



Deliverable

2

## Water Research Commission

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**Project Number:** K5/2719/4

**Project Title:** Collaborative knowledge creation and mediation strategies for the dissemination of Water and Soil Conservation practices and Climate Smart Agriculture in smallholder farming systems.

**Deliverable No.2:** Report on stakeholder engagement, case study development and site identification

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# Report on stakeholder engagement, case study development and site identification

## 1 OVERVIEW OF PROJECT AND DELIVERABLE

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### Contract Summary

#### Project objectives

1. To evaluate and identify best practice options for CSA and Soil and Water Conservation (SWC) in smallholder farming systems, in two bioclimatic regions in South Africa. (Output 1)
2. To amplify collaborative knowledge creation of CSA practices with smallholder farmers in South Africa (Output 2)
3. To test and adapt existing CSA decision support systems (DSS) for the South African smallholder context (Outputs 2,3)
4. To evaluate the impact of CSA interventions identified through the DSS by piloting interventions in smallholder farmer systems, considering water productivity, social acceptability and farm-scale resilience (Outputs 3,4)
5. Visual and proxy indicators appropriate for a Payment for Ecosystems based model are tested at community level for local assessment of progress and tested against field and laboratory analysis of soil physical and chemical properties, and water productivity (Output 5)

#### Deliverables

No	Deliverable	Description	Target date
FINANCIAL YEAR 2017/2018			
1	Report: Desktop review of CSA and WSC	Desktop review of current science, indigenous and traditional knowledge, and best practice in relation to CSA and WSC in the South African context	1 June 2017
2	Report on stakeholder engagement and case study development and site identification	Identifying and engaging with projects and stakeholders implementing CSA and WSC processes and capturing case studies applicable to prioritized bioclimatic regions Identification of pilot research sites	1 September 2017
3	Decision support system for CSA in smallholder farming developed (Report)	Decision support system for prioritization of best bet CSA options in a particular locality; initial database and models. Review existing models, in conjunction with stakeholder discussions for initial criteria	15 January 2018
FINANCIAL YEAR: 2018/2019			
4	CoPs and demonstration sites established (report)	Establish communities of practice (CoP)s including stakeholders and smallholder farmers in each bioclimatic region.5. With each CoP, identify and select demonstration sites in each bioclimatic region and pilot chosen collaborative strategies for introduction of a range of CSA and WSC strategies in homestead farming systems (gardens and fields)	1 May 2018
5	Interim report: Refined decision support system for CSA in smallholder farming (report)	Refinement of criteria and practices, introduction of new ideas and innovations, updating of decision support system	1 October 2018
6	Interim report: Results of pilots, season 1	Pilot chosen collaborative strategies for introduction of a range of CSA and WSC strategies , working with the CoPs in each site and the decisions support system. Create knowledge mediation productions,	31 January 2019

		manuals, handouts and other resources necessary for learning and implementation.	
<b>FINANCIAL YEAR 2019/2020</b>			
7	Report: Appropriate quantitative measurement procedures for verification of the visual indicators.	Set up farmer and researcher level experimentation	1 May 2019
8	Interim report: Development of indicators, proxies and benchmarks and knowledge mediation processes	Document and record appropriate visual indicators and proxies for community level assessment, work with CoPs to implement and refine indicators. Link proxies and benchmarks to quantitative research to verify and formalise. Explore potential incentive schemes and financing mechanisms. Analysis of contemporary approaches to collaborative knowledge creation within the agricultural sector. Conduct survey of present knowledge mediation processes in community and smallholder settings. Develop appropriate knowledge mediation processes for each CoP. Develop CoP decision support systems	1 August 2019
9	Interim report: results of pilots, season 2	Pilot chosen collaborative strategies for introduction of a range of CSA and WSC strategies, working with the CoPs in each site and the decisions support system. Create knowledge mediation productions, manuals, handouts and other resources necessary for learning and implementation.	31 January 2020
<b>FINANCIAL YEAR 2020/2021</b>			
10	Final report: Results of pilots, season	Pilot chosen collaborative strategies for introduction of a range of CSA and WSC strategies , working with the CoPs in each site and the decisions support system. Create knowledge mediation productions, manuals, handouts and other resources necessary for learning and implementation.	1 May 2020
11	Final Report: Consolidation and finalisation of decision support system	Finalisation of criteria and practices, introduction of new ideas and innovations, updating of decision support system	3 July 2020
12	Final report - Summarise and disseminate recommendations for best practice options.	Summarise and disseminate recommendations for best practice options for knowledge mediation and CSA and SWC techniques for prioritized bioclimatic regions	7 August 2020

## Overview of Deliverable 2

The desktop review process for this brief has been divided into three distinct sections:

1. A review of Climate Smart Agriculture (CSA) practices potentially relevant to this brief including agroecology, soil and water conservation(SWC), conservation agriculture (CA) and landscape management approaches. Included here are the policies, strategies and present best practice internationally, regionally and nationally. These aspects were covered in Deliverable 1.
2. A review of participatory, livelihoods and socio-ecological approaches relevant to this brief, including an overview of present methodological and participatory frameworks being used in vulnerability assessments and climate change adaptation. These aspects are to be covered in Deliverable 2 along with stakeholder engagement, case study development and site identification; thus, the present document
3. A review of decision support systems that have been developed to date for CSA assessing their viability and potential for adaptation in our context. These aspects are to be explored, along with the initial development of the broad outlines of a decision support system (DSS) to be used in this brief. These aspects will be reported under Deliverable 3.

The reason for this is twofold; the first being the sheer volume and complexity of published material on these topics and the second is to accommodate for the team writing process being employed. All team members, including the students and field staff are involved in writing sections of these reports. The students are mentored by other members of the research team and joint writing sessions and



review processes have been set up. This is an inherent part of the capacity development process for this research brief. It is also the reason why in this deliverable the author/s of each section will be noted.

The layout of the report follows the logic of introducing processes and methodologies as a desktop review and then applying this information into the context of our research brief.

## 2 SOCIAL AND PARTICIPATORY METHODOLOGIES AND PROCESSES

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### 2.1 Introduction

*By Bobbie Louton*

This document builds on the *Desktop review of Climate Smart Agriculture and Water and Soil Conservation* (Deliverable 1 for this project) and lays the foundation for the social and technical methodologies that will be used in this project. In chapters 2 and 3, existing social and technical methodologies described in the literature are explored for their usefulness to this study. Chapter 4 will look at the selection of sites and participants for the study, with detailed exploration of four prospective sites in the form of case studies. In Chapter 5, the learnings gleaned from the methodologies and examples presented in the previous chapters are applied to develop the methodology that will be used in this study. Based on this methodology, the team will prepare for implementing the project in the selected communities

### 2.2 Principles for social engagement

*By Bobbie Louton*

Key principles of engagement can be summarised as follows:

#### **COLLABORATION: Researchers and community members co-create the intervention**

Assessment of need, design of intervention, and evaluation are done together, with community inputs carrying weight. Collective self-determination should be the basis for needs assessment. This requires flexibility as the intervention may take new directions not initially envisioned by researchers.

#### **INCLUSION: Everyone who has a stake in the intervention has a right to participate in processes and decisions**

Efforts will be made to ensure no one who has stake is excluded from participation or decision making on the basis of any demographic or socio-political factor. Work for diversity. The research team will not default to working with visible or influential players. The vulnerable, marginalised, least vocal will be actively included. Be aware of how power is recognised, structured and shared in a community.

#### **SAFETY: The process and intervention is conducted in a way that is safe for all participants**

This includes the spaces chosen for meetings, the design of processes and interactions (eg. how small groups are set up), the design of learning tasks (begin with simple, clear tasks). Allow small groups to find their voices. Establishing competence and experience contributes to safety. Make space for informal interactions where views or needs can be expressed in safety.

#### **RESPECT AND BUILD ON LOCAL AND TRADITIONAL KNOWLEDGE**

People are experts in their own context and what they know is the foundational for new engagement. The research team must become thoroughly acquainted with the community: culture, social networks, economic conditions, demographics, history with other interventions – and respond to the realities and dynamics that exist.

**MUTUALITY AND EQUALITY IN LEARNING: Everyone already has knowledge and experience, everyone will learn**

Prior knowledge of everyone is taken into account; life experience is used as the basis for relating to new knowledge, attitudes or skills. Researchers and participants are equals; all are learners. Peers challenge and mentor each other. Aim for both individual and collective learning and growth.

**PRAXIS: Learning is structured through active doing and reflecting**

Learners consider new content (skills, knowledge, attitudes) and re-create them to fit their context, then try it and reflect on how it works. Learning happens with the mind, emotions and muscles. Passive learning teaches passivity. The process, not only the outcomes, are important.

**BUILD A CULTURE OF OPEN DIALOGUE**

Encourage expression of different opinions and value minority views and individual insights. Talk transparently about power dynamics.

**FLEXIBILITY**

The research, programmes, projects and interventions must serve the wellbeing of the community and the environment; not the other way around. They should be structured with reflective processes that allow them to be reshaped as needed as a clearer perspective unfolds.

**TRANSPARENCY AND ACCOUNTABILITY**

Work for a culture where researchers and community members operate with transparency and are accountable for their roles and actions. Work for a culture of accountability to oneself for realising one's aims in the process.

**BUILD FOR THE LONG TERM**

Build into the intervention mechanisms to sustain collaborations over the long term and work to mobilise community assets to this end; as collaborations mature and grow, their ability to address complex and long-range issues also grows.

## **2.3 Brief review of relevant participatory methodologies**

*By Erna Kruger, Bobbie Louton*

This section focuses on summarising participatory methodologies in assessment, analysis and action that support the community of Practice (CoP) in contextualisation, understanding and learning and involves the broader community in a meaningful way.

The international development community is giving increased attention to agricultural innovation processes and systems that lead to outcomes at scale. Inclusive multi-dimensional and multi-stakeholder learning processes are seen as important. Smallholder family farmers become more central in the design and implementation of research processes as partners in planning and implementation processes (Kruger & Gilles, 2014).

Key trends or changes in Participatory Agricultural development thinking are moving from:

- Increases in production to improvement in local livelihoods
- Technology transfer to local innovation development
- Beneficiaries of projects to influential stakeholders within programmes
- Technology transfer to co-development of innovation systems
- Functional participation to empowerment and
- Applied and adaptive research to strategic and pre-adaptive research.

Global experience shows that new ways of thinking about and doing agricultural research and development are required. The basic paradigm shift is one of moving away from the idea that research and development is a process of generating and transferring modern technology to 'farmers'. And then moving towards seeing the idea as an inclusive multi dimensional learning process that:

- Works from a holistic perspective that includes biophysical, socio-political and economic perspectives in agriculture AND natural resource management;
- Draws upon diverse source of knowledge – from local to global
- Provides for meaningful participation of user groups in the process of investigating improvements in local situation;
- And builds synergy between local capacities, resources and innovations by
  - Providing decision support tools and information that enables various types of users to make strategic choices and actions and
- Which results in a wide range of knowledge products (technological through to socio-political) for generating, sharing, exchanging and utilizing knowledge.

Now, concepts such as strategic and pre-adaptive participatory research become important as does the idea of best practise scenarios and options and the mainstreaming of cross cutting issues and themes. In many ways, these concepts are still in a developmental phase and are not as yet integral in existing institutional and research cultures.

The development of methodological frameworks and processes to encompass the above themes and goals has followed two broad tracks/lines depending to an extent, on the type of institution at work and their overall aims: researcher and innovation; namely Participatory Action research (PAR) and Participatory Innovation Development (PID). (Brock & Pettit, 2007). These processes are discussed in more detail in the sections below.

## 2.4 Communities of practices (CoPs)

*By Temakholo Mathebula, Erna Kruger*

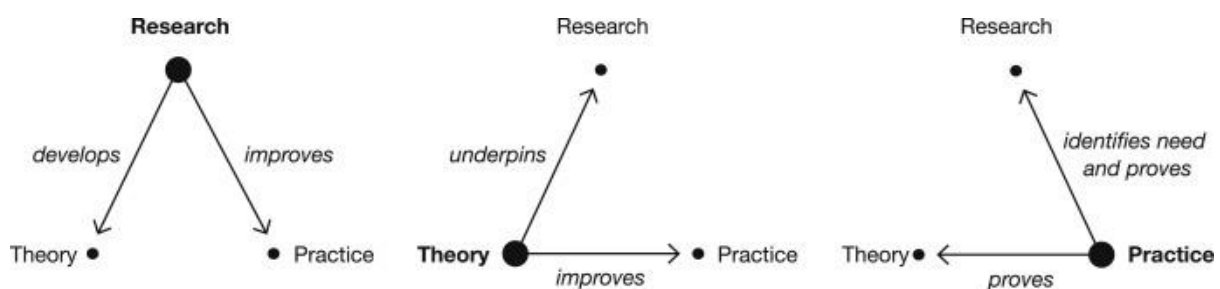
Communities of Practice (CoPs) are a progressive theory of knowledge management, knowledge creation and learning. It is a type of contextualised learning within the theory of Situated Learning as proposed by Jean Lave and Etienne Wenger (Lave & Wenger, 1991). Situated Learning proposes that the learning process of an individual is much more than the cognitive process of acquisition of skills and knowledge but situated in a social context, and it is through participation in the social context that the learning process occurs.

CoPs are both a theory of learning and a part of the field of knowledge management. It thus depends on a group of people, contextually defined, who share a common interest and a desire to learn from and contribute to the community with their variety of experiences. Stated more simply, the primary purpose of a CoP is to provide a way for practitioners to share tips and best practices, ask questions of their colleagues, and provide support for each other.

