) Adult/experiential learning v)Entrepreneurial skills training (management training – to manage any enterprise)
	5. Quality control	i) Monitoring and Evaluation of extension (accountability and responsibility)

Elements	Interactions	Essential knowledge/skill areas required from irrigation extensionists
	6. Finance (budget)	i) Salary ii) Working capital iii) Equipment
DOWNSTREAM	1.Agric. Management	Farming is a business – economically viable and sustainable
	2. Land care	Conservation of the environment
	3. Land reform and irrigation revitalization	Priority program
	4. Agric. And marketing policy	Global competitiveness
	5. Political expectations	Restructuring

- ***The highlighted "Upstream" and "Downstream" as illustrated in this framework for agro- climatology will be the same for the other technical and extension frameworks that will follow, and will therefore not be included in the illustrated frameworks.***

7.5.2.2 Landscape for irrigation water management

The following skills and knowledge in irrigation water management were identified for effective extension delivery after various discussions held with subject matter specialists and extensionists in the various provinces.

Technical learning area	List of possible modules
Irrigation Water Management	1.Basic understanding of the different tools and approaches to select from with regard to irrigation scheduling 2.Basic understanding of principles applicable with regard soil-crop-atmosphere interaction and plant water consumption 3.Basic understanding of the soil water balance principles 4.Basic understanding of the consequences of over- and under irrigation 5.Basic knowledge and skills to help a farmer to calculate on-farm water use efficiencies 6.Basic understanding of the principles that apply with scheme management 7. Basic knowledge of water measurement concepts (units, methods, dam capacity, stream flow, etc.) 8. Basic principles in fertigation 9. Basic principles in management of poor irrigation water quality 10. Basic understanding and skills required for the planning of irrigation 11.Irrigation management principles applicable to ensure water sustainability

Landscape for irrigation water management

The aim with this learning material is to acquaint learners with a comprehensive understanding of irrigation water management principles, basic understanding of soil-plant-atmosphere continuum, introduce them to various irrigation systems that can be selected, understanding of the layout and operation of an irrigation system and what is expected regarding efficient irrigation water management on the farm.

Elements	Interactions	Essential knowledge/skill areas required from irrigation extensionists
1. General introduction	• Principles of irrigation • Irrigation in practise • The wetting front	• Understand the concept and principles of irrigation • Define a wetting front

Elements	Interactions	Essential knowledge/skill areas required from irrigation extensionists
	• Advantages of irrigation	• Ability to identify advantages of irrigation
2. Assessing water resources	• Identification of various water resources (rivers, dams, canals and boreholes) • Calculations of water requirements for various enterprises	• Identify and assess the quantities of water available from various sources • Estimate the amounts of water required for various irrigation enterprises
3. Irrigation water quality	• Common irrigation water quality problems • Effect of salinity, pH, sodium, chloride on crop growth • Effect of algae and pesticides on irrigation efficiency • Interpreting of water analysis • Management practices for poor water quality	• Understand the importance of water quality for irrigation • Basic knowledge of water quality problems • Ability to interpret water analysis • Basic knowledge of plant sensitivity to water salinity • Ability to manage poor water quality
4. Planning for irrigation development	• Why do we plan? • Factors determining the choice of an irrigation system: a. Physical a. Availability of water b. Water quality, c. Soil texture d. Soil depth and drainage e. Topography f. Climate g. Crop h. Energy sources and costs b. Economical a. Capital investment and period b. Expected lifespan of irrigation system c. Costs for maintenance and operation d. Labour and supervision e. Efficiency of irrigation system f. Viability of irrigation development c. Institutional a. Management requirements for specific irrigation system b. Labour c. Availability of support service (extension and technical) d. Water legislation e. Maintenance and operation requirements of system	• Basic understanding of the factors determining the selection of an irrigation system • Ability to apply the checklist for the planning of an irrigation system

Elements	Interactions	Essential knowledge/skill areas required from irrigation extensionists
	f. Socio-economic issues g. Personal consideration h. Environmental impact • Planning checklist • Designing of irrigation systems	
5. Introduction to irrigation systems	• Sprinkler irrigation o Permanent o Semi-permanent ▪ Semi dragline • Floppy • Quick coupling/fixed base system • Micro irrigation • Mechanised sprinkler irrigation o Centre pivot o Travelling gun • Dip irrigation • Flood irrigation o Furrow o Border o Basin	• Basic understanding of the various irrigation systems • Ability to help with the selection of the most appropriate irrigation technique for varying circumstances
6. Layout of irrigation system	• Basic system layout • Pumps o Function of pumps o Types of pumps o Pump house checklist o Net positive suction head (NSPH) • Pipelines • Filtration o Pre filtration o Types of filters o Filter system • Management of filter system	• Basic understanding of functioning of the different components of an irrigation system
7. Irrigation scheduling	• Why irrigation scheduling • Principles of irrigation scheduling • Advantages of irrigation scheduling • Crop water requirements o Crop growth stages o Drivers of crop water use • Introduction to various irrigation scheduling methods and techniques • Planning of irrigation schedule o Crop o Soil o Climate o Irrigation system o Management o Calculation of irrigation requirements	• Basic understanding of principles of irrigation scheduling • Determine crop water requirements • Compare irrigation scheduling methods • Develop an irrigation schedule

Elements	Interactions	Essential knowledge/skill areas required from irrigation extensionists

8. Fertigation	• Introduction to fertigation
	• Reasons for application of chemicals through the irrigation system
	• Planning of fertigation program
	  o Types of fertilisers for fertigation
	  o Production mixtures and solubility
	  o Timing of fertigation
	  o Ratios and units in fertigation
	• Fertigation methods and techniques
	  o Quantified fertigation
	  o Proportional fertigation
	  o Fertigation techniques:
	  ▪ Injection through suction pipe of pump
	  ▪ Injection through suction pipe of pump
	  ▪ Injection of fertiliser with pump
	  ▪ Hydraulic and Venturi type injectors
	  ▪ Stock solution stored in storage dam
	  ▪ Crop spray inject into system
	  ▪ Multisystem inject controllers
	• Calibration and calculation of fertigation injections
	• Precautionary measures with fertigation
	• Herbigation, insectigation, fungigation and nemigation
	• Prevention of clogging of irrigation equipment:
	  o Chlorination
	  o Hydrogen peroxide
	  o Flocculation, aeration and sedimentation
		• Basic understanding of chemigation and fertigation
		• Planning of fertigation program
		• Basic understanding of various fertigation methods and techniques

9. Irrigation benchmarking	• What is irrigation benchmarking? • Principles in irrigation benchmarking • Key performance indicators	• Understand the use of water efficiency benchmarks for a farm • Ability to identify key performance indicators for benchmarking water use on the farm

7.5.2.3 Landscape for Irrigation Engineering

The following skills and knowledge in irrigation engineering were identified for effective extension delivery.

Technical learning area	List of possible modules
Irrigation engineering	1. Basic understanding and ability to determine area, peak demand and water availability 2. Basic understanding to provide appropriate advice on the location in terms of distance/height/cost 3. Appropriate knowledge and skills to help with the selection of adapted irrigation systems 4. Basic understanding of the principles applicable with the evaluation and maintenance requirements of the selected irrigation system 5. Basic understanding and skills needed to determine the application and distribution efficiency of an irrigation system 6. Basic understanding of the principles applicable with the implementation of on-farm conservation practices (drainage) 7. Basic understanding of the principles applicable with the implementation of small-scale water harvesting 8. Basic understanding with regard to different irrigation systems and irrigation in general

The objective with this learning guide in irrigation engineering is to provide learners with an overview of the irrigation engineering aspects as required for effective management of irrigation systems. Therefore the project team in close consultation with subject matter experts and irrigation engineers identified the following to be included:

- Maintenance of irrigation systems from the farmer or irrigation manager's point of view
- Evaluation of various irrigation systems once again form the farmers' perspective
- Basic understanding of conservation practices like drainage, contours and waterways

This knowledge and skills will enable the extension agent to communicate effectively with specialists like irrigation engineers. The following framework was adopted for the development of this learning material.

Landscape Irrigation Engineering

Elements	Interactions	Essential knowledge/skill areas required from irrigation extensionists
1. Irrigation system maintenance	• Basic maintenance requirements o General maintenance ▪ Pipes ▪ Valves ▪ Air valves ▪ Pumps and electrical motors ▪ Filters ▪ Water meters o Sprinkler system o Centre pivot	• Basic knowledge of requirements for maintenance of various components of irrigation system • Ability to observe whether an irrigation system is correctly functioning

Elements	Interactions	Essential knowledge/skill areas required from irrigation extensionists
	○ Drip irrigation ○ Micro irrigation ○ Dragline • General trouble shooting of problems ○ Pumps and electrical motors ○ Filters ○ Valves ○ Supply system ○ Irrigation system	
2. Field evaluation of irrigation systems	• Pump and pump station ○ Pump suction end ○ Pumps (operation and power required) ○ Electrical motor ○ Alignment of pump • Supply system ○ Pressure readings ○ Delivery readings ○ Evaluation procedure • Irrigation systems: ○ Moving system (Centre Pivot) ○ Sprinkler irrigation system ○ Micro irrigation system ○ Flood irrigation system ▪ Test procedure, e.g. catch can layout ▪ Evaluation of mean application rate (MAR) ▪ Distribution efficiency (DU) ▪ Pressure reading • Interpretation of evaluation sheets	• Basic understanding of the meaning of "irrigation efficiency" • Basic knowledge and understanding of general evaluation of the pump station, pump, supply system and irrigation system • Ability to interpret evaluation sheets
3. Soil conservation	• Sustainable agriculture • What is soil conservation? • Principles of soil conservation and Landcare • Soil conservation practices and structures: ○ Drainage ○ Contours ○ Waterways ○ Reduced tillage ○ Cover crops	• Basic knowledge and understanding on various soil conservation practices • Basic understanding of principles applicable for soil conservation and land care regarding irrigation fields

7.5.2.4 Landscape for Irrigation Legislative Context

The following essential knowledge about the legal environment in which an irrigation farmer operates was identified.

Technical learning area	List of possible modules
Legal aspects regarding irrigation	1. Interpretation and understanding of water use right and allocation for irrigation 2. Basic understanding of water availability and licensing for water use right 3. Determination of water reliability 4. Basic understanding of water quality and its influence on crop production and quality maintenance (ecology)

This broad framework served to develop a landscape, which was used to describe the basic knowledge and understanding required to apprehend the legal environment of an irrigation farmer. After consultation with experts in this field, the initial framework was adjusted and redrafted.

Landscape for Irrigation Legislative Context

Elements	Interactions	Essential knowledge/skill areas required from irrigation extensionists
1. Agricultural policy 1995	• Why we need a proper planned Agricultural Policy • Importance of irrigated agriculture for food security • Strategic Plan for South Africa • Additional legislation that impacts on irrigation farming: o National Environmental Act No 107 of 1998 (NEMA) o Section 24 of the Constitution of SA o National Water Act, No 36 of 1998 o Environment Conservation Act No 73 of 1989 o Fertiliser, farm feed, Agricultural Remedies and Stock remedies, 1974 (Act No 36 of 1947) o Fencing Act, 1963 9Act No 31 of 1963) o Agricultural credit Act, 1966 (Act No 28 of 1966) o Marketing Act, 1968 (Act No 59 of 1968) o Subdivision of Agricultural Land Act, 1970 (Act No 70 of 1970) o Plant Breeders Rights Act, 1976 (Act No 15 of 1976) o Plant Improvement Act, 1976 (Act No 53 of 1976) o Cooperatives Act , 1981 (Act No 91 of 1981) o Perishable Products Export Control Act , 1983 (Act No 9 of 1983) o Agricultural Pests Act, 1983 (Act No 36 of 1983) o Conservation of Agricultural resources Act,	• Basic knowledge and understanding of the Agricultural Policy, 1995 • Basic knowledge and understanding of the legal environment in which the irrigation farmer operates

Elements	Interactions	Essential knowledge/skill areas required from irrigation extensionists
	1983 (Act No 43 of 1983) o Agricultural Produce Agents Act, 1992 9Act No 12 of 1992) o Land Reform (Labour Tenants) Act No 3 of 1996 (LTA) o Extension of security of tenure Act No 62 of 1997 (ESTA) o Land restitution of land Rights Act No 22, 1994 o Basic Conditions of Employment Act 75 of 1997 o Labour Relations Act 66 of 1995 o Employment Equity Act o Skills Development Act 97 of 1998 o Occupational Health and Safety Act o Unemployment Insurance Fund Act	
2. National Water Act (1998) and registration of water users	• National Water Policy • Purpose of Act • Authorisation of water use o Registration as water user under water Act No 36, 1998 (Entitlements) (Section 21) o Reasons for registration of water use o Transfer of authorization o Requirements for registration of storage dams o Classification of dams • Water allocation and regulations • Irrigation water charges	• Basic knowledge and understanding of the National Water Act • Basic knowledge and understanding of the various water management strategies • Basic knowledge and understanding of dam safety and legislation requirements • Basic knowledge about water allocation and differential charges
3. National Water Resource Strategy	• Main objectives with NWRS • Integrated water resource management principles • Water management institutions • Strategies for water resource management o Protection of groundwater o Strategies to balance supply and demand o National water conservation and demand strategy o Water pricing strategy	• Basic knowledge and understanding of: o Integrated water resource management o Different water institutions that play a role o Different strategies applied for water resource management
4.Irrigation strategy for South Africa	• The purpose of an Irrigation Strategy for South Africa • Challenges for irrigated agriculture in the country • Institutional strategies required for effective irrigated agriculture • Non-institutional strategies required for effective irrigated agriculture	• Basic knowledge and understanding of: o Purpose and need for an irrigation strategy o Challenges for irrigated agriculture in the country o Different strategies required for improving irrigation efficiency

7.5.2.5 Landscape for Assessing of Soil Resources

Practitioners and subject matter specialists identified the following skills and knowledge in soil science during discussion forums and stakeholder workshops held.

Technical learning area	***List of possible modules***
Soil	1.Soil genesis: soil composition, soil forming and soil classification 2.Interpret soil profile for irrigability by using relevant parameters 3.Interpret texture in terms of water holding capacities 4.Observe visible signs of problems (water logging, salinity, crusting, restrictive layers) 5.Identification of potential water-logging problems and drainage potential 6.Basic interpretation of chemical and physical parameters of soil 7.Basic soil mapping/profile interpretations/soil sampling 8.Interpretation of soil topography 9.Interpretation of Landsat/ aerial maps 10.Maintenance of soil fertility and principles of soil fertility 11. Basic skills in soil preparation/cultivation 12. Basic principles of land care and soil conservation 13. Land use planning: steps to be taken with land use planning

The objective with this learner guide in soil science is to provide learners with a basic but comprehensive understanding (in depth) of the soil factors that is required for land suitability evaluation and land use planning for irrigated agriculture and in irrigation management. The following framework of learning content was developed to identify possible modules to address the knowledge and skills required for irrigation extensionists to function effectively. Specific attention in the development of the learning material was given to soil requirements (ideal conditions) and tolerances of crops grown under irrigation – with emphasis on the different crops.

Landscape for Assessing of Soil Resources

Elements	**Interactions**	**Essential knowledge/skill areas required from irrigation extensionists**
1. Importance of soil in irrigated agriculture	• Importance of soil in irrigated agriculture • SA irrigable soil resources • Soil science terminology	• Basic understanding of the importance of soil in irrigation
2. Introduction to soil	• What is soil • Components of soil • The soil profile and soil horizons	• Basic understanding of soil and main components of soil • Identify soil layers
3. Soil formation	• Soil forming process o Additions o Transformations o Translocations o Losses (evaporation, organic matter, erosion, etc.) • Soil forming factors o Climate	• Basic understanding of the soil forming process • Basic understanding of the role of soil forming factors

Elements	Interactions	Essential knowledge/skill areas required from irrigation extensionists
	○ Parent material ○ Topography ○ Living organism ○ Time	
4. Soil texture (Particle size distribution)	• Introduction to soil texture • Soil particle size classes • Soil texture • Soil mineralogy • Importance of soil texture	• Understanding of impact of soil texture and structure on irrigability and waterholding capacity of soil • Understanding of soil texture on water holding capacity
5. Soil organic matter and soil organisms	• Introduction to soil organic matter and organisms • Factors affecting the organic matter content of soils ○ Organic matter ○ Temperature ○ Aeration ○ Texture • Soil organisms (soil borne diseases and examples of it in SA)	• Basic understanding of the role of soil organisms and organic matter on irrigability
6. Cation adsorption and exchange	• Cation adsorption and the cation exchange capacity of soils • Factors affecting the CEC of soil ○ Soil texture and more specifically clay content of soil ○ Type of clay mineral ○ Organic matter	Basic understanding of: • Concept cation adsorption and exchange capacity of soils • Factors affecting the CEC of soil
7. Flocculation, dispersion, swell and shrink	• Flocculation and dispersion • Swell-shrink phenomena in soils	• Basic understanding of the concepts flocculation and dispersion
8. Soil structure	• Description and classification of soil structure ○ Types of structure ○ Soil structure classes ○ Grades of soil structure • Soil structure formation • Stabilization of soil structure	• Basic understanding of soil structure formation • Ability to identify soil structure classes and grades of soil structure • Identify effective rootzone
9. Bulk density and soil porosity	• Bulk density • Soil porosity (macro and micropores)	• Basic understanding of the concepts bulk density and soil porosity
10. Soil aeration and soil colour	• Soil aeration • Basic factors regarding soil aeration (soil air volume, gas exchange in soils, aeration requirement) • Consequences of poor soil aeration • Sensitivities of different crops to poor soil aeration	• Ability to identify soil aeration • Basic knowledge of sensitivities of different crops to poor soil aeration

Elements	Interactions	Essential knowledge/skill areas required from irrigation extensionists
	• Soil colour as indicator of soil aeration	
11. Soil compaction	• Typical compacted zones in irrigated soils in South Africa • Criteria for measuring degree of compaction • Soil factors affecting susceptibility of a soil to compaction • Management systems affecting soil compaction • Effects or consequences of soil compaction	• Basic understanding of the concept soil compaction and ability to address the problem
12. Soil crusting (surface sealing)	• Mechanisms of crust formation • Soil factors affecting soil crusting in SA • Effects on soil crusting • Management factors and soil crusting	• Basic understanding of the concept soil crusting and ability to address the problem
13. Salt affected soils	• Saline soils o Factors causing development of saline soils o General effects of salinity on crops o Effects of specific ions associated with salinity on crops o Management of soil salinity • Sodic and saline-sodic soils o Factors causing development of sodic and saline-sodic soils o Effects of high sodicity in soils o Management of soil sodicity • Irrigation water quality in relation to soil salinity and sodicity o Water quality related to salinity o Water quality related to sodicity o Irrigation water quality in SA	• Assess the suitability of soil for irrigation • Ability to recommend management practices to rectify problems like salinity and sodicity
14. Soil water dynamics	• Infiltration o Infiltration rate o Cumulative infiltration o Infiltrability o Water redistribution in a homogenous soil during infiltration o Infiltration into strongly stratified soils o Methods for determining the infiltrability of soils • Hydraulic conductivity	• Basic understanding of the concept infiltration and factors that determine infiltration rate of soils • Basic understanding of the concept hydraulic conductivity
15. Soil water statics	• Soil water potential • Soil water constants and water retention curves o Field capacity o Permanent wilting point o Soil water retention curves • Plant available soil water • Gravimetric and volumetric soil	• Define the terms field capacity, permanent wilting point and readily available water • Ability to interpret soil water holding analysis and draw water retention curves

Elements	Interactions	Essential knowledge/skill areas required from irrigation extensionists
	water content o Methods	
16. Soil fertility in irrigated agriculture	• Soil pH • Macro nutrients (N,P,K,S,Ca, Mg) • Micro nutrients (B, Cl, Fe)	• Basic understanding of soil fertility • Understanding of the effect of irrigation management on soil fertility
17. Soil surveys for irrigated agriculture	• Preliminary semi-detailed soil surveys • Detailed soil surveys • Base map • Survey techniques • Definition of mapping units and map units • Taxonomic soil units versus soil map units • Soil maps and soil survey reports	• Ability to integrate the knowledge and understanding in detailed soil surveys

7.5.2.6 Landscape for Irrigation Economics

The following skills and knowledge in irrigation economics were identified for effective extension delivery during the various interactions with various stakeholders.

Technical learning area	List of possible modules
Irrigation economics	1. Basic understanding of cost analyses (long-term and short term) 2. Basic understanding and skills to prepare enterprise budgets 3. Basic understanding and skills to prepare whole farm/partial budget 4. Basic understanding and skills to prepare an appropriate marketing strategy for specific farm 5. Basic understanding and skills to help with the selection of appropriate financing alternatives 6. Basic understanding and skills to prepare a risk analysis 7. Basic understanding of cost saving options (e.g. Ruraflex)

Landscape for Irrigation Economics

The initial framework drafted was revised after extensive consultation with specialists and practitioners in order to address the major concerns (Deliverable 24).

Elements	Interactions	Essential knowledge/skill areas required from irrigation extensionists
1. Introduction to farm Management	• What is farm management? • Decision making process • Farmer objectives • Farm enterprises (profitability, income, costs)	• Basic knowledge and understanding of: o the concept farm management o five steps in decision making o farmer goals and objectives (personal and business) o production process on the farm o income, costs and profitability of a farm
2. The farm business and its enterprises	• Income, costs and profitability of farm enterprises	• Basic knowledge and understanding of: o Concept of farm enterprises and their roles in the operation of the farm o Costs, income and profitability o Calculate enterprise gross margins, enterprise profit and whole farm income
3. Production economic concepts	• Input-output ratios • How to produce? • How much to produce? • What to produce? • Cost principles • Economics of scale	• To understand and apply the production function concept • Basic knowledge and understanding of the concept optimum input application or production level to acquire a desired profit level • Basic understanding of the concept optimum combination of inputs at the lowest cost • Basic understanding of the optimum combination of enterprises in order to maximise profits • Basic knowledge and understanding of the cost principles to determine the optimum production level in order to maximise profits with given constraints
4. Marketing	• Introduction to agricultural marketing • The marketing environment (consumer needs, demands, objectives, goals, incentives) • Strategic marketing-the marketing mix • The marketing plan • Marketing costs • Agricultural marketing of commodities in SA	• To understand the scope of marketing activities • To understand the South African agricultural marketing environment as well as the workings of the South African food marketing system • Basic understanding of SAFEX and other marketing instruments • Basic ability to describe and analyse costs of marketing activities • Marketing management within agribusiness sector • Construction of marketing plan
5. Budgets	• Use of budgets as a tool for planning and control • Enterprise budgets • Partial budgets • Break-even budgets • Capital budgets • Total budgets • Cash-flow	• Basic knowledge and understanding for the use of a budget on the farm as a planning tool • Basic knowledge and understanding of the various types of budgets applicable for financial management

Elements	Interactions	Essential knowledge/skill areas required from irrigation extensionists
6. Financial management	• Information systems • Organisational structures • Record keeping and data • Production records • Financial statements • Financial analysis • Investment analysis and decision making	• Basic understanding for the use of an organisational structure • Basic ability to analyse and interpret the financial position of the farm • Basic knowledge and understanding of the financial statements required for effective farm management • Ability to use simple financial analyzing tools to identify problems or shortcomings in financial management • Ability to analyse and interpret appropriate financing options for a farm in a simple setting. • Distinguish between equity and debt financing, understand leverage and determine whether a farm is relying too heavily on debt financing • Understand venture capital and the use of it • Calculate present as well as future values of single amounts, annuities and mixed stream cash flows • Analyse and interpret the financial position of the farm and provide recommendations to improve or maintain the financial situation • Calculate and determine whether a farm should be rented or bought?
7. Financing principles	• Principles of mechanisation costs and interpretation • Mechanisation costs and irrigation • Choosing appropriate asset or machine • Asset replacement	• Basic understanding of: o Sources and types of finance o Criteria financiers use when deciding whether they provide finance o Taxation and the underlying principles
8. Risk management	• Risk in agriculture • Types of risks • Risk management strategies • Responses: o Market-related o Production o Financial responses	• Understand risk in agriculture and identify the various sources of risk • Implement a risk management plan • Understand the different risk mitigation strategies and determine the most suitable one for a given situation
9. The business plan	• Construction of a business plan for an agribusiness venture • Evaluation of a business plan presented for obtaining finance	• Ability to construct a business plan and evaluate one presented for obtaining finance

7.5.2.7 Irrigated crop and fodder production

The following skills and knowledge in irrigated crop and fodder production were identified for effective extension delivery to irrigation farmers.

Irrigated crop and fodder production	1. Insight and knowledge with regard to the selection of adapted crops 2. Ability to help with appropriate cultivars selection 3. Determining of crop water requirements 4. Interpretation of satellite/Landsat/infra-red photos or maps 5. Calculation of production potential or the production level of crops 6. Basic understanding of principles applicable with the implementation of integrated crop/pest/diseases management 7. Basic understanding of principles applicable with the implementation of integrated weed management 8. Basic understanding of fertigation 9. Basic understanding of principles applicable with sustainable crop production practices 10. Basic understanding of principles applicable with the implementation of crop rotation

Landscape for irrigated crop and fodder production

The following framework for the development of learning material on irrigated crop and fodder production was adopted by the project team. Several practitioners participated in the developing of the learning material namely researchers from universities, ARC, private consultants and commodity organisations like Cotton SA and SASRI.

Elements	Interactions	Essential knowledge/skill areas required from irrigation extensionists
1. Cropping systems: growth and development of plants	• The functions of the root system in the growth and development of the plant • Functions of the stem in the growth and development of the plant • Role of the leaf in the plant growth and development • Role of the flower in the reproductive process of growth and development of the plant • Difference between plant growth and development • Different stem and root growth patterns of plants and the implications for the crop farmer • Different types of bud dormancy and the effect on crop management • Different factors affecting plant growth and development and the implications for crop management • Photoperiodism and vernalisation	Basic knowledge and understanding of growth and development of plants
2. Crop water requirements	• Why does a crop consume water? • Crop development stages (critical	Basic knowledge and understanding of basic crop physiology principles,

Elements	Interactions	Essential knowledge/skill areas required from irrigation extensionists
	development stages) • Root depth of crops • How much water can a crop extract?	crop development stages, root development and crop water requirements
3. Sustainable crop production	Sustainable crop production practices • Crop rotation • Mulching • Intercropping • Companion crops	Basic knowledge and understanding of sustainable crop production practices
4. Irrigation requirements of crops and fodder	Production practices and irrigation requirements of the following crops: • Grains (wheat, maize,) • Oilseed (soybean, drybeans, groundnuts and sunflower) • Citrus • Deciduous fruit (stone and pome fruit) • Vines and table grapes • Vegetables • Fodder crops and perennial pastures • Industrial crops (sugarcane, tobacco and cotton)	Basic knowledge and understanding of: • Brief overview • Place and agricultural scene • Climatic requirements o Temperature o Relative Humidity o Frost acceptability o Wind o Drought resistance • Soil requirements o pH, soil structure, soil texture, soil depth, crusting, compaction • Growth and development o Growth stages o Dormant stages o Heat and cold units o Stress acceptability • Irrigation requirements

7.6 Development of extension frameworks

The 21 extension related unit standards and the newly developed units standards on NQF level 3 (7), NQF level 4 (6) and NQF level 5 (13) for agricultural extension were used to define the learning content and for drafting of the learning framework for agricultural extension in an irrigation environment.