Research, theory and practices are interrelated design aspects in a programme. This integration is supported through CoPs.

There is a need for collaboration. Work on large, complex projects goes beyond the knowledge of one person to require the knowledge and skills of people from different disciplines. They need to coordinate their activities and synthesize their knowledge. Cross-disciplinary team participation requires an ability to negotiate team process and participate in decision-making (Helmer Poggenpohl, 2015).

For example, both research and practice can develop theory, theory needs to be proven through practice, practice can flag needs for research, research can overthrow theory, and research can improve the performance of practice. Research, theory, and practice are not isolated activities, but are tightly interrelated.



**Figure 1: The relationships and interplay between research, theory and practice**  
©S Poggenpohl,2015

It approaches knowledge in terms of an organism that adapts and interacts with its environment; uses ideas as instruments or plans of action; and retains ideas that practically work, discarding those that do not. It moves from primary experience through refined reflection to explanation; moving from the tacit to the explicit.

Communities of practice are important because they:

- Connect people who might not otherwise have the opportunity to interact, either as frequently or at all.
- Provide a shared context for people to communicate and share information, stories, and personal experiences in a way that builds understanding and insight.
- Enable dialogue between people who come together to explore new possibilities, solve challenging problems, and create new, mutually beneficial opportunities.
- Stimulate learning by serving as a vehicle for authentic communication, mentoring, coaching, and self-reflection.
- Capture and diffuse existing knowledge to help people improve their practice by providing a forum to identify solutions to common problems and a process to collect and evaluate best practices.
- Introduce collaborative processes to groups and organizations as well as between organizations to encourage the free flow of ideas and exchange of information.
- Help people organize around purposeful actions that deliver tangible results.

- Generate new knowledge to help people transform their practice to accommodate changes in needs and technologies.

To design or set up a CoP the following steps of processes are important. Successful and sustainable communities have focused, well-defined purposes that are directly tied to the sponsoring organization's mission. Purposes should be defined in terms of the benefits to the community's stakeholders and the specific needs that the community will be organized to meet.

**Essential elements of a CoP:**

- Share experiences and know-how
- Discuss common issues and interests
- Collaborate in solving problems - Analyse causes and contributing factors
- Experiment with new ideas and novel approaches
- Capture/codify new know-how
- Evaluate actions and effects
- Learning

Purposes can be categorized into the following four areas of activity; developing relationships, learn and develop practice, carry out tasks and projects, create new knowledge

1. *Developing relationships:* Interaction with and developing of a wider network of peers working with a process of building trust, reciprocity, mutual respect and commitment.
2. *Developing practice:* Practice evolves with the community as a collective product, becomes integrated into members' work, and organizes knowledge in a way that reflects practitioners' perspectives. Successful practice development depends on a balance between "the production of 'things' like documents or tools and deep learning experiences for community members.
3. *Carrying out tasks and projects:* Small group projects, sponsored by the community, help members create personal relationships and also provide a way to produce the resources for developing the practice: cases, effective practices, tools, methods, articles, lessons learned, databases, heuristics, models, Web sites.
4. *Creating new knowledge:* Members go beyond current practice to explore the cutting edge of the domain, to innovate. Community may redefine its boundaries and membership and foster boundary-crossing, possibly working with people from other communities to explore emerging technologies, practices, and ideas.

Actions for the CoP are based on the premises of inquiry, design, activities, communication, interaction ,learning, knowledge sharing, collaboration, roles and social structures and piloting and roll out of the processes, as set out below.

1. **Inquire:** Identify the audience, purpose, goals, and vision for the community. Who is the community for? What are the key issues and the nature of the learning, knowledge, and tasks? What is this community's primary purpose? What are the benefits to the stakeholders? What specific needs will the community be organized to meet?
2. **Design:** Define the activities, technologies, group processes, and roles that will support the community's goals.
3. **Activities:** What kinds of activities will generate energy and support the emergence of community presence? What will the community's rhythm be?
4. **Communication:** How will members communicate on an ongoing basis to accomplish the community's primary purpose?

5. Interaction: What kinds of interactions (with each other and with the content of the community) will generate energy and engagement?
6. Learning: What are the learning goals of the community, and how can collaborative learning be supported?
7. Knowledge Sharing: What are the external resources (people, publications, reports, etc.) that will support the community during its initial development? How will members share these resources and gain access to them?
8. Collaboration: How will community members collaborate with each other to achieve shared goals?
9. Roles and Social Structures: How will community roles be defined (individuals, groups, group leaders, community administrators, etc.) and who will take them on?
10. Prototype: Pilot the community with a select group of key stakeholders to gain commitment, test assumptions, refine the strategy, and establish a success stories
11. Launch: Roll out the community to a broader audience over a period of time in ways that engage new members and deliver immediate benefits.
12. Grow: Engage members in collaborative learning and knowledge sharing activities, group projects, and networking events that meet individual, group, and organizational goals while creating an increasing cycle of participation and contribution.
13. Sustain: Cultivate and assess the learning, knowledge, and products created by the community to inform new strategies, goals, activities, roles, technologies, and business models for the future (National Learning Infrastructure Initiative, 2002)

### **Nurturing CoPs**

A CoP is not immune to constraints and unforeseen circumstances that may hinder or prolong the production of practice. These factors are often external and beyond the control of the participants. In the context of agricultural production, these may include unpredictable weather patterns and lack of access to resources and information, amongst other challenges. There may also be subconscious forces that may undermine the best intentions, i.e. a CoP can become dysfunctional and counterproductive even if practitioners follow the recommended procedures. In reality, the development of a practice reflects the meaning arrived at by those engaged in it. Therefore, no matter how much external effort is made to shape or dictate practice, if it does not make meaningful sense to those engaged in it, it may not materialise. A practice cannot be controlled by external forces, institutions or research, as it is not merely an implementation output but it is a response to it based on active negotiation of meaning (Oreszczyn, Lane, & Carr, 2010)

Cross-disciplinary team participation requires an ability to negotiate team process and participate in decision-making (Helmer Poggenpohl, 2015). Power dynamics are a challenge to nurturing a CoP, particularly when the CoP is facilitated (Cundill et al, 2009). The learning environment can often mask power dynamics that may exists between experts and non-experts in a transdisciplinary setting (ibid). In the case of this study, this would relate particularly to the power which the research team will have within the CoP to prioritize its needs and agendas over those of other members. Power dynamics can prevent some actors from playing an active role as well as banish others to the side-lines with no prospect of joining the core group. It is thus important to create an environment that enables movement in and out of the core group over time (Cundill et al, 2009). Wenger notes that successful CoPs create opportunities for those in the periphery and build “benches” for those on the

side lines (cited in Cundill et al, 2009). Building benches for outsiders means opening opportunities for participants in the periphery to observe the activities of the core group. The CoP should enable movement back and forth between the periphery and the core, with some members taking more active roles at certain times or on certain topics (Cundill et al, 2009).

The establishment of a CoP could also create a platform where previously disempowered members of the community are empowered through the group to address issues they have not been able to individually. This could result in challenges to local authority structures, with possibilities for conflict and also for resolution of previously unresolved issues. One issue where members of the CoPs in this project may find they have common cause is described by one of the authors of this report as follows:

Normally in late October, when the planting period starts, all farmers keeping livestock in the community are required to take their livestock to the mountains where the communal grazing is, and shepherd their livestock there. Farmers who cannot shepherd their livestock on their own due to other commitments are required to hire a shepherd to take care of their livestock (the fee may be based on the number of animals, or a straight fee such as R200/mo). People who wanted to plant at that time are waiting for those who have livestock to remove their livestock, so that their seedlings will be safe. Farmers who keep livestock wait for people who are planning to start planting so that they can start collecting their livestock. This causes tension between livestock and crop farmers because they are both waiting for each other.

In late May to early June, farmers with crops await instructions to start harvesting from the community traditional leadership (isiqongo). No one is allowed to harvest until they are instructed to do so. Once the fields are harvested, livestock are allowed to return and graze locally in the community and household fields. Some farmers finish harvesting earlier than others and allow their livestock to return to the community and their livestock eat the crops of farmers who have not yet finished harvesting.

A farmer who has had their crops eaten by another farmer's livestock is supposed to report that farmer to the local leader so that they can pay fine. But normally farmers say it is not easy to report cases since they are trying to maintain a good relationship with their neighbours, and they are afraid that they might be killed by the owners of the livestock which ate the crops in the fields. Sometimes it happens that crops are eaten by livestock of the farmer who is also a member of a learning group, which also has an impact on the learning group's dynamics.

The only real way to be protected against this problem is for a farmer to fence their fields. Not all farmers can afford to buy fencing, so this creates an inequality between the farmers.

### **CoP and Learning Networks:**

Community learning networks are connections formed and maintained by local people with the aim to share information and support each other's learning. They are generally called learning groups or social support groups. These networks are important in bringing together local people, development practitioners, researchers and other role players to access and share resources and information that can encourage communities to take up improved practices. Most importantly, community learning networks are an effective way for local people to share experiences and assist each other in



understanding and implementing new practices (Steeple & Jones, 2002). Community learning networks have similar features to CoPs, but may include wider platforms of learning and sharing such as community engagement forums, information days and farmer to farmer learning through cross visits. These networks are connected through shared practice and are capable of sharing knowledge and identity. In the context of climate smart agriculture practices, these platforms provide farmers the opportunity to share their experiences on the practices implemented to mitigate the effects of climate change.

#### **CoP and Farmer Field Schools:**

Farmer Field Schools (FFS) are hands-on practical learning schools based on adult education principles and experiential learning. FFS provide a platform for farmers to convene, make field observations, relate those observations to the ecosystems and apply previous and new information to make informed decisions. FFS is implemented through groups with a common interest to investigate a certain topic. Topics can include IPM, organic agriculture, crop production and animal husbandry amongst others. In FFS, what is meaningful is decided by the farmers through exploration and discovery, learning is a result of experience, learning is an evolutionary process and each person has a unique experience of reality. Group managed trials are at the heart of FFS as the learning space is in the field where the trial is conducted (Duveskog, 2013).

#### **CoP and Participatory Innovation Development (PID):**

Local innovation is the process by which people find new and improved ways of doing things and take initiative to try out these new practices using their own resources. They may be doing this as a way of exploring new possibilities and discovering alternatives to coping with changes in their natural resource base, asset availability or other socio-economic contexts which may be a result of changes in policy, natural disasters or other external factors. Through these processes of exploring, experimenting and adopting new practices, people come up with local innovations that were developed and are understood by them. Local innovation can take place at an individual level, through groups or may include the community at large (PROLINNOVA, 2009). The emphasis is on people being actively involved in discovering and exploring new ways of doing things. Participatory Innovation Development which can also be referred to as farmer led joint research is a process whereby local people work together with researchers and development practitioners to investigate possible ways to improve their livelihoods. Research in this context entails going beyond on field trials but also looking at the value chain, community relationships and ways to manage communal resources. With the current global issue of climate change, PID is of significant importance in helping farmers explore ways of adapting and improve the resilience of their farming systems through improved climate smart practices such as those encompassed in conservation agriculture (Wettasinha, Wongtschowski, & Waters-Bayer, 2009).

#### **CoP and Community Savings Groups:**

Community savings groups have been around for a long time and are prevalent in villages in Africa, Asia and Latin America where banking services are absent. Savings are also called rotating savings and credit association (ROSCAs'), savings and credit groups (SCG's), village savings and loans associations (VSLAs) and "merry go round" and they all have similar objectives. Community managed savings and credit groups are a convenient way to save money, gain access to small loans, obtain emergency insurance and ultimately gain a means of livelihood in order to build economic

empowerment. Savings groups are self-managed and respond directly to unmet financial services of the rural poor residing in remote areas (Seifert, 2016). In South Africa, savings groups have gained popularity in over the years, due to their convenience, financial security and ease of access. Financial exclusion from the mainstream economy has led to the development of community based solutions for the black population through savings groups where women make up the bulk of the members (Mathebula, 2014). Community savings groups provide a platform for farmers to learn skills on financial management, create networks for future business opportunities and improve/expand their existing enterprises. In this way, they can form an essential component of a community learning network.

### **Community of Practice in Stakeholder Engagement:**

Communities of practice can play a significant role in linking practitioners, knowledge producers and policy processes to analyse, address and explore solutions to problems. There are three ways in which CoPs can link knowledge, policy and practice:

- Firstly, they can encourage collaboration between researchers, and practitioners. Researchers can capitalise on knowledge by practitioners to ensure that the problems they are working on are relevant. CoPs create an environment for reflection, interpretation and feedback.
- Secondly, CoPs can be useful in creating an environment where researchers can work together to influence policy.
- Lastly, CoPs can play a role in involving policy makers in knowledge generation, seeing that the domains of research and policy are interlinked by complex social networks.

Other ways in which CoPs can be useful to development practitioners, policy makers and researchers are when emphasis is placed on fostering learning, rather than trying to control CoP's. Organisations can focus on facilitation not technology, understand members' needs and capacities, recognise the two faces of communities as some communities can reject new ideas and practices and finally they need to be sensitive to the different stages of CoP development (Hearn & White, 2009)

The real challenge of communities of practice is to develop the community and the practice simultaneously. Community development refers to the development of skills of the people involved in coordination, facilitation and knowledge management of the community. Development of the practice entails that resources, information and knowledge are captured and enhanced over time. A community of practice has flexible boundaries, meaning that membership involves whoever is interested in the practice, members participate in different ways and to varying degrees (Wenger, 1998).