7.6.1 Selection of subject matter specialist and drafting of landscape

The participants in the development of the extension training modules represent the agricultural extension discipline and related subject matter disciplines communication, land use planning, business and entrepreneurial management, etc. The process started with the identification of subject matter specialists for the extension learning areas as well as team members with appropriate skills and knowledge to steer the process. The desired outcomes and format of the training material were discussed to ensure consensus in the final product envisaged.

7.6.2 Drafting of a landscape for the extension learning area

The initial step was to do a contextualization of the essential skills, knowledge and elements required from irrigation extensionists. A *landscape* was drafted for this learning area according to the outcome of the Stakeholder workshop and the discussion forums held with extension workers.

7.6.2.1 Landscape for Agricultural Extension

The following skills and knowledge in agricultural extension were identified for effective extension delivery during the various discussion forums and stakeholder workshops held in various provinces.

Technical learning area	***List of possible modules***
Agricultural extension	1.Basic understanding and skills required for socio-economic analysis 2. Basic understanding and skills required for institutional organisation and capacity building (WUA, FO, etc.) 3.Basic understanding and skills required for leadership development 4.Basic understanding of principles applicable for effective communication 5.Basic understanding and skills required for effective mobilising and formation of groups 6.Basic understanding of the principles applicable for gaining the necessary credibility for efficient extension delivery 7.Basic understanding of the concept holistic/whole farm approach 8. Effect of culture diversity on group functioning and dynamics

Landscape for Agricultural extension

The following framework of leaning content was developed to identify possible modules to address the knowledge and skills required for irrigation extensionists in serving irrigation farmers.

Elements	**Interactions**	**Essential knowledge/skill areas required from irrigation extensionists**
1. Principles of extension	Ability to define and elaborate on: • Purpose and function of irrigation assistance service • Concept of extension • Extension principles • Adult learning in irrigation extension • Challenges for agricultural extension	• Basic understanding of the role of irrigation extension in promoting of irrigation development • Basic understanding of agricultural learning principles • Basic understanding of extension principles
2. The extension agent or extensionist	• Role of the extension agent • Knowledge and personal skills • Role of extension policy in the delivery of	• Basic understanding of the role of the extensionists • Basic understanding of the knowledge

Elements	Interactions	Essential knowledge/skill areas required from irrigation extensionists
	extension • Extension manager and extension management • Management functions	and personal qualities required • Basic understanding of extension management and the main function of extension management
3. Communication for innovation	• Fundamentals of the communication process • Types of communication and the functional application • Barriers in communication intervention • Nature and characteristics of interpersonal, small group and mass communication • Role of communication in agricultural decision making (networking, social learning, persuasive communication and negotiation) • Irrigation extensionists as a skilled communicator • Development of a communication strategy • Role of a mentor in the communication process	• Basic knowledge and understanding of the key elements and principles of the communication process • Basic skills and knowledge to apply the principles of effective communication in a specific communication situation • Basic understanding of the factors that influence effective communication • Ability to skilful help farmers with decision making in agriculture • Illustrate the ability to apply knowledge and skills of communication in effectively managing a communication strategy • Ability to effectively mentor the protegė
4. Approaches to agricultural development	• Top-down versus interactive system • Participatory extension approaches o On farm research o Farmer Field Schools o Demonstration trials	• Basic understanding of the term approaches and extension systems • Basic understanding of various extension approaches and the ability to implement
5. Group mobilising and facilitation	• What is a group? • Types of groups • Group dynamics (external and internal) • Group facilitation methods and techniques (brainstorming, PRA) • Forming of farmer groups like WUA • Facilitating of group formation o Role of the facilitator o Managerial skills and qualities o Personal skills and qualities o General problems facilitators may encounter • Enhancing group cohesiveness • Setting group goals	• Basic understanding of the types of groups and forces (internal and external) that influencing the dynamics of farmer groups • Adequate knowledge and understanding to establish groups • Ability and skills to help farmer groups to enhance cohesiveness
6. Community development and mentorship	• Ability to facilitate community development	• Basic understanding of the following: i) Development environment ii) Role-players and stakeholders in community development iii) Rural sociology, structures and leadership iv) Task of extensionists as community developer v) Organizational and institutional structures vi) Participation and empowerment

Elements	Interactions	Essential knowledge/skill areas required from irrigation extensionists
		vii) Facilitation, negotiation and conflict resolution viii) Community developing roles ix) Social networking and co-ordination • Basic understanding of the general principles that apply with community development • Basic understanding and ability to facilitate participatory community management
7. Leadership for effective group functioning	• What is leadership? • Leadership styles • Characteristics of effective leaders • Situational leadership for effective group functioning • Managing conflict in the group o Principles of mediation and conflict management	• Basic understanding of leadership and leadership style • Basic understanding of leadership qualities required for the planning and implementation of extension programs • Ability to identify and resolve conflict in a group
8. Situation analysis	• Individual need analysis: face-to-face interviews, key interviews, formal or informal observation, questionnaire • Group interviews: PRA, Brainstorming, SWOT analysis • Data collection and resource mapping • Gap analysis through feedback to community • Requirements for participatory planning	• Illustrate the ability to identify and examine the various resource factors that influence agricultural development • Ability to apply basic knowledge and skills in collecting of data and support with decision making
9. Project planning and management	• Difference between project and program • Types of agricultural projects • Characteristics of a project • Project management process and cycle • Project planning principles and stages • Evaluation and monitoring of impact • Role of the project manager	• Basic understanding of the difference between a project and a program • Basic knowledge and understanding steps in planning of a project • Basic understanding of the project cycle • Developing of a work break down structure and project schedule • Understanding the organisation requirements for the implementation of a project plan • Assessing the progress of a project
10. Holistic irrigation farm planning and decision making	• Farm planning o Farmer's goal and personal consideration o Inventory of natural resources data o Evaluation of present land use o Resource planning and appropriate knowledge about maps and symbols used o Implementation of planning	• Basic understanding of the requirements for the development of a holistic farm plan • Ability to demonstrate a basic knowledge and understanding of: o Role and function of soil and water samples, climate and weather information, livestock and crop characteristics, production cycles, records and markets within production procedures

Elements	Interactions	Essential knowledge/skill areas required from irrigation extensionists
	and conservation principles o Development of management and information system	o Description, characteristics and properties of vegetation, infrastructure, weather, production cycles, markets within production procedures o Understand how the land capability affects viable land use planning • Knowledge should be demonstrated on a holistic nature of whole farm planning.
11. Land suitability evaluation for irrigated agriculture	• Basic principles of land suitability evaluation • Preparatory investigation and data collection for evaluation of land suitability • Collecting and analysing of climatic data for provisional identification of potential crops • Determination of soil requirements and tolerances of potential crops • How to conduct a detail soil survey • Delineation of areas • Evaluation of soil suitability for potential crops • Evaluation of soil suitability for different irrigation systems • Evaluation of suitability of irrigation water • Conducting of Environmental Impact Assessment and drafting of preliminary mitigation plan • On-site and off-site EIA	• Basic understanding of the factors to take into consideration with the evaluation of the suitability of land for irrigation purposes • Basic knowledge of the steps to be followed in the identification, delineation and planning of irrigation land
UPSTREAM	1. Agric. & Extension Research	i) New innovations (5-10 years in advance) ii) Adaptation and transformation of technology to be applicable to the specific farm & farmer situation – sustainability.
	2. Technical skills & knowledge in Agriculture	i) NQF Level 5 Qualification in Agriculture (Nat. Diploma) ii) Specific agric. skills programs (short courses) – certificates SAQA accredited.
	3. Knowledge Support Service (SMS)	i) Subject matter specialists to support extensionists.
	4. Soft skills	i) Understanding human behaviour ii) Networking ability

Elements	Interactions	Essential knowledge/skill areas required from irrigation extensionists
		iii) Organisational development iv) Adult/experiential learning v) Entrepreneurial skills training (management training – to manage any enterprise)
	5. Quality control	i) Monitoring and Evaluation of extension (accountability and responsibility
	6. Finance (budget)	i) Salary ii) Working capital iii) Equipment
	7. Marketing	i) Identify and facilitate mainstream and niche marketing
DOWNSTREAM	1.Agric. Management	Farming is a business – economically viable and sustainable
	2. Land care	Conservation of the environment
	3. Land reform	Priority program
	4. Agric. and marketing policy	Global competitiveness
	5. Political expectations	Restructuring

7.7 Evaluating of technical and extension frameworks

These frameworks for technical and extension learning material have been evaluated in the field amongst irrigation extensionists, land use planners, subject matter specialists and lecturing staff at tertiary training organisations like Fort Cox Agricultural College, Lowveld Agricultural College, Tompi Seleka Training Institute, Madzivhandila Agriculture Training Centre, Grootfontein Institute for Training, University of Fort Hare, University of Free State, Agrofert Academy, Transvaal Sugar Limited (TSB) and local cooperatives like GWK and MGK. The participants in the evaluating of these frameworks and content represent a range of stakeholders broad enough to adequately explore the topic.

With these frameworks the emphasis was to ensure that the qualities and abilities that we are seeking for in the learners are engender based on the information gathered from farmers and from the industry. The assessment methods incorporate thinking about what qualities or abilities you are seeking to engender in the learners. Nightingale *et al* (1996) provide eight broad categories of learning outcomes which should be addressed:

- Thinking critically and making judgments (developing arguments, reflecting, evaluating, assessing and judging)
- Solving problems and developing plans
    - (Identifying problems, posing problems, defining problems, analysing data, reviewing, designing experiments, planning, applying information).
- Performing procedures and demonstrating techniques. (Computation, taking readings, using equipment, following laboratory procedures, following protocols, carrying out instructions)
- Managing and developing oneself
    - (Working co-operatively, working independently, learning independently, being self-directed, managing time, managing tasks, organising)

- Accessing and managing information
    - (Researching, investigating, interpreting, organising information, reviewing and paraphrasing information, collecting data, searching and managing information sources, observing and interpreting)
- Demonstrating knowledge and understanding
    - (Recalling, describing, reporting, recounting, recognising, identifying, relating & interrelating)
- Designing, creating, performing
    - (Imagining, visualising, designing, producing, creating, innovating, performing)
- Communicating
    - (One and two-way communication; communication within a group, verbal, written and non-verbal communication. Arguing, describing, advocating, interviewing, negotiating, presenting; using specific written forms)

Based on the feedback received from the authenticators and experts in the field, frameworks were adapted and aligned.

7.8 Testing of technical and extension learning material content

The development of the framework and the learning material in module format enclosed the identification and mobilisation of SMEs for the technical and extension modules, the planning and facilitating of the development of the content learning material with the active participation of academic staff, practitioners, trainers and private consultants involved in the industry. The project team strived to comply fully with the instruction to use Unit Standards where available, and to ensure that the learning material will address the priorities of the WRC and the National Department of Agriculture, Forestry and Fisheries and accreditation requirements of AgriSETA. The writing of the content of the learning material on this level , where basic theoretical as well as examples of practical application is imperative, required special authors who are grounded with ample knowledge and experience in the various learning areas identified for irrigation water management.

The testing of the learning material was done amongst extensionists attending short courses, facilitators of training, students and lecturing staff from agricultural colleges and universities of technology, and authenticators and specialists. The competence of irrigation extensionists after completion of a learning module will be assessed against “competent” or “not yet competent” which will include the following assessment criteria (Mothamaha, 2001):

- The know-how and knowledge to accomplish the required task
- Ability to perform an actual occupational role
- To do something in real context
- Transfer of skills to many other situations
- Practical competence (considering a range of possible actions in authentic context and ability to make decisions), foundational competence (demonstrates understanding of the knowledge and thinking underpinning the action taken) and reflexive competence (integrate performances and decision making an ability to change)
- To act or perform with evident and identifiable action

These assessment criteria are built into the various activities that are required of the learner to complete/

The first phase of the testing of the learning material involved the evaluation by authenticators, specialists and academics of the learning content of the material. A matrix for assessment was developed to determine whether the learning material is appropriate (Table 7.4).

The feedback received from authenticators, specialists, academic staff and practitioners were used to fine tune the learning material to ensure that it is aligned for the intended learners. After this phase of the testing was completed, the learning material was tested amongst extensionists and students at colleges to identify shortcomings and fine tuning required (second phase).