## **2.5 Participatory research and intervention methodologies**

As discussed at the beginning of this chapter, the paradigm used for community-based research and interventions has moved increasingly towards a prioritising of participation of programme beneficiaries or research subjects, with stakeholders playing a more central and powerful role. Strenger et al (2009) note that participation has been motivated by both normative arguments (equity, democracy, citizenship) and pragmatic arguments (better and more sustainable decisions are made with stakeholder engagement). The table below illustrates how this shift, since the 1960s

has incorporated new ideas as participation has been used in different ways, with criticism of and disillusionment with participation eventually arising and incorporating lessons that have been learnt.

**Table 1: Evolution of approaches to stakeholder participation (Reed cited in Strenger et al, 2009)**

Decade	Phase
Late 1960s	Awareness raising (the anti-modernisation critique of the transfer of technology paradigm)
1970s	Incorporation of local perspectives into data collection and planning
1980s	Development of techniques that recognised local knowledge and 'put the last first' such as farming systems research and rapid and participatory rural appraisal
1990s	Increasing normative use of participation in the post-Rio sustainable development agenda
2000s	Subsequent critiques of participation and disillusionment over its limitations and failings: an emerging 'post-participation' consensus on best practice, learning from the mistakes and successes of the past.

The challenges that have been identified in using participatory approaches include the following (Stringer et al, 2009):

- They do not take place in a power vacuum: when previously marginalised groups are empowered, conflict may arise with existing power structures which has not been anticipated or planned for and may not be managed successfully
- Insistence on consensus can discourage minority perspectives from being expressed, creating - 'dysfunctional consensus'
- The perception of co-ownership in the project may raise participants' expectations; if the project team does not fulfil this suspicion, cynicism and distrust may take root
- Participants may lack the technical knowledge to participate at some levels, if required to make decisions or engage in debates they could feel forced into areas where they aren't competent

These challenges should be taken into consideration in the planning and implementation of this project to optimise the possibility for meaningful participation.

Stringer et al, (2009) notes that a continuum of typologies have been developed to understand the differences between different participatory methodologies which provide a basis for selecting methods and levels of stakeholder engagement appropriate for the intervention. They provide an extensive list of sources for these typologies, which could be useful should the project team need to grapple further with how to design different aspects of the intervention in ways that optimise the participation of stakeholders given the objectives and their capacities.

This section reviews participatory methodologies for assessment, planning and action that can be used by both research teams and CoPs. Building on these methodologies, international agencies such as USAID, World Vision, Care International, Red Cross, Practical Action and Oxfam have developed participatory processes for risk and vulnerability assessments, community based analysis of these risks and participatory action planning which could be of use in this project.

### **2.5.1 Participatory Action Research (PAR)**

Action research is exactly what the word implies; it combines action and research by learning and thus coming up with new information and improving a particular practice (Brydon-Miller,

Greenwood, & Maguire, 2003). It is a continuous process where learning is done through researching certain things so that action is made more efficient and this is done at the same time. As described by Fisher, action research is “A process in which a group of people with a shared issue of concern collaboratively, systematically and deliberately plan, implement and evaluate actions. Action research combines action and investigation. The investigation informs action and the researchers learn from critical reflection on the action.” (Fisher, 2006)

Discovery learning and empowerment are the two outcomes desired. Research is done at farm level and farmers have control over the actual research process and this is crucial for community development. This process is iterative and works effectively when done in a group as it is also participatory where everyone’s opinion is taken into consideration. In the context of research with smallholder farmers, this takes the form of a cyclical process where farmers plan, act on the plan, evaluate action and make necessary adjustments and replan and the process starts all over again.

With specific reference to agriculture, traditional forms of research have favoured the approach of researchers identifying solutions to problems and these are then “transferred” to the farmer to try out. Research – the process of generating new knowledge and understanding – is done ‘on’, but not ‘with’, farmers (Lowenson, Laurell, C, & Shroff, 2014). However, adoption levels of technologies transferred have been rather dismal; often due to lack of consideration for contextual differences. While the potential benefits of researched technologies should not be overlooked, continuous testing and evaluation of technologies with the farmers is needed to ensure it meets their own needs.

There are important things to consider when employing action research. This form of research is often time consuming. Action research takes time where farmers try out actions, observe and improve continuously. The tested solutions may not be as responsive as desired and this translates to more time trying out other possibilities. Action research is collaborative; it involves stakeholders and implies a culture of sharing, giving and taking where everyone’s say matters and should be considered. The change which results might even challenge local practice and the knowledge people have believed for years. Consideration is important in this regard: how people do things needs to be reflected upon continuously and in context. Action research generally aims to find out information and answer question to problems, empower community people and strengthen mutual respect and participation in the process, close the existing chasm between knowledge and practices as well as validate information collected and disseminated (Loewenson et al, 2014).

Researchers understand that people know their situation so listening and being taught is key in understanding acting up against issues which is why stakeholder engagement is key (Brydon-Miller, Greenwood, & Maguire, 2003). Research is located within the community where people are affected making use of lived experiences people have gone through. People are the main subjects of the study and have to be self-represented where sampling is omitted and a purposive group of people faced with an issue are included. However, “community” does not rule out variations on experience and perceptions based for instance on age, gender, power dynamics and so forth. Therefore listening to experiences, observations and perceptions will allow rich information where, for example, people with less power may see things differently from those enjoying more power in the community. This should be done before a bigger group discussion where information is validated by

consensus; registering observations and experiences the whole group sees as valid. The shift from individual to group insights seeks to triangulate information; information is then transferred from words to images or drawings where observations and experiences are analysed for things to be measured in identifying bad from good, trends in time and any other changes (Lowenson, Laurell, C, & Shroff, 2014). Some tools used in this process are:

**Table 2: tools used in Action Research (Loewenson et al, 2014)**

TOOL	Function in the research process
Spider-grams: Visual representations used to analyze existing relationships. The 'body' of the 'spider' represents the issue facing the community while the 'legs' reflect relevant factors	Used to draw evidence on outcomes from a particular situation, identify problems and link influencing factors to outcomes.
Participatory mapping: Create a map collectively which notes physical conditions related to the targeted problem.	Used to draw and validate information on experience and current conditions. From this, problem sites are identified, proposals for changes can also be identified. This tool can be used at different level of the problem solving process to track changes.
Social mapping: Collective mapping of social characteristics such as population, social groups	Identify key social groups and processes, needs and preferences.
Transect walk: Systematic walks across the community to identify resources and conditions in the area.	Can validate information supplied by the community or generate similar information.
Wellbeing ranking, preference ranking, matrix ranking: Different forms of scoring and ranking issues or representing scales of issues.	These are used for valuing or scoring parameters.
Seasonal calendar: participants draw these to show seasons or changes annually.	Relates information collected to time periods in the year and also for the identification of relationships between factors and outcomes.

Other tools that can be used include questionnaires, problem trees, life histories and narratives, as well as photographs and videos. However data collected can be problematic to generalize as research is often area specific.

Akponikpe, Bayala and Zougmore (2015) discuss experiences with community-based CSA implemented through participatory action research across 5 countries in West Africa. They found that the most significant challenge faced across the programmes was that while the farmers were well aware of the impacts in their areas caused by climate change, they attributed these to simple environmental degradation and so the links between proposed actions and climate change often did not ring true to them. The researchers found that they needed to facilitate an understanding of the links between meteorology, climate and human activities or else the CSA interventions would not be perceived as qualitatively different from previous initiatives aimed at addressing environmental degradation. One of the techniques they used to achieve this was to use a paradigm the farmers were familiar with – the cause, symptoms, interventions and outcomes of the HIV/AIDs epidemic to model climate change and CSA. This paradigm would be familiar to most South Africans as well, and this or other examples, could be useful in communicating the cause and effects of climate change to smallholder farmers in this study. They found that the most successful CSA activities in the project were those that were implemented on an individual basis, were carefully planned with enough lead time with farmers, were inexpensive and were grounded in local values and practices (Sereme, Macauley, & (Eds), 2012)

Diobass, an NGO in Burkina Faso, has combined the principles of action research with elements of participatory innovation development in its farmer innovation development. The programme:

Works with farmers to collect and describe farmers' initiatives and innovations in the domains of plant and animal production. These are reviewed by a committee with equal representation of farmers and advisers, and a selection is made on the basis of criteria they predefined together. Men and women farmers can then enrol in groups for the innovations of their choice with a view to testing them in field trials. In this case, the farmer-innovators are called upon to formulate open questions and factors to be considered, which are then translated into an experimental setup and methodology. All this is documented in a research protocol. The field trials are carried out by the men and women farmers in conjunction with the research scientists, the state agricultural advisers and the advisers from Diobass. This multi-stakeholder strategy makes it easier to disseminate farmer innovations after successful conclusion of the series of trials (Mongbo & Dorlöchter-Sulser, 2016).

## 2.5.2 Participatory Rural Appraisal (PRA) and Participatory Learning and Action (PLA)

*By Khethiwe Mthethwa, Bobbie Louton, Erna Kruger*

PRA is 'a growing family of approaches and methods to enable local people to share, enhance and analyse their knowledge of life and conditions, to plan and to act' (Chambers, 1993). It is primarily a process of understanding contextualised situations and analysing issues for action. Participatory rural appraisal (PRA) uses methods that facilitate understanding of the problems and perspectives of local communities. PRA can focus on an entire community or on specific sections of the community such as women or self-help groups. PRA methods are used to analyse and understand different aspects of target communities or groups.

A key feature of PRA is its holistic approach, in which the interaction between different elements in complex people-environment relationships is an important focus. A common thread in all these methodologies is their recognition of important inter-linkages between different elements of rural livelihood and production systems. Unlike earlier methodologies, PRA recognizes that indigenous people are capable of identifying and expressing their needs and aspirations themselves and in their own way, such that the role of the researcher is changed to that of a listener, learner, catalyst and facilitator.

Participatory Learning Action (PLA) evolved from Rapid Rural Appraisal (RRA), an approach which was popular with development agencies in the late 1970s and 1980s. PLA uses many of the same tools, but the underlying philosophy and purpose is different: the emphasis is on interactive mutual learning for development agencies and local people

Examples of how PRA tools can be used in an assessment of climate change adaptation in a community (Jain, 2011) are shown below as a way of introducing some of the techniques and also indicating some of the tools that will be useful in this study.

- Significant changes in resources and livelihoods over a 10 to 20-year period were discussed through a **Community Historical Timeline**. Changes and events contributing to these changes, were discussed collectively drawing from individual knowledge and experiences.

- Using a **Seasonal Calendar**, the major weather events (precipitation and so forth) were discussed and noted. Community members were asked to rate the past as well as present intensity of each weather event on a scale of 1 to 5 (from lowest to highest intensity).
- A **Seasonal Dependency Matrix** was prepared to identify the dependency of communities on various resources or occupations during the course of the year – at present and 10-20 years' ago. This facilitated a comparison of changes over time.
- Subsequently, the impacts of changes in weather (mapped through the Seasonal Calendar) on community livelihoods were assessed through a tool called '**Community Ranking of Hazards**'. Major weather events impacting livelihoods were ranked on a scale of 1 to 5 using a radar chart. The results indicated that the impacts of weather variations on local communities are increasing.
- The dependency of villagers on institutions within the village and outside was ascertained with a **Venn diagram on institutions**. Community perceptions about the external help they needed to overcome the impacts of climate change were identified and documented.

Another example that could be very useful in our present process is one where PRA and PID have been combined, using some elements of appreciative enquiry (Saha, 2012).

Below is an outline and description of the tools used:

**Tool 1: Time Line Seasonal Characteristics: Challenges & Farmers' Wishes to Climate Change Adaptation.**

The specific objective of this tool is to facilitate farmer's participatory dialogue on:

- What kinds of seasonal characteristic changes farmers are experiencing?
- How are those changes of seasonal characters affecting agriculture and livelihoods?
- What challenges are farmers facing in relation to generated effects of seasonal characteristic changes?
- What are farmers' wishes to overcome those challenges (leading to determine affirmative topics)

**Tool 2: Village Agriculture Innovators Mapping**

The specific objective of this tool is to facilitate farmers in identification of:

- Individual actors and groups/organizations in and outside the village who have either created innovations or who are perceived as potential innovators by the community
- Perceived effectiveness, influence and relationships of those actors

**Formation of Farmers' Group**

The main purpose of the group is to plan and implement actions to learn from each other and practice adaptation. There are no fixed and pre-determined rules for the formation of farmer's groups outside of how it emerges through dialogue and discussions among farmers. Depending on the local situation and needs a farmer's organization can be formed. The facilitator has to allow the natural process of interactions among farmers and emergence of their organisations in the village.

**Tool 3: Discovery Story Telling-Listening to Farmer's Innovations towards Adaptation**

This tool is applied in relation to farmer level analysis of experimentation. The specific objectives of this tool are to facilitate farmers:

- To listen to the local innovators about how they could do better.

- Listening to the story of success.