Table 7.4. Example of evaluation matrix used for assessment of learning content

Reviewers evaluation of learning material: Authenticator 1:						
Criteria	**1 Very poor**	**2**	**3**	**4**	**5 Excellent**	**Comments**
1.Rate the layout of the learning material				x		
2. Rate the technical soundness and scientifically base of the learning material content				x		
3. The learning material encourages logical and systematic learning?				x		
4. To what extend are useful experiences integrated into the learning material?			x			More practical experience could be integrated
5. To what extend are useful illustrations integrated into the learning material?				x		More required
6. Learning material's ability to provide adequate industry specific examples to explain difficult concepts?				x		More required
7.Learning material's ability to illustrate balance between knowledge and understanding			x			
8. Rate the language used in the learning material with regard to simplicity (technical terminology as well as thinking and doing required by learners to understand the material)				x		Attend to minor grammar problems indicated
9. Appropriateness of language for specific learner audience (extensionists, students, advisors in irrigation management)			x			
10. Learning material's ability to explain technical concepts				x		
11. Learning material's ability to use clear and simple directions to break any general directive into manageable steps for example: "look at" and then "find" once you have located x you should try.				x		
12. Learning material's clarity on reaching competency			x			Perhaps a bit on the high side for target learners in mind
13. Learning material designed in such a way that the learners will find it easy to refer back				x		Pay attention to the references used-couple of places where references are required
14. Learning material utilizes a diversity of teaching strategies			x			

Reviewers evaluation of learning material: Authenticator 1:						
Criteria	**1 Very poor**	**2**	**3**	**4**	**5 Excellent**	**Comments**
intelligently (e.g. includes stories, comparisons to life experiences of the learner)						
15. Learning material reflects a clear understanding of the expectations (knowledge and skills) for this specific occupation. Ask yourself the following: What do we want to learn learners? Why do we want the learners to learn this? How can this learning material assist this?				x		
General remarks on the learning material Good and complete, perhaps more comprehensive than what is required for the learners at this level descriptor.						

The following evaluation matrix was developed and used after consultation with various stakeholders and experts in this research field (Table 7.5).

Table 7.5. Evaluation matrix used for the assessment of learning material by learners

Questions related to the course material	Use the following scale provided to assess the course				
Relevant	1	2	3	4	5
	▲ Disagree				▲ Agree
Appropriate	1	2	3	4	5
	▲ Disagree				▲ Agree
Fresh and up-to-date	1	2	3	4	5
	▲ Disagree				▲ Agree
Stimulate new thinking	1	2	3	4	5
	▲ Disagree				▲ Agree
Practical and applicable	1	2	3	4	5
	▲ Disagree				▲ Agree
Easy to understand	1	2	3	4	5
	▲ Disagree				▲ Agree
Illustrations clear and understandable	1	2	3	4	5
	▲ Disagree				▲ Agree
Important information	1	2	3	4	5
	▲ Disagree				▲ Agree
Stimulate participation by learners	1	2	3	4	5
	▲ Disagree				▲ Agree
I learnt something new	1	2	3	4	5
	▲ Disagree				▲ Agree
Content structured logically and clearly	1	2	3	4	5
	▲ Disagree				▲ Agree
Learning material aligned to my level of skills and experience	1	2	3	4	5
	▲				▲

Questions related to the course material	Use the following scale provided to assess the course				
	Disagree				Agree
Tried to cover too much in too little time	1	2	3	4	5
	▲ Disagree				▲ Agree
I can apply what I learnt to my position	1	2	3	4	5
	▲ Disagree				▲ Agree

The evaluators and authenticators were reminded of the competencies, knowledge and skills required form a learner on a NQF level 5 as revealed in Table 7.6.

Table 7.6. Competencies, skills and knowledge required from a learner on a NQF level 5

	Fundamental competence	Practical competence	Reflexive competence
Learner level pitching: NQF 5 level	• Possession of wide ranging scholastic and technical skills • Possession of a broad knowledge base with substantial depth in other areas	• Operate in variety of routine and non-routine contexts under general supervision • Select from wide choice of procedures, ranging from standard and non-standard	• Full responsibility for nature, quantity and quality of output • Possible responsibility for the achievement of group output

7.8.1 Testing and evaluation of learning material on agro climatology

The draft version of the content was distributed to three authenticators for critical reviewing of the content. The authenticators were reminded of the competencies, knowledge and skills required from a learner on a NQF level 5 in this learning area.

The feedback from the one authenticator was positive with minor editorial shortcomings to address, while the second and third authenticator raised major concerns as reported in Deliverable 24. This necessitated the discussion of the learning material with the authors of this learning material, which resulted in the repacking of the framework by the project team and rewriting of the material by one of the authenticators in a modular format.

The revised version of the learning material was once again distributed for comments to two authenticators from the University of the Free State, and very positive feedback was received:

- "Good and complete, perhaps more complete than what is required for the level descriptor in mind" (reviewer 1)
- "Very impressive, a very informative reader. Especially the examples!" (reviewer 2)

7.8.2 Testing and evaluation of learning material on assessing of soil resources

Two authenticators critically evaluate the draft learning material and in general very positive feedback was received. The evaluators were of opinion that it represents a very balanced approach to the offering of the material and that the practical examples and activities included enrich the learning material.

7.8.3 Testing and evaluation of learning material on irrigation economic

Thirty three extension practitioners and Land Reform staff from NGOs and from various Provincial Departments of Agriculture attended a short course on the “Professional development of practitioners of Land Reform” offered from 13-17 September 2010. This event was used for the testing of three modules developed for the learning material since it was offered on a NQF 5 level .The group of learners mainly obtained a general Diploma in Agriculture and BTech degrees. They assessed the following modules:

Module 1: Farm Management
Module 2: Farm business and its enterprises
Module6: Financial management

At the start of the course the working knowledge and existing practical knowledge on farm management and financial management was identified. For many learners of the group the course was very interesting and they could easily relate to the course material. Unfortunately due to the limited time available very little proportional time was allocated for practical application of the course material, but from the assessment of assignments learners showed their ability to apply the newly gained knowledge.

Figure 7.2 reveals the response of learners on the assessment of the learning material on farm management and financial management by using a five point semantic scale (1=disagree; 5 = agree).

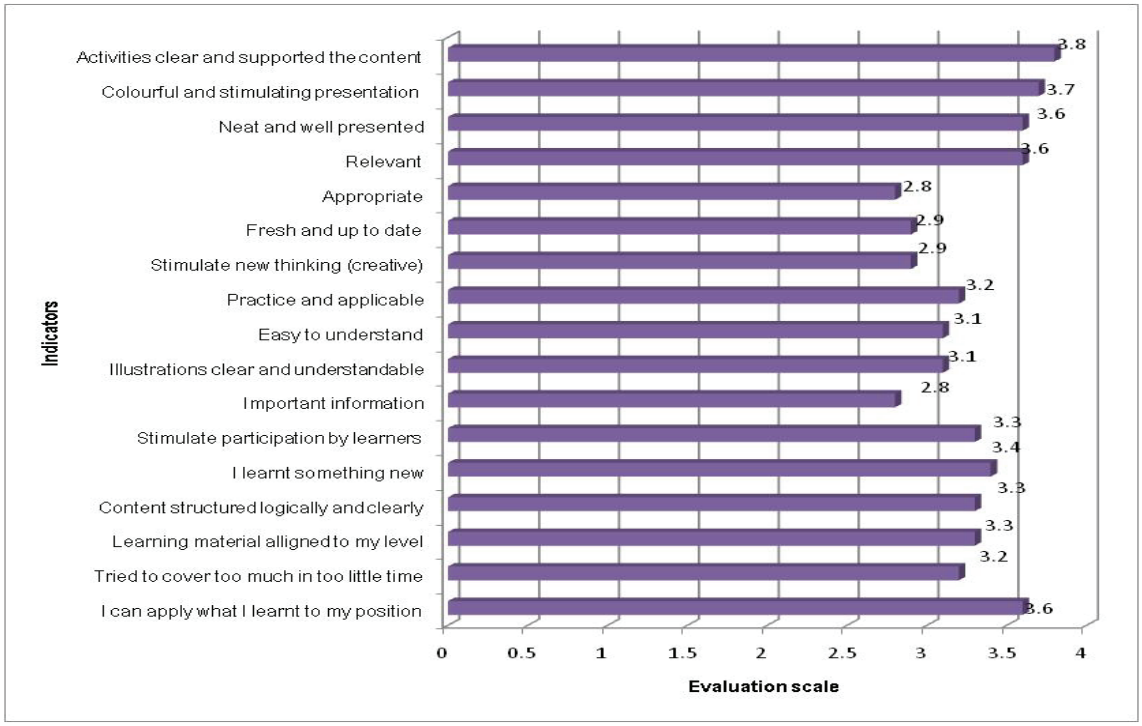


Figure 7.2. Assessment of the content and format of the learning modules on farm management and financial management by learners from various Provincial Departments and NGOs

It was clear from the discussions during the course that a great number of the learners over rated the current knowledge and practical skills to help farmers with the planning of farm and financial management. For many

their role regarding the support of farmers or newly settled farmers is not to help them first hand with the planning of finances and farm management, but rather to put them in contact with the agricultural economists of the Department. Therefore they do not regard this as part of their job! It was clear that learners from NGOs and private companies had a different perception, since they do not have SMEs always to help them. In general learners were satisfied with the learning modules, as it was indicated with their rating of the relevance of the course material (3.6) and that what they have learned will be applied in their respective positions (3.6).

The biggest stumbling blocks identified regarding offering of these modules:

Module 2: Farm business and its enterprises
Unclearness regarding net and gross farm income, enterprise profit and the ability to calculate it. Learners in general found it difficult to apply formulae to calculate the various important benchmarks for the calculation of income and profitability.

Module 6: Financial Management
Learners in general found the interpretation and analysis of financial statement challenging, since it was for many a first experience in this regard. The calculating of important financial ratios should be limited, since many found it very difficult to apply. A huge challenge with application and use of the financial statements is the general inability to do basic calculations due to relative poor basic mathematic knowledge and skills.

Some general comments from learners on the course:

- "Very good course"
- "Thank you for the agric business flavour"
- "More practical examples and case studies welcomed!"
- Eye opening course and very much work related
- It will guide a person well to assist new farmers with their settlement
- Helps me to understand the challenges (financial) of a farmer!
- Capacitate a student to be able to work and understand the farmers' position
- The calculations are extremely difficult!
- Activities and assignments very practical and worth a lot

7.8.4 Testing and evaluation of irrigated crop and fodder production modules: vegetable production

Ten extension officers from the Limpopo Provincial Department of Agriculture involved in various vegetable projects located in the Sekhukhune District were asked to evaluate the course material developed on vegetable production, with specific reference to the general module on vegetable production (Module 9a), Module 9g: Cole crops, Module 9e: Swiss chard during a district event in February 2011. These modules form part of the learning material compiled in Irrigated Crop and Fodder Production.

Some of these extension officers are also involve in a project "Improvement of Potato Production" in the Krokodil Irrigation Scheme (240 ha).The majority of these extensionists have a general qualification in agriculture (Agricultural Diploma) with two of them that have post graduate qualifications in community development and extension and public administration. These extensionists acknowledge the fact that they still lack the necessary knowledge to help farmers with the planning of a specific irrigation and fertiliser management planning, although they have several years of experience working with farmers on irrigation schemes. This

group of extensionists were asked to evaluate the three modules, and Figure 7.3 illustrates the average scoring on these modules.

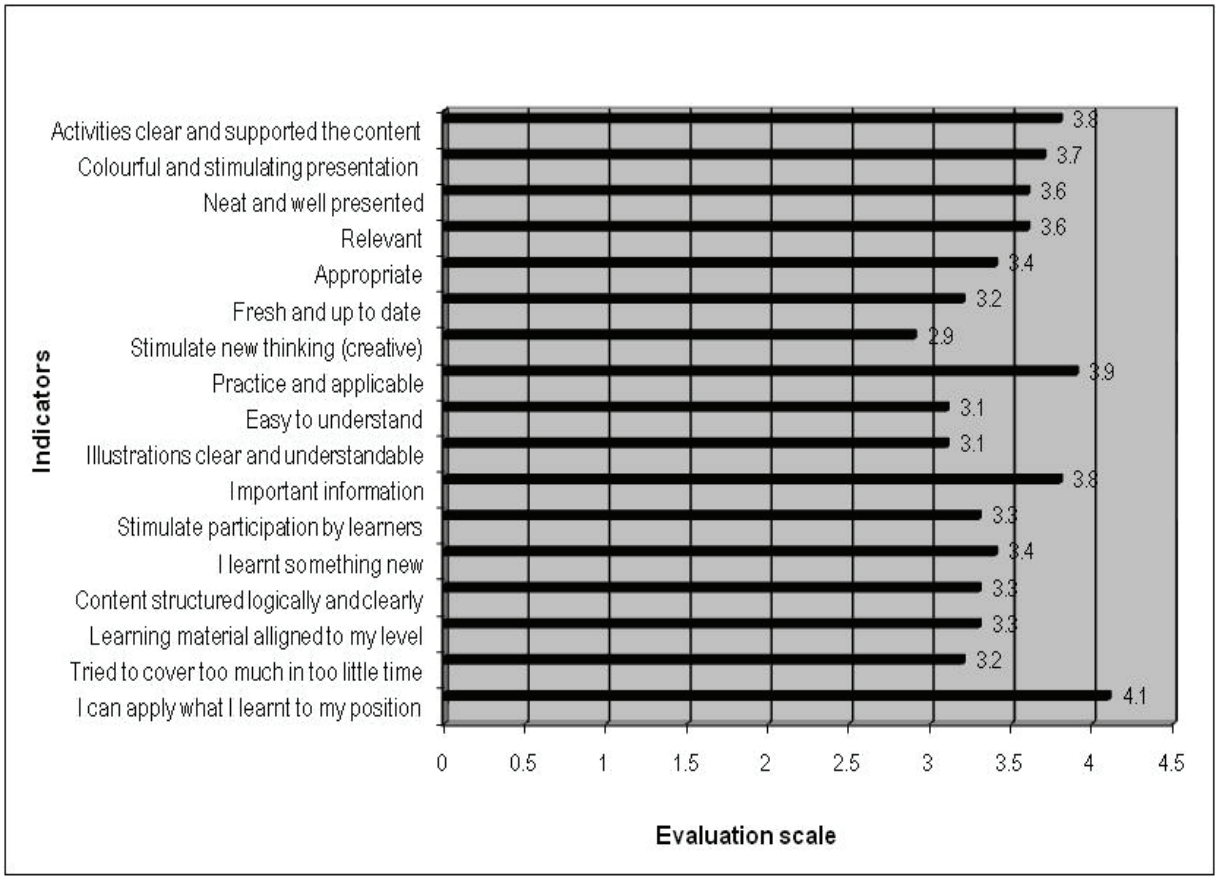


Figure 7.3. Assessment of the content and format of the learning modules on vegetable production by extensionists from the Sekhukhune District

They perceive the role that a strategic partner, like the commercial farmer that is involved in the production of potatoes are playing, as imperative to help skill themselves with the necessary competencies. In general these extension officers were very satisfied with the learning material, especially the guidelines on the irrigation management and fertilising management of specific vegetable crops. Many were interested to get this material for application in their day-today activities.

General comments on the learning material:

- Theme for group discussions should be explained well
- The calculations included in the material may be challenging to some learners
- They appreciate the group activities proposed
- Mathematical competencies of some learners may prohibit them from understanding and applying everything proposed in the material
- A lot of knowledge transferred-highly appreciated since this type of booklet not available
- This course will equip learners with a lot of practical knowledge

7.8.5 Testing and evaluation of extension modules

- **Farm planning**

The assessment of this module was done with a group of 12 extension officers from the Free State at Glen College during November 2010. This is a group of experienced extension officers with experience in the supporting farmers with the planning of a farm and the drafting of a business plan.

First of all the outline of the course was presented to the extension officers after which time was made available for them to study and discuss the course material within two focus groups. The practical part of the module could not be presented since there was not time allocated for that, but the practical activities and possible assignments were discussed and explained to extension officers. Afterwards the assessment of the course material and comments were collated.

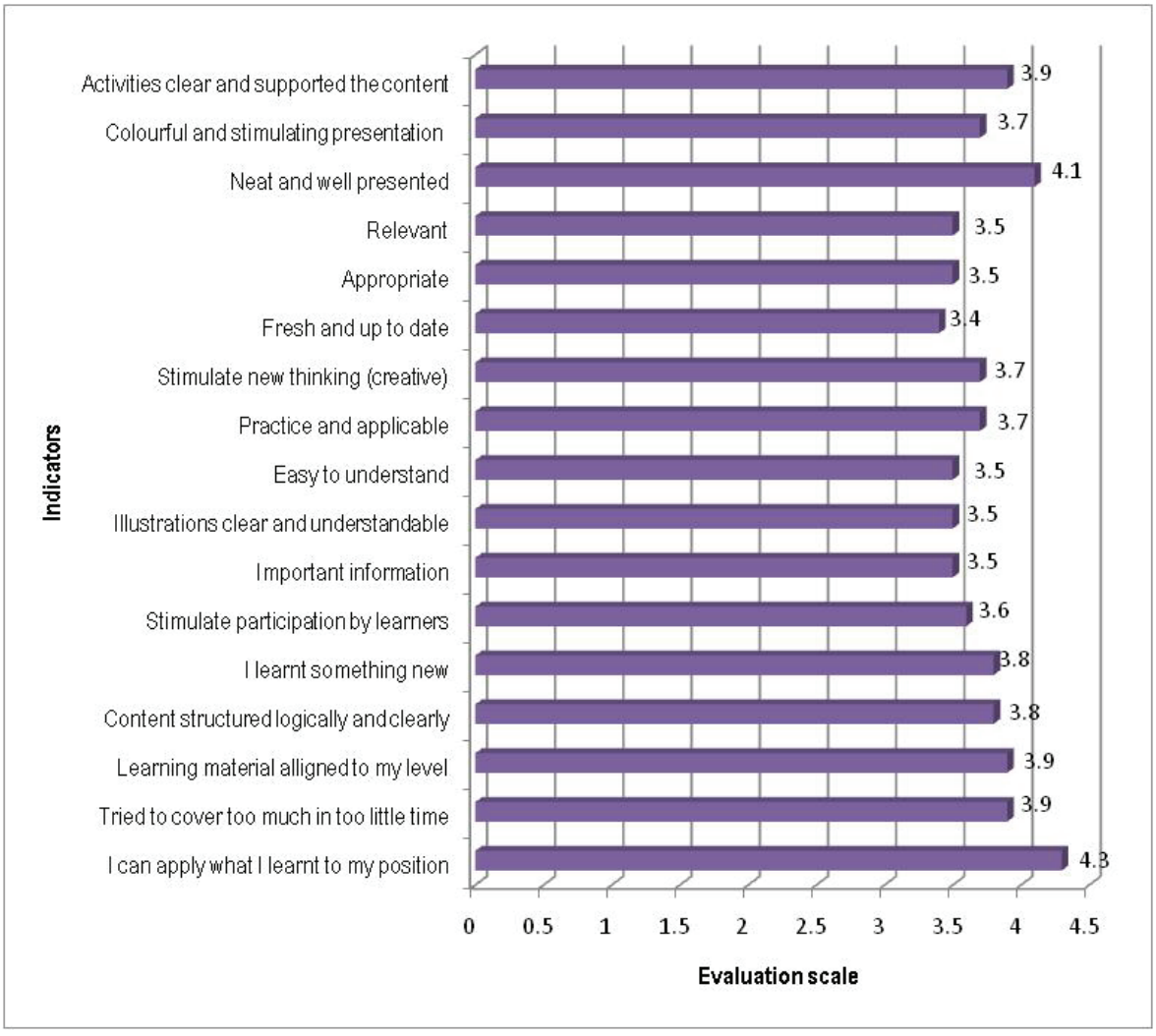


Figure 7.4. Assessment of the content and format of the learning modules on farm planning by extensionists from the Free State

Overwhelmingly the extensionists are of opinion that the learner of this module can apply what they gain from the module in their job environment and position (4.3) and that the learning material is relative simple and easy

enough to understand and align with the current position of the extensionists (3.9). The evaluators are of opinion that the course module is very practical and therefore very relevant for the challenges that extensionists face. They are however concerned that this module will need enough time to address the practical activities included in this module, since this actually forms the core of the module.

General comments made by evaluators:
"This form a good base that is required for every extension worker"
"Very practical and work related course"
"This is essential for an extension worker to deliver a better service to farmers"

- **Extension principles and approaches**

Two authenticators, of which one feedback is illustrated in Table 7.7, evaluated the two modules on Extension Approaches and Extension Principles.

Table 7.7. Assessment by Authenticator No 1 of the modules Extension Approaches and Extension Principles

REVIEWERS EVALUATION OF LEARNING MATERIAL						
Criteria	**1 Very poor**	**2**	**3**	**4**	**5 Excellent**	**Comments**
				x		
					x	
				x		
				x		
			x			More required
				x		More required
				x		
			x			Attend to minor grammar problems indicated
9. Appropriateness of language for specific learner audience (extensionists, students, advisors in irrigation management)				x		
10. Learning material's ability to explain technical concepts				x		x

REVIEWERS EVALUATION OF LEARNING MATERIAL						
Criteria	**1 Very poor**	**2**	**3**	**4**	**5 Excellent**	**Comments**
11. Learning material's ability to use clear and simple directions to break any general directive into manageable steps for example: "look at" and then "find" once you have located x you should try y.					x	
12. Learning material's clarity on reaching competency					x	
13. Learning material designed in such a way that the learners will find it easy to refer back					x	
14. Learning material utilizes a diversity of teaching strategies intelligently (e.g. includes stories, comparisons to life experiences of the learner)				x		
1.Rate the layout of the learning material				x		
2. Rate the technical soundness and scientifically base of the learning material content						
3. The learning material encourages logical and systematic learning?						
4. To what extend are useful experiences integrated into the learning material?						
5. To what extend are useful illustrations integrated into the learning material?						
6. Learning material's ability to provide adequate industry specific examples to explain difficult concepts?						

REVIEWERS EVALUATION OF LEARNING MATERIAL						
Criteria	**1 Very poor**	**2**	**3**	**4**	**5 Excellent**	**Comments**
7.Learning material's ability to illustrate balance between knowledge and understanding						
8. Rate the language used in the learning material with regard to simplicity (technical terminology as well as thinking and doing required by learners to understand the material)						

In general the feedback was positive and very little adjustments were required to improve the impact of the learning material.

The extension module on Agricultural Extension Approaches and Principles was assessed by group of extensionists from the Free State Department of Agriculture after they attended a short course from 13-17 September 2009. This group of extension practitioners included extension staff included university degrees, B Tech degrees and agricultural diplomas. The selection of the group was appropriate educated for the testing of the learning material (Figure 7.5).The assessment of learning material illustrates that learners were in general satisfied with the content and the sequence of learning outcomes addressed.

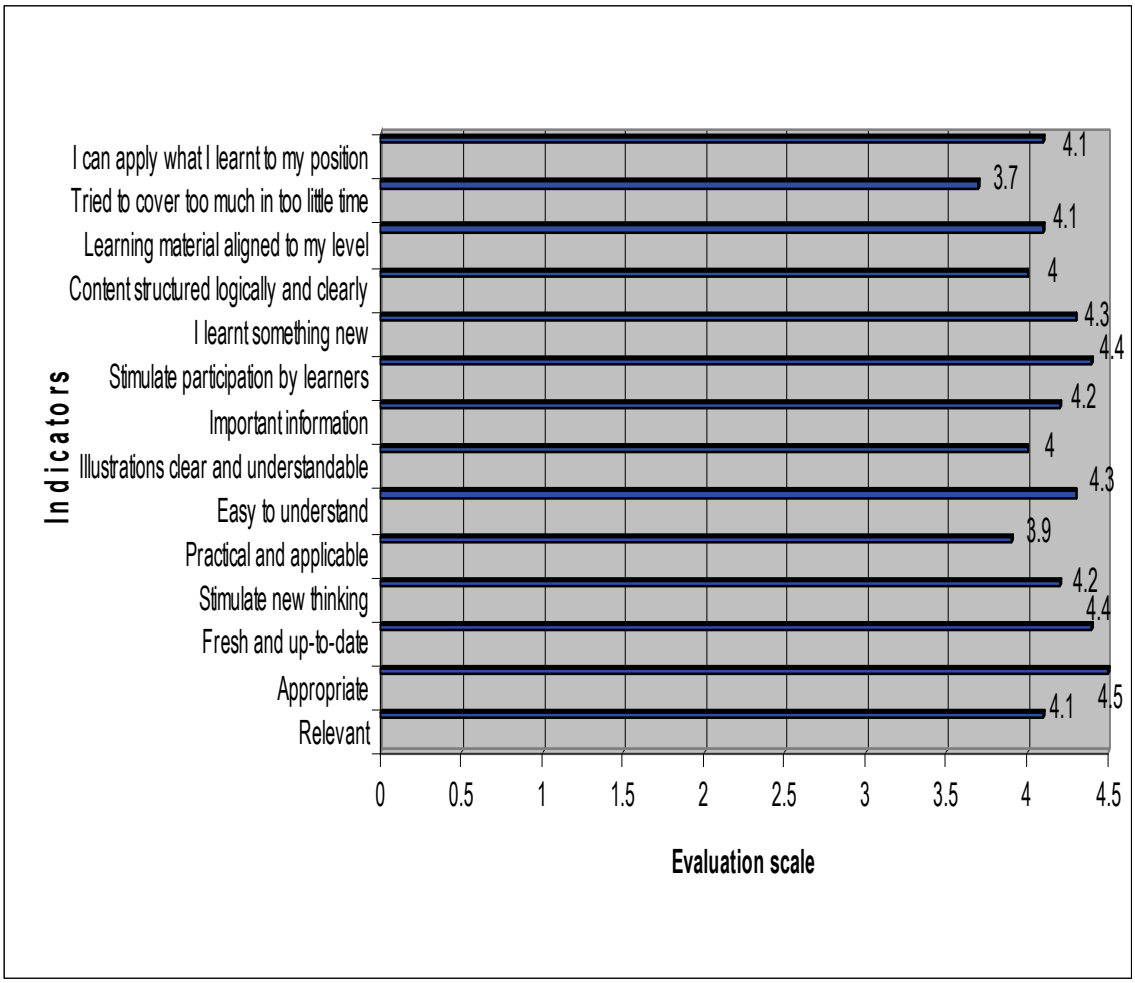


Figure 7.5. Assessment of the content and format of the learning modules on agricultural extension approaches and principles by learners from the Free State

The learners commented as follow on the learning material:

- "Very practical and work related course"
- "Provide clear directions in terms of employment and requirements"
- "Course very applicable especially for the type of work that I do"
- "Open doors for good extension delivering"
- "Helps to get a clear guideline with the practical application"
- "The course will help us to deliver a better service to farmers"
- "This course needs to be extended to our managers"
- "This will help to empower the extension worker"

Some shortcomings that were raised include:

- What about the influence of this on agricultural policy?
- The time for discussion by students should be increased

- **Project planning and management**

Extension workers from the Department of Agriculture in Limpopo assessed this learning module on two occasions. The first assessment of the learning module “Project Planning and Management” was done by 19 extension practitioners from the Limpopo Department of Agriculture attending a short course from 7-9 October 2009 on “Program in project management and development for extension officers”. This group of extension practitioners included extension staff mainly from the western districts of Limpopo Province, and the academic qualifications of this group of learners included university degrees, B Tech degrees and agricultural diplomas. The selection of the group was excellently educated for the testing of the learning material.