**Table 3:Example; timeline of seasonal characteristics, challenges and farmers' wishes for climate change adaptation**

Season	Timing	Characteristics at the past	Emerging characteristics	Crops		Effects on agriculture and Livelihoods
				Past	Present	
Summer	(February-May) Bengali Month Falgun-Joishto	<ul style="list-style-type: none"> <li>High temperature but Tolerable</li> <li>Regular storm during the period last part of March or first part of April ( Kal Boishakhi)</li> <li>Regular rain during the period of last part of March and first part of April ( Bain er bristi))</li> <li>Time to time there were hailstone rain. I Shila bristi)</li> <li>Farmers used to sow seeds of aus &amp; aman paddy and Jute</li> <li>Plenty of Mango, black berry , jack fruit and Banana used to grow</li> <li>Wind used to flow from the south resulting rain</li> <li>Less fall of thunder</li> <li>Large area coverage by the Kal Baishakhi storm</li> </ul>	<ul style="list-style-type: none"> <li>Extreme/intolerable hit</li> <li>Irregular storm during the period of last part of March or first part of April ( Kal Boishakhi)</li> <li>Irregular rain during the period last part of March and first part of April ( Bain er bristi))</li> <li>No hailstone rain (shila bristi)</li> <li>excessive rain while some times drought</li> <li>In the month of April storm occurs in a small place</li> <li>Period of summer season has extended</li> </ul>	<ol style="list-style-type: none"> <li>Jute</li> <li>Aus paddy</li> <li>Aman Paddy</li> <li>Sugar cane</li> <li>Chili</li> <li>China</li> <li>Vuro</li> <li>Kaun</li> <li>Cantaloupe</li> <li>Water Melon</li> <li>Til (oil seeds)</li> </ol>	<ol style="list-style-type: none"> <li>Jute</li> <li>IRRI paddy</li> <li>Sugar cane</li> <li>Chili</li> <li>Til (oil seeds)</li> </ol>	<ul style="list-style-type: none"> <li>Excessive hit/ temperature makes us tired.</li> <li>Increase of hit stroke</li> <li>Increase of farming expenditure due to increased demand irrigation , chemical fertilizer and pesticide</li> <li>Nutrition value of food crops has reduced</li> <li>Due to excessive rain, drought and rain water flooding – cannot harvest crops in time</li> <li>Yield of seasonal fruit has reduced; increased new types of pest attack in fruits</li> <li>Farmers becoming more and more indebted by taking Loans</li> <li>No cropping of Aus and Aman Paddy</li> <li>Production of mango, back berry, jackfruit and banana has reduced</li> <li>Sometimes formation of toxicity in fog resulting destruction of flowers of Mango flowers drop off</li> </ul>

## Discussions & Lessons

### Changes in climate:

There are no longer 6 seasons but 3, there are no more early Autumns, Autumn and Spring seasons have been absorbed in three seasons which are summer, rainy and winter.

Period of summer season has extended

Extreme heat in the summer season

Extreme rain and extreme drought in the summer season

Changes in rain period particularly Kal Baishaki and Amaboti do not happen regularly

### Effects on life and livelihoods:

In all seasons crops diversity has reduced

Fish resources have reduced

Fruits have reduced

Amaon and aush paddy replaced by IRRI

Jeopardy of nutrition value and taste of fruits, vegetable and rice

Loss of soil fertility

Increase of pests and pest attack

Reduction of organic fertilizer use

Incremental use of chemical fertilizer and pesticides

Increase of agricultural production costs

Less crop production and increased family level food insecurity

Increase in indebtedness of farmers' family due to incremental borrowing of money

## Farmer's challenges

In this climate circumstance to be able to do

Agriculture

## What do we want?

- Cultivate and grow vegetable without use of chemical fertilizers
- For other crop cultivation and production reduce the use of chemical fertilizer but increase use of biological fertilizer
- Reduce expenditure of agriculture and agri-products
- Prevent and cure pest attack of crops through collective efforts in the village
- Want to get seeds from the plant prepared without application of pesticides
- Cultivate and grow climate change adaptive crops

Large international support agencies, both government supported such as USAID and NGOs such as World Vision, Care International, Red Cross, practical Action and Oxfam have spent time developing participatory processes in risk and vulnerability assessments, community based analysis of these risks and designing of participatory action plans.

World Vision for example have focussed on PLA (participatory learning and action) methodologies and tools to combine work across conflict management, disaster risk reduction and climate change adaptation.

Participatory Learning and Action (PLA) is an approach for learning about and engaging with communities. It combines an ever-growing toolkit of participatory and visual methods, for use with interviewing techniques, and is intended to facilitate a process of collective analysis and learning. PLA evolved from Rapid Rural Appraisal (RRA), popular with development agencies in the late 1970s and

1980s. PLA uses many of the same tools, but the underlying philosophy and purpose is different: the emphasis is on interactive mutual learning for development agencies and local people. PLA tools are intended to help development agencies tap into the unique perspectives of community members, to help them unlock their ideas concerning the issues they face, and to find realistic solutions. PLA tools combine sharing insights with analysis, and provide a catalyst for the community to act on what is uncovered. PLAs commonly used include focus group discussions, key informant interviews, historical analysis tools (e.g. timelines), geographical mapping (e.g. community maps), livelihood analysis tools, and root cause analysis tools (e.g. problem trees). CCA methodologies often include seasonal calendars. Two further tools - systems mapping and scenario planning - which are not yet commonly used in vulnerability and capacity assessments and planning but can add significant value to the programme design, implementation, and monitoring and evaluation processes have been introduced (Ibrahim & Midgley, 2013).

**SYSTEMS MAPPING:**

Draws upon systems thinking to help participants and facilitators understand how a range of different factors interact with each other to form a system. Systems thinking is a way to understand a context that emphasises the relationships between a system's parts rather than simply the parts themselves.

To create a systems map, participants are asked to identify a number of key characteristics or vulnerability factors in their community. They then identify those factors that contribute to these characteristics or vulnerabilities. They discuss these, and draw links between the different factors.

It can be used to identify particular areas of intervention, or leverage points, that can have both a direct and indirect impact upon vulnerability in the community.

**SCENARIO PLANNING:**

Enables communities to explore potential future changes, their associated impacts and develop locally relevant action plans, looking at both opportunities, risks and potential impacts of change.

Participants work together to identify a number of plausible scenarios utilising local and scientific information and evidence. The impacts of the developed scenarios are assessed and the community's vulnerability is analysed highlighting impacts on specific socio-economic groups, geographical areas and livelihoods.

The output of these discussions is the production of a coordinated action plan agreed by all stakeholders which is relevant to local priorities.

### 2.5.3 Participatory Innovation Development

By Mazwi Dlamini, Erna Kruger

**Participatory Innovation Development (PID)**; is an approach to learning and innovation that is used in international development as part of projects and programmes relating to sustainable agriculture. The approach involves collaboration between researchers and farmers in the analysis of agricultural problems and testing of alternative farming practices.

It has developed out of methodologies such as Farming Systems Research and Extension, PRA and PLA (participatory learning and action) and Indigenous Technical Knowledge Systems and incorporates further methodologies such as Farmer Field Schools.

This approach enables the research and development community to respond to locally defined problems and to find solutions that build upon local knowledge and are consistent with local resources and contexts. Moreover, by involving farmers as the users of the research process, it is more likely that farmers would share and use (new) knowledge.

Local innovation in agriculture and natural resource management goes beyond technologies to socio-organizational arrangements such as new ways of regulating the use of resources, new ways of community organization, or new ways of stakeholder interaction. The term Participatory Innovation Development (PID) embraces this broader understanding of joint research and development and is now being used alongside, or in place of PTD (Participatory Technology Development). It is a process in which farmers and other stakeholders engage in joint exploration and experimentation leading to new technologies or socio-institutional arrangements for more sustainable livelihoods. This action-oriented approach promotes engagement in a process that strengthens the capacities of agricultural services to support community-led initiatives (Hartmann, 2009 ) (Wettasinha, Wongtschowski, & Waters-Bayer, 2009).

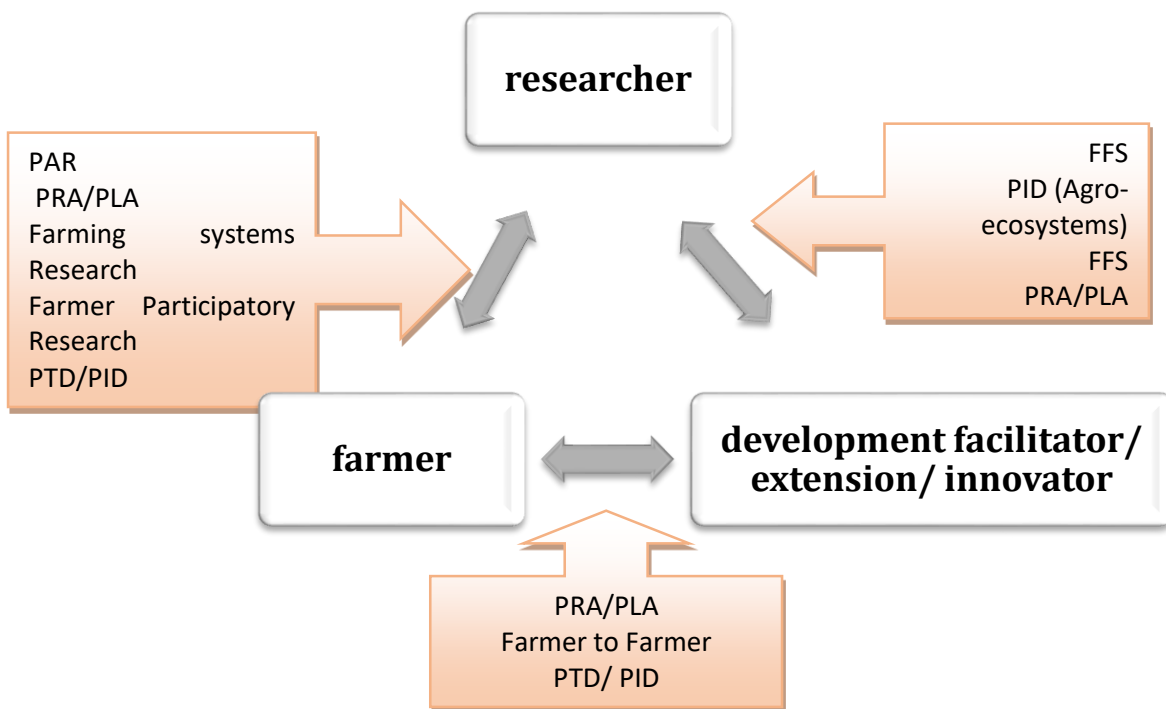


Figure 2: The interplay between researchers, facilitators and farmers, indicating associated methodologies

The following statement in a recent publication in the agricultural development and extension field, sums up the imperative for working with these approaches:

“Scientists are being challenged to re-consider that their role in technology development is through innovation and a complex process involving a reorganization of social relationships, not just technical practice. In this context, technology shifts from something to be applied to something leveraged for networking and organizing. To ensure the future, the idea of sustainability as a dynamic process rather than an endpoint offers a route for understanding and engagement between research, policy and personal spheres. For both research and extension agendas; in considering traditional agriculture in the context of economic development we have to create the capacity to co-operate in a way that opens up the possibility of social change; a way of interacting that preserves and creates new forms of social cohesion. Researchers will come to understand that attitude, environment and relevant issues, not specific tools, achieves participation”. (Caister, Green, & Worth, 2012).

One of the leading authorities on this process is the Centre for learning on sustainable agriculture - ILEIA based in the Netherlands. ILEIA has described PID as “a process between local communities and outside facilitators which involves:

- Gaining a joint understanding of the main characteristics and changes of that particular agro-ecological system;
- Defining priority problems;
- Experimenting locally with a variety of options derived both from indigenous knowledge ... and from formal science, and
- Enhancing farmer’s experimental capacities and farmer-to-farmer communication” (Reijntjes, Haverkort, & Waters-Bayer, 1992)

PID offers opportunities to place smallholder farmers centre stage in the research and development field, recognising that over time, smallholder farmers have adapted and developed innovations to allow them to be productive under their own difficult environments. Development practitioners have realized the need to, not only take this knowledge into consideration but to build upon it. Implementation of a PID process includes the following steps:

1. *Preparation phase:* The PID group (including researchers/teachers, facilitators and key farmers) collects primary information and analyses issues and opportunities in village; from where the topics of PID are identified. This stage includes 2 steps: 1) situation analysis and 2) selection of the PID topic. At the same time, they also prepare the organizational aspects, making agreements with the local authorities, clarifying reasons, purposes, meanings, as well as benefits and responsibilities of local people, and making a plan to involve the local farmers in PID initiation.
2. *Initiation phase:* This is an important phase of the process, new ideas are discovered, appraised and selected for experimentation. The PID group in collaboration with farmer groups design new selected experiments. Farmer interest groups are formed and start designing their expected experiments. There are 5 steps in this stage: 1) Generation of new ideas, 2) Clarification of ideas through idea sheets, 3) selecting prioritized ideas for

- experiments; 4) Selecting households to conduct the experiments; and 5) designing the experiments with specific reasons, indicators and technologies in experiment sheets.
3. *Implementation phase*: The stakeholders develop action plans, visiting schedules and collaboratively implement the experiments. The farmers are implementers; the extensions are facilitators and supporters; the researchers provide consultancy during the experimentation process. This stage includes 2 steps: 1) planning and 2) collaborative implementation.
  4. *Monitoring and documentation phase*: This stage is implemented throughout the implementation phase. The indicators identified in the experiment sheets are recorded in the experiment diary by farmers with support of the extensionists and researchers. Comments of outsiders and other farmers will be fully recorded in the diary. Documents, regular reports are produced by the extensionists and provided to related management staff and other interested people in and outside the village. One key step in this stage is participatory monitoring and documentation of the process.
  5. *Finalisation phase*: The objective of this phase is to evaluate and identify whether the experiments were successful or not? A field evaluation is conducted where farmers who conducted the experiments prepare and explain to other stakeholders and farmers their experiences and results. This stage includes 2 steps: 1) organization of participatory evaluation in the field, and 2) documentation, report writing.
  6. *Dissemination phase*: Experiences and innovations should be disseminated. Tools, extension materials are compiled. "Farmer to farmer" extension techniques are useful for dissemination and experience sharing with other farmers and villages. This stage includes 2 main steps: 1) develop extension materials and 2) organize different ways to disseminate the experiment results.

**To summarise the PID steps**

1. Getting started (getting to know each other);
2. Joint analysis of the situation – the problems and opportunities;
3. Looking for things to try to improve the local situation;
4. Trying them out in community-led participatory experimentation;
5. Jointly analysis and sharing the results; and
6. Strengthening the process, often through improving local organization and linkages with other actors in R&D, so that the PTD process will continue.

## 2.6 Reflective practice

Reflective practice is an intentional approach to learning from one's practice/experience by routinely going through a conscious process of thinking about what you have done or what has happened and gleaning insights which are used to improve future practice. Reflection needs to be a central element of the practices of CoPs, research studies and programmes/interventions.

Tripp (Tripp, 2005) contrasts reflective practice and action research as follows:



Figure 3: Reflective Practice (Tripp, 2005)

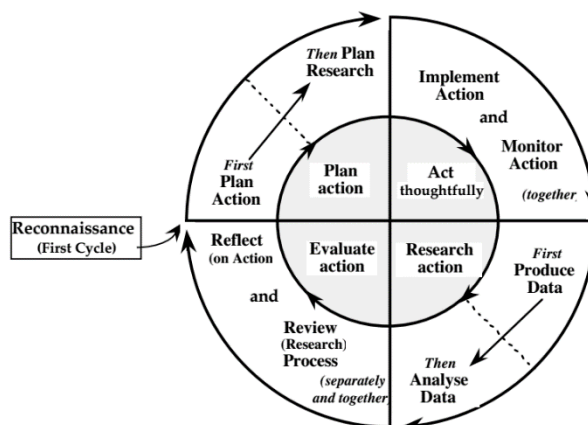


Figure 4: Action Research (Tripp 2005)

Finlay (Finlay, Reflecting on 'Refelctive Practice", 2008) proposes that reflective practice involves:

- examining ones assumptions
- becoming aware of one's implicit knowledge
- critically evaluating one's own responses to practice situations

This could be a valuable tool in a Community of Practice, where smallholder farmers, researchers and other stakeholders could come into the community with very different assumptions, implicit knowledge and responses; as the project unfolds new levels or areas of assumptions and knowledge could come into play, making it valuable to habitually and cyclically examine these, how they differ between the members of the CoP, and the impact of this.

The basic model to capture the reflective process is a cycle of four steps:

PLAN – ACT – DESCRIBE – EVALUATE – PLAN and so on.

Different theorists have developed this basic idea with different models. Various theorists have proposed different 'stations' for reflection within a perpetual cycle (or spiral) of reflective practice.

In the context of this project, where reflective practice will be needed within the research team, the CoP, project interventions and could be used beneficially by individual participants and researchers, a number of different models for reflective practice could prove useful across these contexts.

Rolfe et al (Rolfe, Freshwater, & Jasper, 2001) provides a simple, flexible model for using reflective practice that is easy to remember:

1. **What?** - What happened?
2. **So what?** - What does it mean?
3. **Now what?** - What needs to happen next?

This could be a useful model to build into the practice of a community of practice due to its simplicity, perhaps linking it to words or representations that are easy to remember (eg 3 fingers). This could then be used in a group discussion or by an individual looking at a plant in her field.

Later work has added the ideas of **critical reflection** and **reflexivity** to reflective practice. Critical reflection adds the dimensions of looking at social and political elements with an aim to facilitate transformation as part of the reflective practice, actively questioning assumptions and analysing power relationships (Finlay, 2008); this can aid members of a Community of Practice – and the community as a whole – in becoming conscious of their power and that of their networks, and how they are exercising it. Reflexivity involves practitioners reflecting critically on both the impact of their own behaviour, assumptions, positioning, feelings and background and the impact of the broader organisational, ideological and political context (Finlay, 2008). Reynolds and Gough see reflection (simply thinking about something after it has happened) – critical reflection – and reflexivity (immediate and dynamic self-awareness) as a continuum.

### **Tools**

Numerous tools and techniques have been developed for using reflective practice, including simple ideas such as journaling, drawing, mapping, or taking quick audio or video reflections from participants during or after an activity.

Lynn (Lynn, 2012) describes two more structured tools that can be used in tandem for reflective practice: theories of change and strategic learning debriefs. A Theory of Change (TOC) is a “living” document which provide the structure for ongoing learning during planning, implementation, and evaluation, ensuring that “what matters” remains in focus and is not eclipsed by the “measurable”. Working from a theoretical strategy, key stakeholders work together using backward and forward mapping to create a visual map of practical strategies which links activities to outcomes in spiralling cycles leading to the ultimate impact. Strategic Learning Debriefs are sessions held with staff and stakeholders where the Theory of Change is used as a framework to facilitate reflective practice, resulting potentially in the evolution of the Theory of Change itself.

## **2.7 CSA frameworks, methodologies and processes**

*By Erna Kruger, Jon McCosh, Lawrence Sisitka*

Processes for the assessments of communities’ capacities and vulnerabilities related to both disaster risk reduction and climate change adaptation have been developed by the larger international and national development agencies; most of them based on combinations of methodologies described above. Elements of Livelihoods analysis have been incorporate into most of these frameworks to include an analysis of stresses, shocks, vulnerabilities and capacities within communities and outline potential livelihoods impacts and develop planning frameworks for increased resilience and adaptation capacity.

Broadly, these tools can be classified by the type of approach they use. There are two types of approaches: a top down approach focuses on potential changes in the water cycle as a result of climate change, and designs response options to anticipate and prevent the negative impacts of these changes. By nature, this approach favours long-term responses. The other approach consists in assessing the vulnerability of rural populations, and designing solutions that helps increasing their resilience to external shocks. This bottom-up approach is more generic, not specific to climate change (but to any shock or crisis) and usually considers short- to medium-term responses. Both



approaches are necessary when designing management responses in relation to climate change. An impact-based approach is needed to ensure that long-term investments take into account expected changes (FAO, Climate Smart Agriculture Source Book, 2013).

More recently, systemic approaches have been developed primarily to also include some empirical data on climate change into the community based analysis of changes specific to climate change and weather variability. This has been spearheaded by USAID programmes in Asia and the Pacific (RECOFTC, 2016), but is also now being incorporated in the Resilience in the Limpopo basin (Resilim) programme (AWARD, 2017). These tools are interesting and significant for the present research process, albeit that they are somewhat complicated to facilitate at community level.

The Nepal process for example focusses the vulnerability and capacity assessments through the five livelihoods categories, to be able to fully assess adaptive capacity at community level.

**Adaptive Capacity:** According to the IPCC, adaptive capacity is the ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damage, to take advantage of opportunities, or to cope with the consequences. CARE International (Care International, 2009) argued that one of the most important factors shaping the adaptive capacity of individuals, households and communities is their access to and control over natural, human, social, physical, and financial resources. Examples of resources that may be important to adaptive capacity are as follows:

- Human - Knowledge of climate risks, conservation agriculture skills, good health to enable labour;
- Social - Women's savings and loans groups, farmer-based organizations;
- Physical – Irrigation infrastructure, seed and grain storage facilities;
- Natural – Reliable water source, productive land; and
- Financial – Micro-insurance, diversified income source.

All information is analysed into 4 consecutive matrices that include both community based and empirical data:

1. **Matrix 1 - Identifying Climatic Threats and Impacts:** Analysis of empirical and community based perceptions related to weather and climate
2. **Matrix 2 - Assessing Threats and Impacts through an Asset Lens:** It lists which sectors (e.g forestry, agriculture, livestock and water) have been identified by the community as key sectors of climate vulnerability. Then, for each sector, this matrix assesses both community-based and empirical information on impacts through the lens of the different asset types (namely the assets under the sustainable livelihoods approach: social, financial, physical, human and natural)
3. **Matrix 3 – Identifying Vulnerabilities:** based on standard vulnerability assessment tools with a view to listing impacts and adaptive capacities
4. **Matrix 4 - Identifying Response Options to Vulnerabilities:** This final matrix serves two purposes. First, it provides a structure through which to arrive at a vulnerability rating, necessary for later prioritization and selection of adaptation options. Second, it tries to fill a gap in existing VA frameworks which do not explicitly link vulnerabilities to possible adaptation responses. This final column is aimed at generating general adaptation option

‘topics’ in response to identified vulnerabilities (which will be direct responses to climate threats, but may cut across both threats as well as sectors).

Below is an extract from a synthesis table/matrix produced for the Nepal pilot programme.

**Table 4: An Example of matrix 4; Identifying response options to vulnerabilities (RECOFTC , 2016)**

CLIMATE CHANGE THREATS (from Matrix 1, Column E & Matrix 2 and 3, Column A)	FREQUENCY OF THREAT	VULNERABILITIES (synthesized from Matrix3, Column E)	SERIOUSNESS OF IMPACTS (evidence according to indicators)	VULNERABILITY RATING (by the community)	POSSIBLE BROAD OPTION RESPONSES result of other tools)*
<b>Temperature increase , more intense dry season</b>	Prolonged drought, typically every 2-3 years Temperature rise is continuous, but extreme peaks periodically every 5-6 years Fire in sugarcane fields occurs periodically every 2-3 years	Declining productivity of agricultural crops due to decreasing quality of soil (a function of extended periods of dryness, current cropping practices and chemical fertilizers)Reliance on a single monocrop(sugarcane)More labour intensive and increasing labour costs associated with sugarcane	More than 40% handpumps are now dry for 4 months of the year Reduced cropping cycle of sugarcane to 2 years from 3	High  Medium	Development of agroforestry plots on private land Planting of fast growing fodder and multipurpose tree species Introduction of no or low till agriculture practices to reduce soil evaporation Water retention pond construction Agroforestry within community forests, within home gardens Shift in agriculture crops to incorporating integrated farming systems which include agroforestry
<b>Changing seasonality (agriculture)</b>	Continuously decreasing agricultural productivity Erratic rainfall Rainy season being pushed back several weeks	Decreasing agricultural productivity and income due to changing rainfall patterns Decreasing income from sugarcane due to loss of productivity(result of multiple factors including pests, weeds, soil fertility and also capped prices by the sugar mill)	Invasive weeds and grasshoppers damaged more than 50 ha Declining price paid per kg of sugarcane as result of high weed composition	Medium  High	Diversification of agriculture crops Natural buffers and pest breaks by interspersing crops and/or agroforestry Natural pest predators Conventional pest management Usage of compost manure as pest management strategy Capacity building of local people in integrated pest management Enterprise development to diversify income Delay of planting timing by 20to 25 days

\* Based on consultations with community members, technical experts, desk research, experiences of project staff and comparable practices employed elsewhere

Basically, what this process does, is provide a decision support framework for CSA. It This is a very appropriate methodology and set of tools to use as a starting point to design the decision support system for this research process.

### **2.7.1 Frameworks which define criteria for assessing effect/impact of CSA interventions**

Climate-smart interventions are highly location-specific and knowledge-intensive, requiring considerable effort to make CSA a reality. In the context of assessing impact, this means that impact assessments cannot focus on specific practices, but rather the positive (and negative) impacts of chosen CSA practices (FAO, Climate Smart Agriculture Source Book, 2013). Furthermore, CSA technologies and practices are evolving rapidly. These factors mean that assessing the effect of CSA interventions needs to be well thought out. This section considers frameworks that define criteria for assessing the effect of CSA interventions.

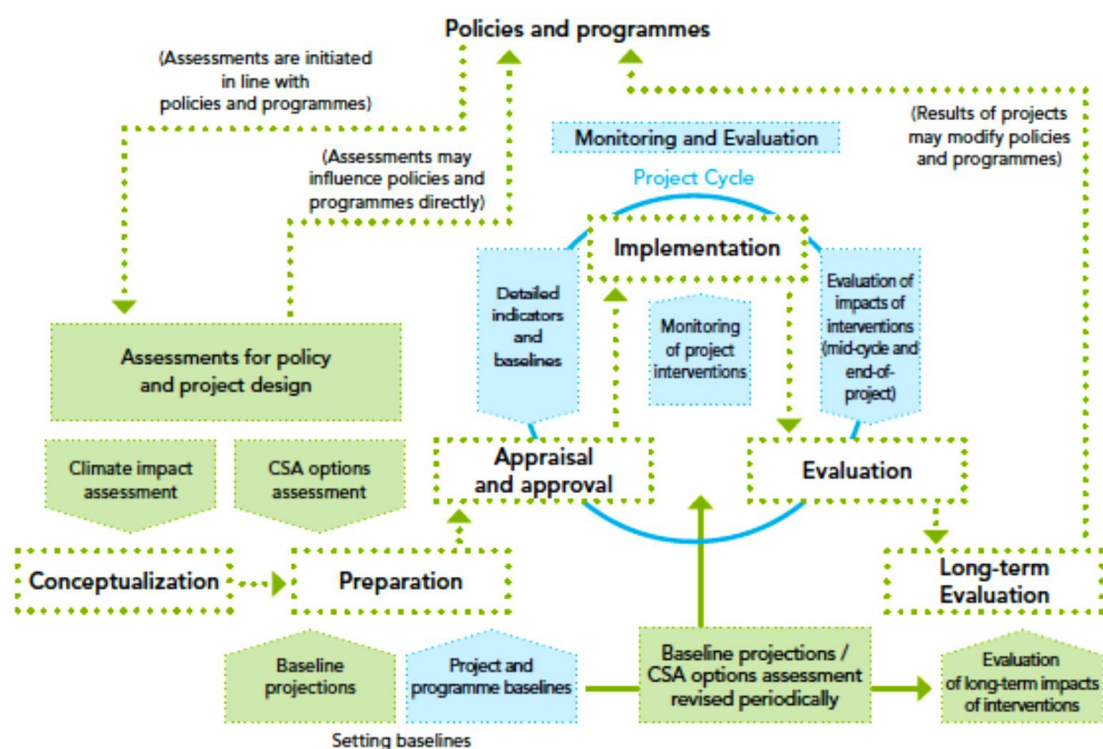
#### **Impact and effects of interventions**

It is helpful to define a number of concepts when considering impact assessments to allow for a common understanding of terms (FAO, Climate Smart Agriculture Source Book, 2013):

- Impact – this refers to effect of climate change on natural and anthropogenic systems
- Vulnerability – this is a function of two factors:
  - Firstly, impact (exposure and sensitivity of exposure to climate change in turn)
    - Exposure – refers to the extent to which a system is impacted by climate change
    - Sensitivity – refers to how affected the system is affected after the exposure
  - Secondly, adaptive capacity – the ability of the system to avoid potential damages, take advantage of opportunities and cope with the consequences of damages. It can also be framed as the capacity of people in a given system to influence resilience
- Resilience – the ability of a system to anticipate, absorb, accommodate or recover from the effects of an extreme climate event in a timely and efficient manner.