At the start of the course, the working knowledge and experience in the planning and implementation of project management principles was assessed in an attempt to define the learner’s experience. To great surprise with the exception of one or two students, the working knowledge and skills were far below required for effective planning and implementation of agricultural projects. After the offering of the module on “Project planning and management” to the group it was followed with practical training in the implementation of the program Microsoft Project Management 2003. The use of the computer program requires basic computer skills and knowledge assumed to be in place. It was clear that the younger learners were more eager to either learn new computer skills or to experiment with the newly gained learning. The elder learners in the group clearly opted to use more traditional hand system methods to prepare Gannt charts and construct work break down structures (WBS) in the planning of their projects.

After the offering of the course learners were asked to assess the learning material with regard to the understandability and addressing of learning outcomes or expectations set for the specific learning module by using a five point Likert scale (1= disagree and 5 = agree).

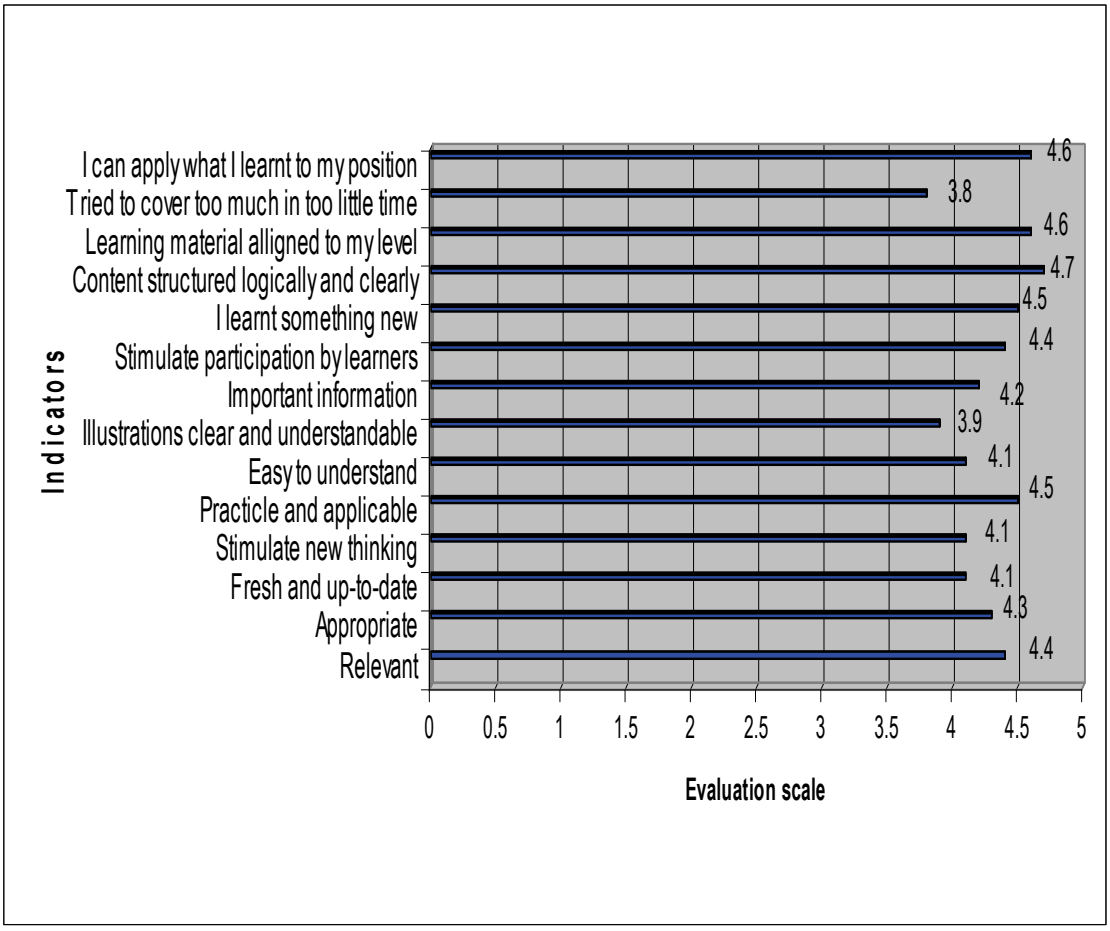


Figure 7.6. Assessment of the content and format of the learning module on project planning and management in the western districts of Limpopo

The learners rated the ability of the learning material to provide direction in decision-making and use of the newly gained knowledge in the job situation very high (4.6). The sequence of learning outcomes and logical sequence of learning content was perceived positive for effective learning. The learners however expressed concerns on the allotted time scheduled for the offering of the course, and in general expressed a need that more time should be allocated for this activity. This was mainly because of the additional time spending on the learning of basic computer skills required for the operation of the computer program that the progress regarding this activity was slow and not anticipated in the planning and development of the learning module.

The second assessment of the learning module “Project Planning and Management” was completed by 30 extension practitioners from the Limpopo Department of Agriculture attending a short course from 25-27 November 2009 on “Program in project management and development for extension officers”. This group of extension practitioners included extension staff mainly from the eastern side of Limpopo province, and the majority has an Agricultural Diploma as their highest academic qualification. At the beginning of the course and again at the end of the course, the working knowledge and experience in the planning and implementation of project management principles was assessed. The theoretical presentation of the learning material was once

again followed by a practical session where learners were asked to use the computer program Microsoft Project Management 2003 for the planning of the agricultural project of their choice. Like with the first group of learners, the biggest constraint experienced was again the general computer literacy amongst many of the learners. Only a few of the learners were initially prepared to use the computer program, but as more confidence was built amongst learners, nearly 90% of the group at the end of the course made use of computers to draft Gannt charts, work break down structures and general cost budgeting of the project in addressing the compulsory assignments that were required.

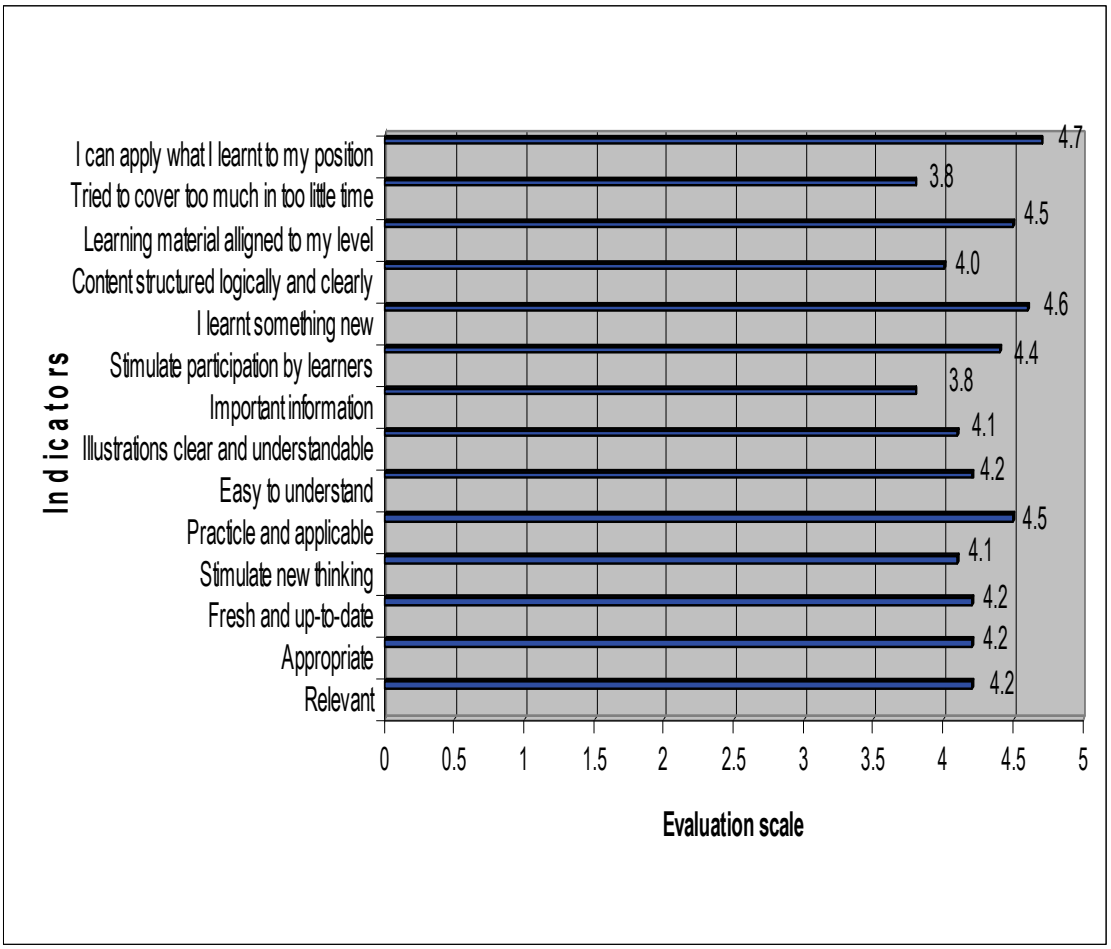


Figure 7.7. Assessment of the content and format of the learning module on project planning and management in the eastern districts of Limpopo

The findings in Figure 7.7 depict the perceived assessment of learners on the learning outcomes and format used for this specific training. Clearly this group of learners indicated their appreciation for the fact that they have gained new knowledge and skills with regard to project planning and implementation from the course, as well as the fact that can apply this in their current working situation. The relatively lower rating of the importance of the information (3.8) was surprising, since as was identified at the start of the training the majority of this group of learners lack the required knowledge and competency in the planning and implementation of agricultural projects.

The need for more time allotted to offer the course was mainly raised because of the problems encountered to use the computer program. Very few (less than 40%) of the group of learners exist of the basic knowledge and experience in using the computer and respective computer program.

- **Community development and mentorship**

The extension module on Community Development and Mentorship was assessed by group of 33 extensionists from the Free State Department of Agriculture after they attended a short course from 19-21 October 2009. This group of extension practitioners included more senior extension staff with university degrees; post university degrees some also in agricultural extension, B Tech degrees and agricultural diplomas. A large percentage of this group of learners is employed as middle level extension managers, and therefore their feedback and perception regarding the learning material was of great importance to gain lessons to be taken into account with the development of learning material.

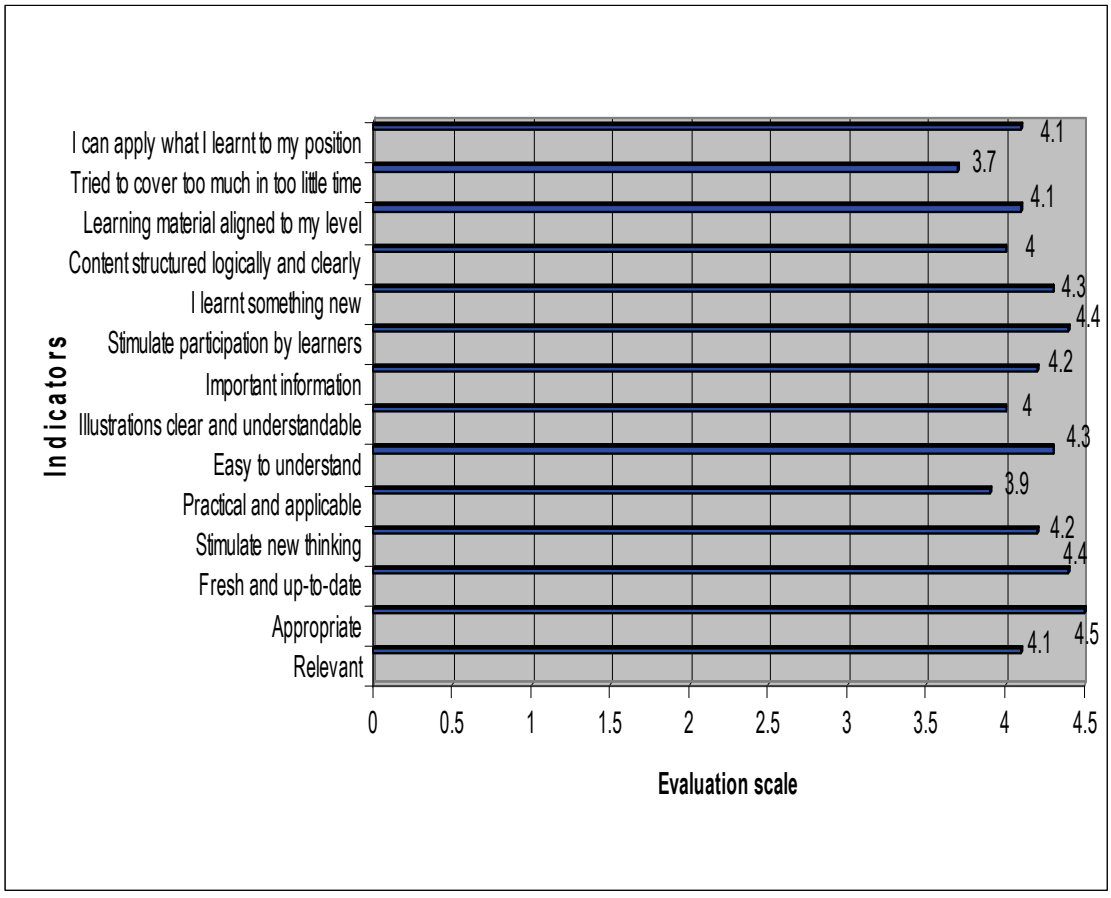


Figure 7.8. Assessment of the content and format of the learning module community development by learners from the Free State

The general feedback was positive and the following comments were made:

- "Empower extensionists for future positions"
- "Very appropriate for working with communal farmers"
- " The group work is very important and more time should be allocated for that"
- "Very appropriate"

- **Leadership and facilitation**

The extension module on Leadership and Facilitation of Groups was assessed by group of extensionists from the Eastern Cape Department of Agriculture during a short course presented in August 2009 at Tsolo Agriculture College. This group of extension practitioners included extension staff with either a two or a three-year agricultural diploma. At the start of the course a placement evaluation was done to identify the level of knowledge and skills regarding group dynamics, leadership and the facilitation of group formation. Although the majority of these extensionists have extensive experience in agricultural extension, very few reflected the minimum knowledge and skills required for effective group mobilization and facilitation.