Assessments are closely related to monitoring and evaluation (M&E) activities and are found within most prevailing policies and programmes. The figure below outlines an assessment framework for a full project cycle, based on the FAO's CSA sourcebook. Assessments are occurring at a number of levels (policies and programme impacts; climate impacts; project impacts) and at different project stages (project preparation; project planning; project implementation).

Table 5: Assesmnet, monitoring and evaluation from a project cylce management perspective (FAO, 2013)



Assessments for policy and project design (green background) and monitoring and evaluation (blue background) are color coded respectively.

This diagram provides a broad overview of the assessment process, but for the purposes of this work, we are interested primarily in the local impacts of the CSA interventions from a resilience perspective and secondarily any mitigation effects that may result from the interventions, supported by evidence (qualitative and quantitative). Furthermore, the focus of this framework is largely a top down approach. From a community perspective, bottom up approaches are more appropriate as they are locally relevant and consider the local socio-economic context – often referred to as contextual vulnerability.

Contextual vulnerability is locally focussed and considers the present as the departure point and considers socio-economic dimensions of vulnerability as a basis for assessing future vulnerability. This is largely a participatory process as opposed to modelling approaches that are applied at programme and policy scales. Vulnerability and adaptation needs are contextualised with the local context and will include factors that aren't necessarily directly linked to climate change or CSA.

Vulnerability and resilience frameworks are different in key aspects (FAO, Climate Smart Agriculture Source Book, 2013)

The vulnerability approach tends to:

- Be oriented towards research on hazards and risks.
- Be centred on people and more translatable to application and policy outcomes.
- Conduct assessments for single spatial scale and 'snapshots' in time.
- Be less focused on ecological and environmental aspects.
- Assess present and future vulnerability from past information.

The resilience approach, on the other hand, tends to:

- Be oriented towards ecological sciences.
- Be more focused on complex interactions, feedbacks and processes of social-ecological systems.
- Be conceptual and not easily translatable into practice.
- Assess one particular system and can often not be generalised for wider application.
- Produce more dynamic assessments (but with present methodological difficulties in measuring and characterising).
- Be less focused on the social aspects of social-ecological systems.
- Assess more positively future needs by building on present assets.

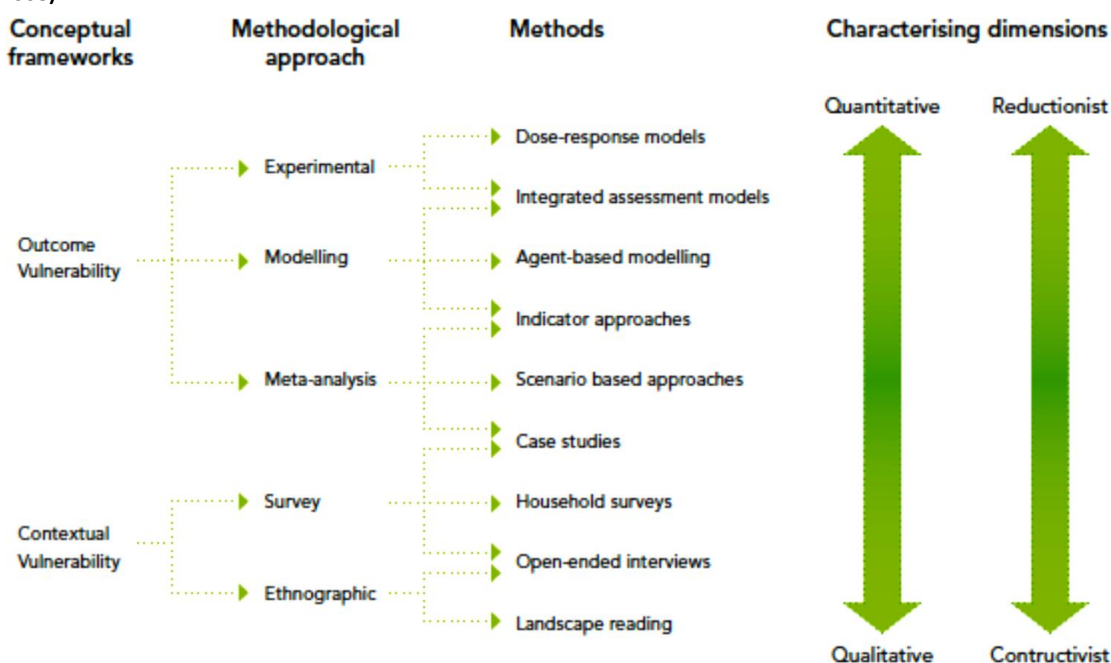
However, more recently, resilience frameworks are placing more emphasis on social systems (moving towards a social-ecological-system framework), while vulnerability frameworks are including more environmental factors and thus becoming more alike. Nevertheless, both frameworks are connected through adaptive capacity assessments (FAO, Climate Smart Agriculture Source Book, 2013). Ultimately, the effect of any CSA intervention should contribute simultaneously to reduced vulnerability and increased resilience.

### **Vulnerability assessments**

Vulnerability of livelihoods is determined by the capacity of communities to replace a negatively affected production system with one which would prevent losses in income, sustain subsistence production or supply food to markets. Vulnerability assessments characterise areas that have low livelihood resilience, allow for the identification of vulnerable subsectors in the community (e.g. elderly, women, youth) and provide the basis for developing strategies to increase the resilience of livelihoods to climate change (FAO, Climate Smart Agriculture Source Book, 2013).

Considering a bottom-up approach, a vulnerability assessment would collect indicators that represent changes in vulnerability of communities to risks. Such indicators could include socio-economic, technology, infrastructure, information and skills, biophysical conditions and equity (Desai & Hulme, 2004). Considering the figure below (Pearson & Langridge, 2008), survey and ethnographic methodologies are best suited for assessing contextual vulnerability.

Table 6: Conceptual frameworks, methodologies and methods for vulnerability assessments (Pearson and Langridge, 2008)



Within this survey context, three basic approaches are available

- Full scope social assessments (key informant interviews, focus group discussions, community surveys).
- Rapid social assessments (checklists of key vulnerabilities, current coping strategies and limiting factors).
- Applying models and project management tools.

### Monitoring and evaluation frameworks

There exists a variety of frameworks and manuals for monitoring and evaluation of impacts of CSA interventions. However, all monitoring and evaluation systems should include the following (FAO, Climate Smart Agriculture Source Book, 2013):

- Conceptualisation – conceptualising the intervention, based on available information and engagements with stakeholders
- Preparation and appraisal of the project, which should include:
  - How the project or intervention will contribute to adaptation / mitigation
  - Developing an adaptation hypothesis or theory of change – what are the expected changes and result chains between activities, changes in behaviour, outcomes and impacts. The theory of change should help to define:
    - Inputs and activities – description of the interventions
    - Outputs – direct results of the interventions (e.g. increased yield, access to finance)
    - Project outcomes – the expected effects of the interventions (e.g. higher food security, access to credit to purchase inputs)
    - High level outcomes – the expected effects of the interventions at household and community scales (e.g. healthier children due to higher food security, increased income as a result of purchasing inputs for production).

- Developing indicators – in relation to the theory of change.
- Developing results based management – encourage stakeholders to consider outputs and outcomes, rather than inputs and activities.
- Appraisals – review the design in relation to risks.
- Implementing adaptation actions, with the collection of data on identified indicators.
- Evaluation at regular intervals for the design, implementation, outputs, outcomes, impact and sustainability of the intervention.

The objective of M&E is for continuous learning during the project. Given uncertainties associated with any intervention, the learning process allows for adaptive management, learning from the process and builds local capacity. It is critical to include participatory and socially sensitive (e.g. gender, age, wealth) processes in the monitoring of interventions.

There are many M&E frameworks that can be used, some of which are outlined in the table below.

**Table 7: examples of planning and M&E frameworks used development initiatives (FAO,2013)**

Framework / Tool	Focus
<b>Logical frameworks</b>	Projects and programmes – specific to interventions being considered
<b>Results framework</b>	Links interventions to results
<b>Project and programme frameworks</b>	Delineating expected outputs and outcomes from stakeholder participation
<b>Driving forces – Pressure – State – Impact – Response (DPSIR)</b>	Captures causal chain from the driving force (the environmental issue) through to the impact and required responses. Usually applied in the environmental management context
<b>Outcome mapping (IDRC)</b>	Focussed on institutional change. Delineates outcomes among different stakeholders and monitors institutional changes, changes in capacity and the resulting change in the delivery of services.
<b>Sustainable Livelihood Framework</b>	Multifaceted assessment of livelihood assets and by implication, resilience to climate change.
<b>Participatory poverty assessment</b>	Aims to assess who are the most vulnerable in the community as defined by community members' own criteria. This helps to identify key intervention target groups.
<b>Project and programme baseline assessments</b>	Done through surveys of intervention and control areas, measuring food security, incomes, basic household assets and services, as well as environmental parameters.
<b>Regular project monitoring</b>	Gathering of activity and output progress data, financial management information, and signalling emerging issues or good practices.
<b>Management information Systems</b>	web-based support systems increasingly managed through remote devices, linked to financial management and GIS systems.
<b>Agriculture and natural resource management monitoring</b>	Measured at frequencies and scales significant enough to provide meaningful information. The measurements can be done by a range of methods from structured crop to participatory transect walks.
<b>Process monitoring</b>	Often done in support of regular monitoring to assess project process and institutional changes and relationships – to rapidly identify management responses.
<b>Participatory monitoring and evaluation methods</b>	A wide range of methods engaging communities, not just enhancing information gathering but also increasing ownership and project adaptation.
<b>Impact evaluation methodology</b>	Impact evaluation assesses the impact of an intervention using counterfactual analysis. The estimated impact of the intervention is calculated as the difference

	in mean outcomes between a 'treatment group' (those receiving the intervention) and a 'control group' (those who don't).
<b>Stakeholder, Institutional and legal assessments</b>	To assess changes in capacity, human resources, organizational systems, coordination, as well as laws and policies.
<b>Economic and Financial analysis (EFA):</b>	Using mainly agricultural, environmental and socio-economic data, as well as detailed market, labour and trade information, analyses are made of the economic and financial returns at household, farm and system levels.

An example of a results-based framework is provided below. This framework gives a sense of the kinds of measurable indicators that can be used to indicate impact or effect of adaptation practices.

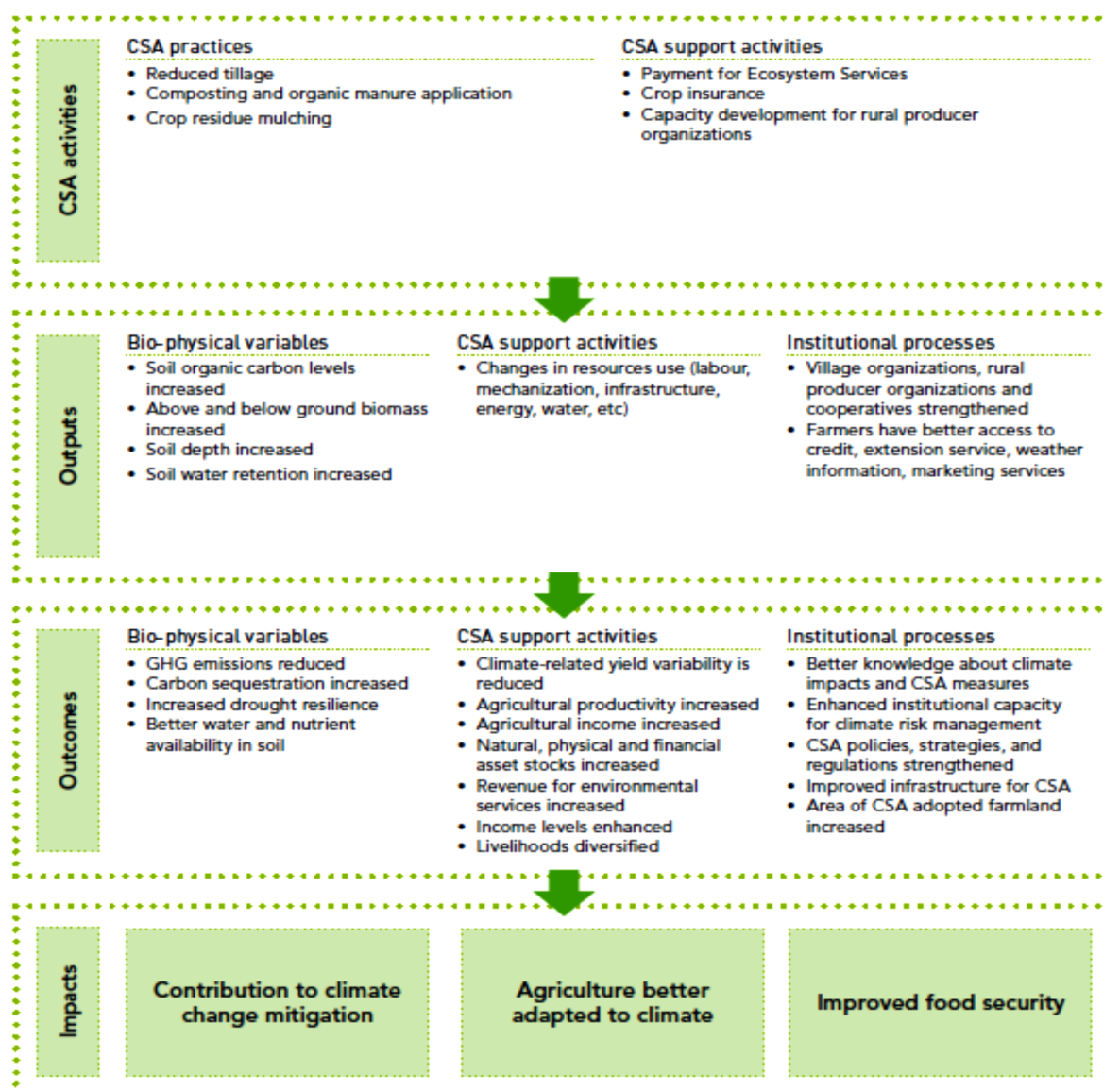


Figure 5: Results based framework (FAO,2013)

### Indicators

For indicators to be relevant, baseline conditions are necessary to provide a benchmark and it is therefore necessary to ensure that the indicators used can be compared against a benchmark. Indicators should be Simple, Measurable, Attributable, Realistic and Time-bound (SMART), which is



well understood by the project team. In addition to the SMART requirements for indicators, additional guidance for choosing indicators includes (FAO, Climate Smart Agriculture Source Book, 2013)

1. Validity: Does the indicator measure a change in climate risk or vulnerability?
2. Precise and specific meaning: Do stakeholders agree on exactly what the indicator measures in this context?
3. Practical, affordable, and simple: Are climate- and adaptation-relevant data actually available at reasonable cost and effort? Will it be realistic to collect and analyse information?
4. Reliability: Can the indicator be consistently measured against the adaptation baseline over the short, medium and long term? With regard to mitigation, are the indicators robust enough for formal auditing under measurement, reporting and verification (MRV)?
5. Sensitivity: When the respective climatic effects or adaptive behaviours change, is the indicator susceptible to those changes?
6. Clear direction: Is it certain that an increase in value is good or bad and for which particular aspect of adaptation? Is it ultimately attributable to intervention?
7. Utility: Will the information collected be useful and relevant for adaptive management, results accountability, and learning? Does it measure achievable results?
8. Owned: Do stakeholders agree that this indicator makes sense for testing the adaptation hypothesis?

Indicators can be (FAO, Climate Smart Agriculture Source Book, 2013):

- Quantitative (e.g. tonnes per hectare of incremental crop production, number of days a year a household has adequate meals, or number of men and women with increased income).
- Qualitative (e.g. beneficiary perception of satisfactory service delivery by intervention agency).
- Proxy indicators, which give an approximation of a desired measure, where a direct indicator is difficult to assess.
- Indices, which are composed from other indicators to provide a more simplified aggregate measure of change.

Indicators should relate to the project or intervention objectives.

#### **The question of attribution**

A particular methodological issue for M&E is the question of attribution. This is the particular challenge faced when attempting to ascribe observed change and results specifically to a project while it could also be due to other external changes and interventions taking place. This is a very big concern for climate change programmes since they are potentially affected by long term and large scale climate and economic processes. In the context of projects the issue is dealt with through the design of rigorous project baselines and impact evaluation surveys, which take into account external effects. They do so principally by including 'control' areas and households in the survey samples, against which changes in project beneficiaries' livelihoods and land use can be compared (FAO, Climate Smart Agriculture Source Book, 2013).

## **2.7.2 Decision Support Systems**

Decision Support Systems (DSS) have been developed and used in a variety of contexts, including business and commerce, and agriculture. Conventionally, they are understood as in the following definition from [www.technopedia.com](http://www.technopedia.com) (Technopedia, 2017): *...a computer-based application that collects, organizes and analyses business data to facilitate quality business decision-making for management, operations and planning. A well-designed DSS aids decision makers in compiling a variety of data from many sources: raw data, documents, personal knowledge from employees,*

*management, executives and business models. DSS analysis helps companies to identify and solve problems, and make decisions.*

From this it is clear that a DSS is currently seen as a computer, or perhaps more saliently, internet-based system, which enables large amounts of diverse information to be analysed in order for managers to reach rational decisions. The dominance of computer-based models is reinforced by the 1999 UNFCCC publication: *Compendium of Decision Tools to Evaluate Strategies for Adaptation to Climate Change* (UNFCCC, 1999). All the decision support tools evaluated here are computer based, in fact based on now archaic software and operating systems such as Linux and Windows 95. This, certainly at the time of the evaluation, rendered them inaccessible to smaller-scale farmers, and many of them, given their complexity require mediation by software specialists. A further factor in their inappropriateness for such farmers was the focus in the agricultural sector on large-scale cereal and other field-crop practices. However, this was relatively early days in the development of DSS related to climate change.

A more recent (2014) publication, developed to provide guidance for the disbursement of the Adaptation Fund of the Kyoto Protocol: *A review of decision-support models for adaptation to climate change in the context of development* (Nay, Chu, Gallagher, & Wright, 2014) provides some very useful pointers in terms of the different models being employed in developing DSS. These incorporate both technical, mostly computer/internet-based, approaches and social, participatory approaches, an orientation which it describes as '*...balancing community input and technical tools*'. (ibid.) One of the most telling statements, however, in the document is: '*The Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC, 2007) concluded that planned adaptations to climate risks are "most likely to be implemented when they are developed as components of (or as modifications to) existing resource management programs or as part of national or regional strategies for sustainable development."* Many general development activities, such as creating more effective and equitable agricultural markets or diversifying livelihood options beyond rain-fed cultivation, can simultaneously improve the lives of the poor and reduce climatic risks.' (ibid.) In other words CSA is best seen as integral to broader development processes, an approach which is entirely compatible with the idea that CSA practices are essentially good developmental agricultural practices, applicable in and suitable for a wide range of contexts.

The publication, which looks at different types of simulation to develop scenarios relevant to different contexts, draws on a conceptual model, shown in the figure below, from which different technical models can be derived.

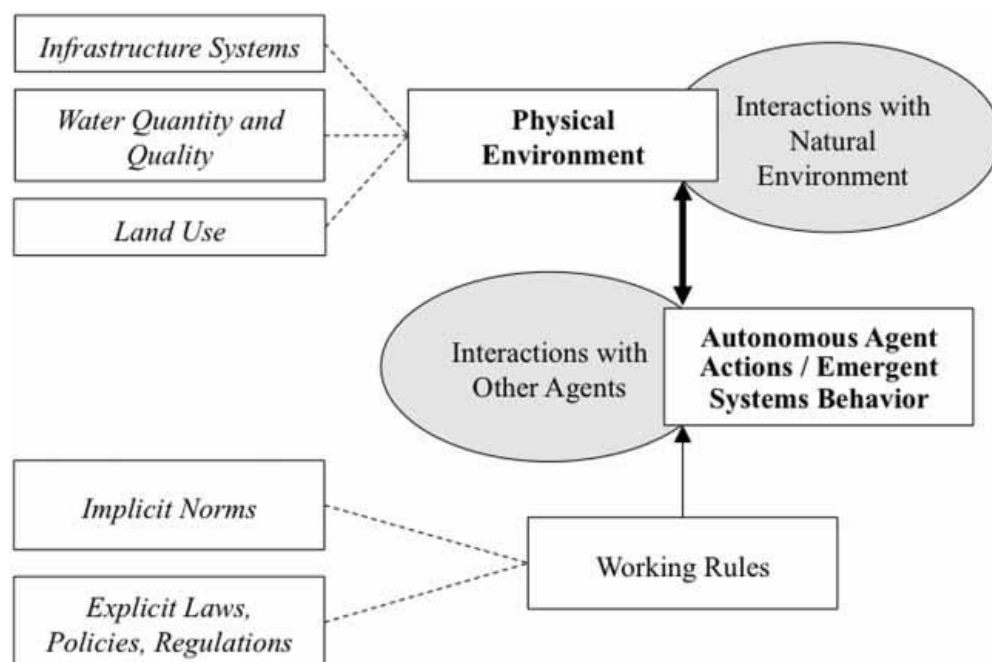


Figure 6: Conceptual model for DSS development (Nay et al 2014)

The technical models included in the review include:

Equation-based models (EBM) – essentially the mathematical/statistical approach to vulnerability to climate-change impacts

Agent-based models (ABM) – where Agents are described rather confusingly, as follows: “Agents” in computational ABMs are autonomous decision algorithms that interact with other agents and their environment.’ Further reading however reveals that they are essentially talking about people in their communities, and the interactions between them and between them and their environment.

Geographic-based models (GBM) – self-explanatory, based on extensive GIS mapping of geo-climatic regions

Participation-based models (PBM) – again self-explanatory, where the simulations and resulting scenarios are developed through intensive participatory processes with farming communities. This includes what is described as Role-play Games (RPG), a specific participatory technique enabling farmers to express what they understand might be the impacts of climate change and their possible responses to these.

The reviews conclusion is that it is advisable to adopt approaches incorporating both technical and social components: *Community-based adaptation seeks to incorporate current and future climatic risks into the design of interventions that are key for local economies and overall well-being* (Dumaru, 2010).

*While communities have extensive knowledge of local environmental changes, they often have limited knowledge of the causes and effects of exogenous change. Building and utilizing integrative models may, in some circumstances, help evaluate and manage trade-offs inherent in local adaptation options... It is crucial that tools selected for use are appropriate to the situation, remaining cognizant of the resources available for conducting the effort. Under some circumstances, a stakeholder- focused approach to cost-benefit analysis has been deployed, which enables*

stakeholders to reach an informed consensus based on analyses that take account of both monetary and non-monetary benefits (Blanco, 2006)

*Whether qualitative or quantitative in nature, however, model and cost–benefit analyses outputs should be seen as decision-support tools rather than as definitive justifications for particular interventions (or for any intervention).* (Lunduka, Bezabih, & Chaudhury, 2013)

### **Broad-scale DSS**

While the CSA project is particularly concerned with local-level DSS, some of the more complex DSS have been developed to support national and regional level policy development. This is very much the case with the TargetCSA project as described in: *How to target climate-smart agriculture? Concept and application of the consensus-driven decision support framework “targetCSA”* (Brandt, Kvakić, K, & Rufino, 2017)

This is aimed specifically at planners and decision makers that aim to implement CSA at the regional or national level. The approach taken by TargetCSA includes 3 stages:

Stage 1: structuring the decision-making problem

Stage 2: eliciting stakeholder preferences and consensus building

Stage 3: spatial aggregation and coupling of vulnerability and CSA indices

And identifies critical indicators:

Biophysical indicators: Precipitation; soil organic matter

Social indicators: % households with secure access to safe water; literacy rate

Economic indicators: female participation in economic activities; connectivity through transport infrastructure

The report identifies broad-brush CSA practices: Improvement of soil fertility and soil management; identification and distribution of drought resistant cereal crops; reduction of GHG from livestock; improvement of water harvesting and water management; establishment of agroforestry; implementation of livestock insurances (ibid.).

The critical process is linking vulnerability in terms of the three kinds of indicators, with selected CSA practices, suitable for the specific kinds and levels of vulnerability in specific geo-climatic areas. This process was conducted across the whole of Kenya and informed the agricultural component of the Kenya National Climate Change Action Plan.

A further broader-scale DSS is the CSA Prioritization Framework, developed by CIAT (International Centre for Tropical Agriculture) under the CGIAR umbrella, and linked to its Climate Change, Agriculture and Food Security (CAAFS) research programme. This is described as: *A set of filters for evaluating CSA options & establishing CSA investment portfolios...For National and sub-national decision makers Donors, NGOs, implementers* (Ulrichs, Cannon, Newsham, Naess, & Marshall, 2015)

As yet no CSA specific policies or plans have been developed in South Africa at provincial or national level in relation to CSA. A scoping study conducted by the University of Fort Hare (Mkeneni & Mutengwa, 2014) proposes that the National Climate Change Response Policy (NCCRP) (DEA, 2011) can, together with the Climate Change Sector Plan for Agriculture Forestry and Fisheries (CCSP)

(Department of Agriculture, Fisheries and Forestry, 2013) provide something of a framework for CSA. However, criticism of the CCSP by some civil society organisations (CSO) suggests that the CSA policy is framed in very general and wide terms that can accommodate almost any 'new' technology and institutional structure and that it is too biased towards commercial agriculture and agribusiness and does not question the basic structural imbalances and development paradigm that created this problem in the first place.