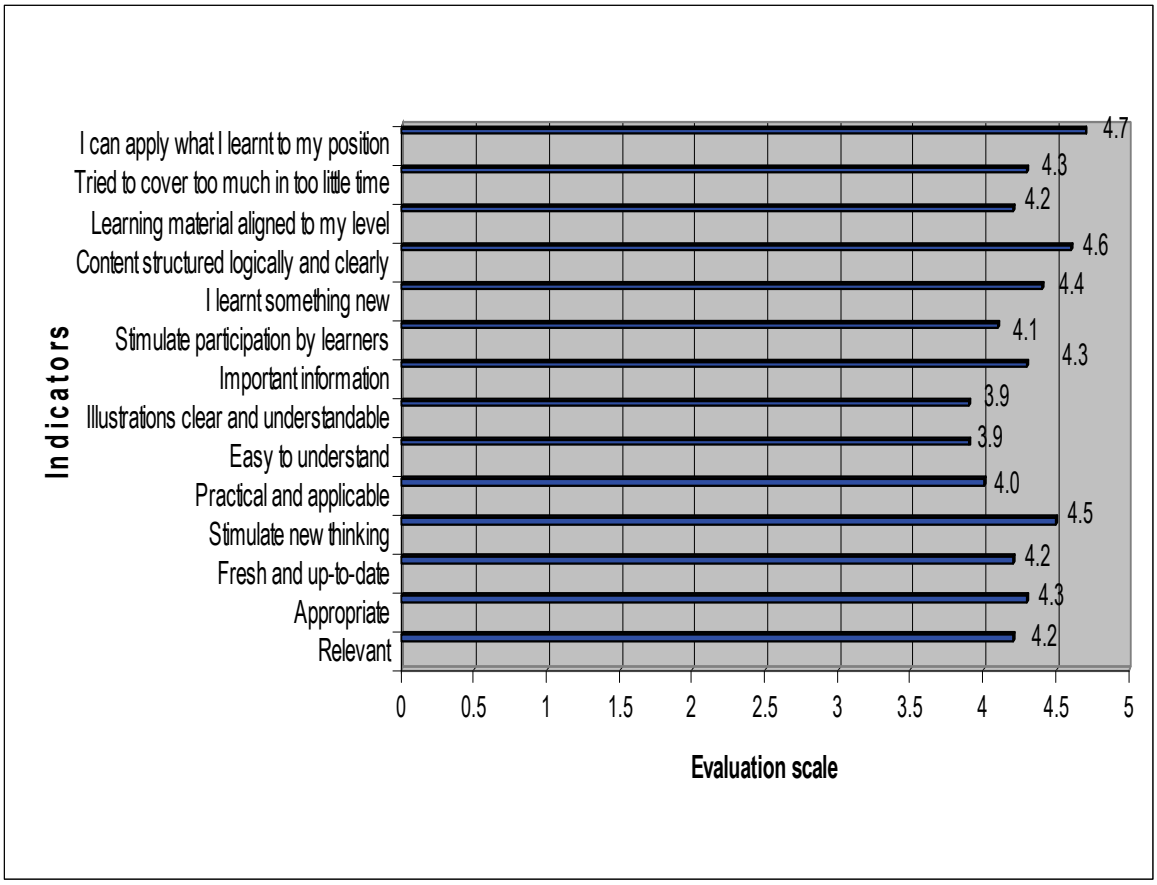


Figure 7.9. Assessment of the content and format of the learning modules leadership and group facilitation by learners from the Eastern Cape

The following general comments were made on the content and format of the course presented in Leadership and Facilitation of Groups:

- 'The course should be compulsive for extension staff in the department of Agriculture"
- "Helps to capacitate students"
- "Excellent course – will carry me for the next 20 years"
- " Helps me to gain experience and knowledge to do a better job"
- " Provide us with a good overview "
- "Provide the necessary skills and knowledge regarding leadership and development of groups"

- “Very appropriate”
- “Help to open my mind about group development”
- The course helps to address the current problems experienced as a group promoter”

8. CONCLUSION AND RECOMMENDATIONS

Thirty two percent of the 1192 extension officials employed by the Department of Agriculture are responsible for serving of small and commercial irrigation farmers in South Africa. Extension practitioners are at the forefront of learning in agriculture. They are uniquely placed to be a very important channel between the vast and complex mountain of information and ways of working through that to be useful for the farmer. The discussion forums held by the WRC from 2000 to 2003 throughout the nine provinces, highlighted that the extension linkage with farmers has deteriorated in recent years and therefore become less effective. The baseline study indicates the lack of competence and knowledge required by extensionists to serve irrigation farmers effectively. The fact that many extension workers lack the necessary skills and knowledge in irrigation management to support irrigation farmers, also results in a lack of confidence amongst extensionists, a decline in credibility and withdrawal from the community they are supposed to serve.

The assessment of the current education curricula in irrigation management offered to agricultural students by tertiary training organisations illustrates that these organisations do not prepare students adequately for the tasks they have to perform on irrigation schemes. It seems from this investigation into the offering of tertiary agriculture training to extensionists in irrigation management that the majority of tertiary agricultural organisations tend to concentrate on single disciplines where the agricultural scientist or technician is usually found to be thoroughly trained in only one of the above required disciplines, whilst other required learning areas like irrigation management and irrigation economics are usually included as part of a curriculum to a limited extent, if at all. The main concern is that the majority of tertiary training organisations often succeed to produce students relatively s*pecialised in a specific field of agriculture, but are most of the time lacking the ability to train students in a multi-disciplinary approach (problem-orientated learning) required by the irrigation industry to operate successfully on an irrigation scheme*. *Traditional instructional approaches used by the majority tertiary organisations dwell on theories and provide little room for learners to contribute from their practical experience.*

The challenge posed to research team was to develop training material which could assist extension workers in their facilitation of the learning process irrigation farmers need to undergo with regard to irrigation water management. The principal goal with this project is to help create men and women in extension who are capable of doing new things, men and women who are creative, inventive and discovers. To achieve these goals, learners should be placed in a position where they could *learn* and gain the necessary *competence* to *perform* effectively in their service towards the irrigation farmers. The learning material envisaged promoting learning through:

- Learning is for a purpose
- Learning relates to competence
- Learning must be learner centred
- Learning empowers the learner for a better job
- Learning involves skills such as communication, problem-solving, social interaction and learning how – to-learn, which are often beyond subject specific skills.

The aim of the project is to acquaint irrigation extensionists with the necessary skills and knowledge in an effort to restore their self-esteem and credibility amongst irrigation farmers. The conceptual understanding of the

“knowledge profile” of an irrigation extensionist that was developed helped to define the eight learning areas that require attention in the drafting of the learning material. The selection of appropriate (relevant) content as well as the format in which the learning material should be offered is critical determinants for the success of learning. If the information or training is not seen as relevant and applicable by learners, they are unlikely to access it and use it. Therefore it was essential to determine what learning activities are perceived to be relevant to the primary irrigation industry. The question asked – which approach and format should be used for the learning material to be developed within this WRC-project seemed to remain a rhetorical one. It was clear that there is a place for each theory within the practice of learning material design, depending upon the situation and environment. What remained the primary consideration though, were the needs and characteristics of the target group – the learners who are to eventually benefit from this material.

The project confirmed that the application of principles from the field of adult learning improves the quality of learning, and most importantly can lead to superior outcomes in terms of the ability to take advantages of opportunities. The following chronological steps were followed in the process of developing the learning material:

i) Understand the client needs and motivation

The project used a process where client needs were determined through consultation with a wide range of stakeholders through discussion forums held in various provinces, stakeholder workshops, interaction with academia at universities, agricultural colleges and universities of technology, which evolve into negotiated learning objectives and content of the learning material. There should be regular interactive consultation between the industry, educators/trainers and the learners as the target group to ensure that the learning material and program match their context and needs. This process of designing the learning objectives to meet the identified needs was perceived as a collaborative partnership between various stakeholders, which recognised the social nature of adult learning.

ii) Clearly define the objectives and outcomes for the learning material

It was important in the development of the learning material to ensure that shared goals expressed by various stakeholders especially regarding the objectives and outcomes of the training material should steer the development process. The contextualisation of the irrigation extensionists and irrigation farmers’ environment by the project team helped a lot to remind authors to develop material that is relevant and applicable for the target learners.

The development of landscapes and frameworks for the development of the training material helped to contextualise the essential skills, knowledge and competence required from the irrigation extensionists with regard to the different learning areas together with the main “building blocks” to address these expectations. This approach started with the end in mind (what learners intend to achieve) and work backwards to determine the building blocks (knowledge and competencies) to achieve this. The assessing of learners competencies after completion of a training module against “competent” or “not competent” is essential for outcomes-based learning material and therefore was included in these learning frameworks. The development of learning frameworks or landscapes requires intensive consultation and often a paradigm shift is required from participants.

The testing of frameworks and the drafted learning material helped the project team with important feedback that was used for refinement and further planning of the process.

iii) Recognition of current skills and clear and accessible pathways to learning activities

The baseline study or situation analysis at the start of the project was imperative to determine the current knowledge and competency level of irrigation extensionists. It was also used to determine the needs of the target group learners and to ensure that the training material that should be developed match these needs.

Information about the learning objectives, training and learning methods, modes of delivery and expected completion time for activities is clearly defined in the learning material and will meet the national requirements pertaining programs being developed within the NQF context. The developers of the learning material strived to maintain an appropriate balance of theoretical, practical and experiential knowledge and skills. The learning material strived for sufficient disciplinary content and theoretical depth, at the appropriate level (NQF level 5), to serve the training requirements of irrigation extensionists and will meet the requirements of the industry.

iv) Mechanisms for ensuring appropriate delivering of the learning material

Once the learning material is developed, it should be further customised to the needs and contexts of the individual participants at the delivery stage to ensure it fits with each of participants 'learning pathway'. Adults are assumed to be voluntary learners, autonomous, independent and self-directed. Adults are motivated to learn in order to solve a problem or to take advantage of an opportunity. Therefore learning must be relevant to the learner. Every adult is different. Those facilitating learning must be aware that adult learners come to a new learning experience with a unique set of past experiences, knowledge, skills, values, attitudes and aspirations. Furthermore, it is important to keep in mind that a sequential pathway of need, enthusiasm and applicability underpins this type of learning. With this in mind the learning material was designed with a combination of training methods, the kind of interaction required, availability of resources and the capacity of the learners taken into consideration. Practical activities such as demonstrations and field experiments were included in the learning material to ensure that all three senses of the learners namely eyes (visual), hearing (auditory) and practical "hands-on" activities (kinaesthetic) are used.

With the testing of the learning material content amongst students and extensionists attending short courses, it was evident that certain mechanisms should be in place to ensure quality delivery, and that the trainer and learners are involved in a cycle of continuous learning and improvement. It is also important that the facilitator or trainer or training provider skills and qualifications should meet a predetermined standard.

This learning package must be regarded as an introductory course to irrigation management, which could be followed by more advanced training when needed. The insights and understanding gained by learners by completing this learning can form important building blocks for more advanced training that may follow.

8.1 Lessons learned

Several lessons could be drawn from the development of the learning material:

- **Involve the target group in planning:** involve the target clients in the planning, perhaps even prior to the initiation of the development of the learning material and program. Also involve them during testing and evaluation of the initial learning material.

- **Wide consultation networks:** Imperative to ensure wide range of stakeholders, particularly from the target learning group, industry organisations, technical and extension experts and other providers are consulted before and during the developing of learning material. The nature and extent of consultation with these networks will vary.

- **Frameworks /landscapes** helped with the contextualisation of the essential knowledge and skills required from irrigation extensionists**.** In the development of landscapes for each learning area, the essential knowledge and skills required from an irrigation extensionists were sketched together with the "building blocks" or main learning outcomes required to address these requirements.

- **Checklist:** The checklist developed for the evaluation and testing of frameworks and landscapes of learning material helped to guide reviewers with a structured approach to test and evaluate learning material regarding the specific learning outcomes set for learning material and to ensure that the training offered is on an appropriate level of complexity under various conditions and for different learners.

- **Monitoring of impact of learning material:** Although the checklist used in this project was mainly designed to help with the testing and evaluation of the drafted learning material, a strategy (formal or informal) should be applied for the monitoring of learning impact. It is important to receive feedback from the learners on what went well and what could be better after offering of a learning program. Important will be to act on this feedback received.

- **Special type of person required for development of training material:** The development and especially the writing of learning material on this level (theoretical as well as examples of practical application) requires a special person, grounded with ample knowledge and experience in the various fields of irrigation water management. The subject matter specialists identified for this project will hopefully accomplish these challenges.

8.2 Recommendations and way forward

Apart from the research component where the current status of agricultural extension delivery to irrigation farmers was assessed, especially regarding small scale irrigation schemes, 93 learning modules within the eight learning areas were developed. The recommendations for the way forward mainly revolve around the dissemination and inclusion of the newly developed learning material by training organisations. It is recommended that the output of this project, which includes the main report and the learning material (technical and extension), should be distributed to the 12 agricultural colleges for implementation in their training curricula and as part of the marketing and dissemination initiatives of the WRC. From the interaction with agricultural colleges none have the capacity or resources to address the curricula revision with any rigor. The majority of agricultural colleges indicated that they are keen to incorporate the selected content into the existing modules on NQF level 5.

Secondly the nearly 400 extensionists employed by the various provincial departments of agriculture should also benefit from this learning material. Short courses or training of the trainer courses could be considered as part of technology transfer activities. The learning materials, as they have been developed, will comprise approximately 30 credits, which ties in well with the Quality Council for Trade and Occupation (QCTO) occupationally short courses. According to AgriSETA and CE @UP short courses are typically set at 25-30 credits. The technical and extension learning material were written as an integrated package to comply with the "knowledge profile' of the irrigation extensionist, and could be run as single courses for each learning areas (totalling 30 credits), which fits in well with the short course structure.

9. CAPACITY BUILDING

The nature of this project was different from most WRC research projects, as it was about research for the development of learning material. This requires the involvement of mainly people with the necessary knowledge and experience in the field of irrigation and extension.

Capacity building or development for the purpose of this project was defined as a "process that improves the ability of a person, group, organization or system to meet the objectives or to perform better. Taking into consideration this definition three areas of capacity building in this assignment were identified:

- Human resource development and strengthening-training and involvement of project team members, extension workers and students in agriculture.
- Organisational level through the participation of the extension corps, researchers, academia and subject matter experts.
- Creating an environment for learning through the dissemination of information on the research findings via conferences, workshops, publications, etc.

The capacity building took place at several levels during the lifespan of the project:

9.1 Capacity building among students and project members

Through the WRC project capacity was in the first place built amongst the project team members who gained a lot of experience and insight into the drafting of landscapes for technical and extension training material as well as the developing of content that fits these landscapes and unit standards. The interaction and exchange of information between the project team, extensionists, academia, researchers and trainers in the industry contributed to a better understanding of the challenges that each of these role players face in formal and in-formal training of extensionists in irrigation and water management.

The project supported three master students from University of Pretoria and one from the Central University of Technology at Bloemfontein with their studies in Agricultural Extension and master in agricultural economics. These post graduate students appreciated being supported by the project, especially the financial support.

- Mr Ntai, a student from Lesotho assessed the impact of extension support provided to irrigation farmers in his country. The title for his study is *"Critical factors determining irrigation farming in Lesotho."* He determined and analysed the current production efficiency of irrigation farmers and investigated the knowledge support system available to these farmers. This information was used to compare the level of training in Lesotho with a country like South Africa. This will be a first study of this kind in Lesotho, since little information is currently available about the irrigation potential and extension support to farmers in Lesotho. Currently the extension services of Lesotho face serious challenges since 2001 when restructuring of services took place. The student successfully completed this study and will graduate early in 2012.
- The second postgraduate student, Mr Sekogtha focused on the role of extension support rendered especially with regard to beneficiaries of land restitution. The fact that aftercare is so important for successful farmer settlement makes this study very appropriate for the times South Africa faces and it will also highlight the need of irrigation small scale farmers in this program. The study was conducted in the Limpopo (Phalaborwa), Tenbosch (TSB sugar farm) (Mpumalanga) and Badplaas irrigation schemes, where various models for land restitution and extension support are implemented. The student finished the data collection and analyses of data, and is in the process of drafting the

dissertation based on these research findings. This study would be finalized by the end of 2010 academic year.

- A third postgraduate student, Ms Quinty Moroaswi has already submitted a draft final copy of the dissertation with the title *" A financial analysis of management models in Land Reform in South Africa"* and will soon be examined to finalise her study for the degree of Masters in Agricultural Economics (MCom). Her study compares the different management modules that beneficiaries could implement in the settlement of irrigation farmers as part of the Land Reform Program. Two case studies were analysed namely one in Limpopo and the other in Tugela Ferry, KwaZulu-Natal.
- A fourth postgraduate student, Mr P Mashiane, an extensionist from Limpopo Department of Agriculture was supported in his study at Central University for Technology, Free State. The title for his study is *"Investigation into the effectiveness of farmer groups as tools of extension delivery: A case study in Makhuduthamaga-Sekukhune district of Limpopo Province".* This study investigated the role of farmer groups in the successful delivering of extension support to farmers and the important role that the extension worker plays in the establishment of the farmer group. Findings from this research project were included in the learning material drafted on group mobilising and facilitation.

9.2 Capacity building amongst extensionists, land use planners and farmers

The regular interaction between project team members, land use planners and irrigation extensionists contributed to inform them about the research findings. It serves to identify their specific needs regarding content and the specific format of offering this training material in irrigation water management. This exchange of information between the project team, subject matter experts, extension practitioners, land use planners academia and trainers will guarantee that the research is of academic quality, but also that the learning material to be developed will address the needs of the extensionists and stakeholders involved with the implementation of the project.

Regular interaction and discussions with extensionists throughout the country contribute to change and hopefully impact on the knowledge, understanding, and changing of attitudes of extensionists in an effort to restore their self-esteem.

Regular interaction with smallholder irrigation farmers also helps the team to identify the needs of farmers in terms of knowledge support. These discussions were also used to inform farmers about the project and the envisaged training material which is in the process of development to address their concerns of the lack of technical competence and knowledge amongst extensionists. These interactions are part of an on-going process since farmers will play an important role as a barometer to assess whether the final product will fit the needs and specific situation of the irrigation farmer

9.3 Capacity building with other stakeholders

The project team had active collaboration with various tertiary organisations as reported. Regular and intensive intervention and collaboration followed between the team and Lowveld College of Agriculture, Fort Cox Agricultural, Tsolo Development Institute and Tompi Seleka Training Institute, Grootfontein Institute for Training, Elsenburg College for Agriculture (Cape Institute for Agricultural Training) and Cedara College of Agriculture.

Apart from tertiary training organisations the project also interacted regularly with private organizations like Transvaal Sugar Ltd, South African Sugar Research Institute, Agrofert, SUBTROP and various other commercial cooperatives and private consultants.

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Appendix A

COMPETENCE RELATING IRRIGATION MANAGEMENT: EXTENSIONISTS

A. PERSONAL DETAILS | | | | V1

Name _____

Contact No:…….

1.Province | | V2

Eastern Cape ……. (1)
KwaZulu-Natal (2)
Limpopo (3)
Mpumalanga…… (4)

2.a) Name of irrigation scheme:…… | | V3

b)Number of active irrigation farmers that you serve with extension service …….. | | V4

3. Position /Function | | V5

(1) Assistant extension worker
(2) Extensionists
(3) Supervisor or manager
(4) Other: specify……..……

4. Gender Male (1) Female (2) | | V6

5. What is your age? | | V7

< 30 years (1)
31-40 years (2)
41-50 years (3)
51-60 years (4)
61-70 years (5)
> 70 years (6)

6. a What is your highest qualification? | | V8

<Grade 12 (1)
Grade 12 (2)

Certificate (3)
Diploma (2/3 years) (4)
B Tech degree (5)
BSc (7)
Honours (8)
Masters (9)
PhD……(10)

b. Please indicate your technical field of specialisation:……..
……..

B. STANDARD OF IRRIGATION MANAGEMENT TRAINING AND KNOWLEDGE

7. What formal training have you had in Irrigation Management?

None …… .. (1)
Irrigation management courses Agric. Diploma program ….(2)
Irrigation management courses as part of B Tech program (3) V9
Irrigation management courses as part of B Agric, BSc (4)
Honours degree or higher qualification in irrigation management (5) ☐

8. Have you attended any short courses in irrigation management?

YES (1) NO (2) ☐ V10

1. If **YES**, Specify the name of course:…… ☐ V11
When attended?(year)…… ☐ V12
Where attended?……. ☐ V13

Who were the trainers (organisation/institution)?…….
…… ☐ V14

10.List in priority order the sources of information regularly consulted by you to help with support rendering regarding irrigation management

……No1:…… ☐ V15
……No2:…… ☐ V16
……No 3…… ☐ V17
……No 4…… ☐ V18
……No 5…… ☐ V19

11. How would you rate your efficiency or competence in irrigation management using the following scale?

1	2	3	4	5	6	7	8	9	10

▲ ▲

Extremely incompetent **Highly competent**

☐ V20

12. Using the scale given below, rate your knowledge regarding the following aspects of irrigation management.

1	2	3	4	5	6	7	8	9	10

▲ ▲

Extremely low **Extremely high**

Knowledge regarding crop production		☐ V21
Knowledge regarding soil (cultivation, physical and chemical characteristics, irrigation potential, etc.)		☐ V22
Knowledge regarding the use of climate data (ET_0 evaporation, rainfall, temperature, etc.)		☐ V23
Knowledge regarding irrigation economics (enterprise budget, business plan, irrigation operational costs)		☐ V24
Knowledge regarding irrigation engineering (maintenance, delivery rate, system efficiency)		☐ V25

13. Considering your assessment of competence in irrigation management, how will you prefer to improve your knowledge, skills and competence? Please rate your preference using the following scale.

1	2	3	4	5	6	7	8	9	10

▲ ▲

Not preferred **Highly preferred**

Self directed …… ☐ V26

Formal training. ☐ V27

Informal training (viz. short courses, experiential learning, etc.) ☐ V28

14. List your training needs regarding irrigation management in order of priority.

……

……

Appendix B

Attendance of key stakeholder workshop, Tuesday 5 December 2006 at Kopano Hall, ARC Agric Engineering (ARC-AIE), Silverton.

A. Present

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B. Apologies:

Kenny Moabelo	LPDA
Japie Williams	Unive Fort Hare
Gerhard Backeberg	WRC
Charles M'marete	Univ Venda
Isobel vd Stoep	Univ Pta
Chris du Preez	Univ Free State
Leon van Rensburg	Univ Free State
Eduard Hoffman	Univ Stellenbosch
Cornelius Chiduza	Univ Fort Hare
N Raidimi	Univ Venda
Steve Worth	Univ KwaZulu Natal
Bennie Grove	Univ Free State
J Venter	Potchefstroom Agric Coll
Oosie Marincowitz	Cape Inst for Agric Training
Philip Myburgh	ARC
Phonnie du Toit	ARC
Francois vd Merwe	DWAF
Gerrie Albertse	Private consultant
Erna Kruger	Private consultant
Bubi Aphane	Private consultant
Johan vd Hoven	NWDA
James Wallis	NWDA
Charles de Kock	NWDA
Jan Swanepoel	NWDA
Harry Mashiane	LPDA
Z Manona	ECDA

Appendix C

Research products that arose from the project

C.1 Dissertations

a. NTAI PJ, 2011. Critical factors determining irrigation farming in Lesotho. MSc dissertation, University of Pretoria.

b. MOROASWI Q, 2012. "A financial analysis of management models in Land Reform in South Africa". MCom, University of Pretoria (Exam copy submitted)

C.2 Conference papers and Journal publications

1. STEVENS JB & VAN HEERDEN PS, 2006a. Participatory curriculum development for training of extensionists in irrigation management. *SA J. Agric. Ext. 35 (2):242-257.*

2. STEVENS JB & VAN HEERDEN PS, 2006b. Participatory curriculum development for the training of extensionists in irrigation management. *Proc. of 40th SASAE Conf.*, Berg en Dal.

3. STEVENS JB, 2007. Professional extension support: A prerequisite for sustainable irrigation development. *S Afr. Agric. Ext. 36:170-189*

4. STEVENS, JB & VAN HEERDEN, PS, 2007. A conceptual framework of a possible curriculum for training of extensionists and advisors in irrigation management. WRC Report No KV 178/07

5. STEVENS JB, 2007. Efficient extension support: a prerequisite for sustainable irrigation development. ICID, Second African and Regional Conference, 6-9 November 2007, Glenburn Lodge, Johannesburg, South Africa.

6. STEVENS JB, 2008. Knowledge support to smallholder irrigation: can we do better? SANCID Conf. Paper, November 2008, Club Mykonos, Western Cape.

7. STEVENS JB, 2010. From "Best Management Practices" to "Best Fit" Irrigation Management Practices. SANCID Conf. Paper, 16-18 November 2010, Desert Palace Hotel and Casino Resort, Upington, Northern Cape.

8. VAN HEERDEN PS & STEVENS JB, 2010. Impact of climate change on irrigation water management. 44th Annual SASAE Conference, 4-7 May 2010, Langebaan, Western Cape.

9. STEVENS JB & NTAI, 2011. The role of extension support to irrigation farmers in Lesotho. *S Afr. Agric. Ext. 39(2)*