A further tool developed in South Africa with a national focus, is the South African Risk and Vulnerability Atlas (SARVA, 2013), originally developed as a hard-copy publication and since evolved as a web-based information portal in the form of an electronic spatial database. This provides the most up-to-date information available on the climate change predictions for the country, thus helping with decisions as to which CSA practices may be most needed and most suitable in different regions.

### Local-scale DSS

The scale at which the CSA is working is essentially local, and perhaps one of the most useful local-scale approaches developed in recent years is the CGIAR/CCAFS Working Paper 108: *Climate Change & Food Security Vulnerability Assessment Toolkit for assessing community-level potential for adaptation to climate change* (Ulrichs, Cannon, Newsham, Naess, & Marshall, 2015)

While this does not have a specifically CSA focus, vulnerability assessment is critical to an understanding of climate change impacts and is an essential component of a CSA DSS. The paper described its purpose as presenting a toolkit to be used to understand the interrelations between climate impacts, food systems and livelihood strategies at the local level. It applies a multidimensional view of vulnerability of livelihood strategies to climate change, with a focus on differentiated access and entitlements to livelihood resources and food for different groups within the community (often determined according to gender, ethnicity and socio-economic class). It is based on a concept of five (5) Dimensions of Vulnerability (DoV), illustrated in the following figure:

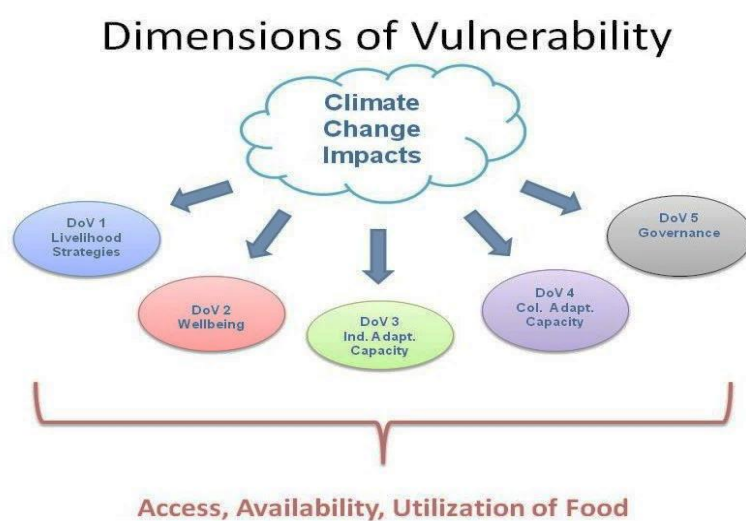


Figure 7: The 5 dimensions of vulnerability (CGIAR/CCAFS, 2015)

For each of these vulnerability dimensions, the paper provides details on what information is required. There is also long section on participatory approaches, techniques and practices, most of which are fully familiar to the CSA project team, with the activities including:

- Transect Walk
- Village Map
- Historical Timeline and Climate Trends
- Well-being Ranking
- Livelihood Strategies and Seasonal Calendar
- Changing Farming Practices and Crop Ranking
- Climate Risk and Coping Mechanisms Matrix
- Food System Analysis – Causal Flow Diagram
- Institutional Mapping and Venn Diagram

This Working Paper clearly provides a very useful approach to the social component of any DSS, and is eminently adaptable to specific local contexts, and to a CSA focus.

### **DSS in this research process**

A key decision will be whether to develop an internet or computer-based DSS or one which may be more readily accessible to the emerging farmers with whom the project is working. It is, however, worth noting here that experience across the world, as detailed in 2 FAO publications: Success Stories on Information and Communication Technology for Agriculture and Rural Development (FAO, 2015), and E-Agriculture in Action (FAO, Bangkok, 2017), suggest that emerging farmers, certainly in the Asia-Pacific countries are using internet technology more than might be supposed. More locally, the Amanzi for Food ([www.Amanziforfood.co.za](http://www.Amanziforfood.co.za)) project in the Eastern Cape has also found that internet usage among small-scale farmers is higher than might have been expected, and not only among the younger farmers (WRC project K5/2277, Grahamstown, 2016).

As discussed above the SARVA is now a web-based platform and is quite essential in terms of the climate predictions it makes for all regions in South Africa. This critical element of any functional DSS is therefore already web-based, and mediating access to this is essential to support farmers in their decision-making in relation to CSA practices.

It would seem inevitable that some components of a contemporary DSS will be internet/computer based, with the challenge being to identify the most appropriate way in which farmers can access this. However, other components such as local vulnerability assessments, and local solutions, are almost certainly best designed for and conducted in the traditional form of face-to-face interactions. Any effective DSS will therefore be a mix of different processes, media and information sources.

### **Decision-making Process**

Whatever the medium (internet or otherwise) employed for a DSS, the fundamental decision-making process is the same and is presented in the figure below.

It is clear from this model that information and access to information is central to any DSS, and that the kind of information required is dependent on the type of decision to be made. Although this is self-evident it does suggest that the starting point for any DSS to support farmers in relation to CSA is an understanding of the type of decision they will need to make. The support system must

therefore include a range of options available in terms of the decisions which can be made, and making accessible the information needed to support the decision-making

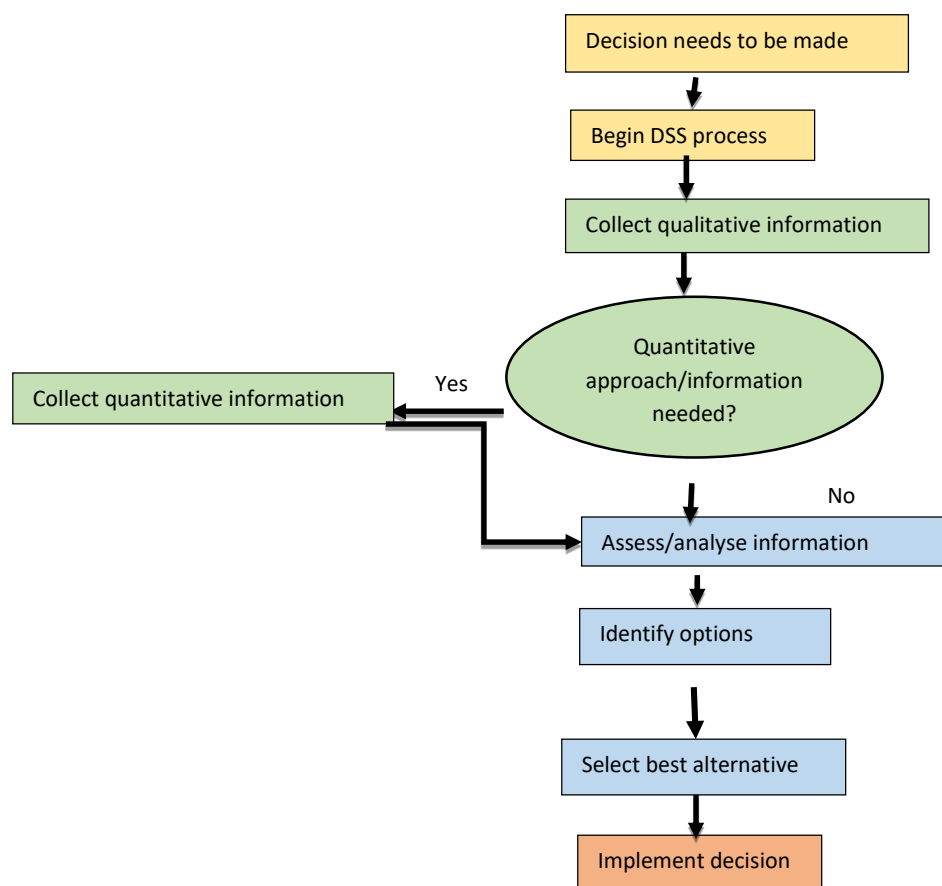


Figure 8: Decision making process (adapted from Heineman, 1988)

## Decisions

The key decisions in relation to CSA will almost inevitably focus on the kinds of agricultural practice which farmers can adopt in order to mitigate the impacts of climate change, and in particular address issues such as changes in rainfall frequencies and quantities, increases in extreme weather events and long-term shifts in climatic and seasonal patterns. Many of these practice options are described in considerable detail in Deliverable 1 of this project, and in a wealth of supporting materials, access to which is essential for farmers to engage with the DSS meaningfully. The CSA project can therefore provide farmers with a range of options from which, based on understanding of these options, on the local situation and the farmers' needs and aspirations, they can make decisions regarding which practice(s), if any, they wish to implement.

## Information

The available literature on agricultural DSS generally suggests that qualitative information (also known as 'expert' information) is often held by the decision-maker, in this case the farmer, through their own lived and learned experience. They understand their own context: their soils; the crops they can and wish to grow; the livestock they can and wish to raise. They also have a good understanding of the resources (financial and human) they have available, and the skills and

technologies to which they have access. They may not, however, have had direct experience of CSA practices, and the DSS will need to include a component enabling farmers to learn about these, as they will need to decide which practices suit their context, and are appropriate for their crops their resources and skills. In addition, farmers may also need advice in terms of the suitability of practices in relation to soil types, slope, exposure, rainfall, and crop types. This will be provided through external qualitative information.

In the Amanzi for Food project (WRC K5/2277) a 'Navigation Tool' was developed to assist farmers to access information in 2 key sets of WRC materials: **Water Harvesting and Conservation** (Denison *et al.*, 2011); **Agricultural Water Use in Homestead Gardening Systems** (Stimie *et al.*, 2010), and 6 supplementary materials. The Tool provides basic information on the main practices detailed in these publications, including:

- The scale(s) of farming for which the practice is suitable
- The main purpose of the practice, with a short description
- The levels of resources, skills, technologies and maintenance requirements associated with each practice
- Where and in what form information is provided on each practice, and in which materials

This supports farmers to select which practices might be most appropriate for their situations, and enables them to access easily detailed information on the practices. In essence it can be seen as a decision support tool. The CSA DSS can either include the Navigation Tool as it stands, or adapt it, or develop a similar tool specific to the CSA practices the project is promoting, although these are almost entirely compatible with the Rainwater Harvesting and Conservation practices promoted in the Amanzi for Food project (see the Amanzi for Food case study in this report).

### **Analysis**

The process of analysing the available (qualitative) information in order to reach a decision is inevitably, to some degree, subjective, depending on the farmers' needs and aspirations. However, it is possible to reduce the subjectivity to some degree by prioritising the variable factors in terms of their importance in any given situation. This will require further work, but, for example, the prioritisation could be to place the variables in the following order:

- Effectiveness of the practice in any particular context – this will probably require external input in terms of analysis of the soils, slope, exposure, average rainfall, crop type etc.
- Financial cost to the farmer of implementing the practice
- Level of technology required for the practice
- Maintenance implications
- Level of skill required

### **2.7.3 Considerations for selecting sites and participants**

*By Khethiwe Mthetwa, Mazwi Dlamini, Bobbie Louton*

#### **Participant selection**

In qualitative research, Sargeant (Sargeant, 2012) explains that -



Qualitative research is purposeful; participants are selected who can best inform the research questions and enhance understanding of the phenomenon under study. Decisions regarding selection are based on the research questions, theoretical perspectives, and evidence informing the study. The subjects sampled must be able to inform important facets and perspectives related to the phenomenon being studied.

If quantitative research is conducted, however, it requires standardization of procedures and random selection of participants in order to minimize the potential influence of external variables and maximise the generalizability of results (ibid). In qualitative research, however, the sample size is not generally predetermined. The number of participants depends upon the number required to inform fully all the important elements of the phenomenon being studied. That is, the sample size is sufficient when additional interviews or focus groups do not result in identification of new concepts, an end point called data saturation. To determine when data saturation occurs, analysis ideally occurs concurrently with data collection in an iterative cycle.

Sargeant continues to give a good description of how the rigour of qualitative data can be ensured. Within qualitative research, two main strategies promote the rigor and quality of the research: ensuring the quality or “authenticity” of the data and the quality or “trustworthiness” of the analysis.

Authenticity of the data refers to the quality of the data and data collection procedures. Elements to consider include:

- Sampling approach and participant selection to enable the research question to be addressed appropriately and reduce the potential of having a biased sample.
- Data triangulation refers to using multiple data sources to produce a more comprehensive view of the phenomenon being studied e.g using multiple sites and/or disciplines.
- Using the appropriate method to answer the research questions, considering the nature of the topic being explored, eg, individual interviews rather than focus groups are generally more appropriate for topics of a sensitive nature.
- Using interview and other guides that are not biased or leading, ie, that do not ask questions in a way that may lead the participant to answer in a particular manner.
- The researcher’s and research team’s relationships to the study setting and participants need to be explicit,
- The researcher’s and team members’ own biases and beliefs relative to the phenomenon under study must be made explicit, and, when necessary, appropriate steps must be taken to reduce their impact on the quality of data collected, eg, by selecting a neutral “third party” interviewer.

Trustworthiness of the analysis refers to the quality of data analysis. Elements to consider when assessing the quality of analysis include:

- Analysis process: is this clearly described, eg, the roles of the team members, what was done, timing, and sequencing? Is it clear how the data codes or categories were developed? Does the process reflect best practices, eg, comparison of findings within and among transcripts, and use of memos to record decision points?
- Procedure for resolving differences in findings and among team members: this needs to be clearly described.

- Process for addressing the potential influence the researchers' views and beliefs may have upon the analysis.
- Use of a qualitative software program: if used, how was this used? (Sargeant, 2012)

Given the team's decision to work in sites where the organisation and its partners are already active, field staff of Mahlathini Development Foundation did an analysis of pros and cons of this approach in terms of good community engagement practice. These are outlined below.

**PROS:**

- Already know the people and their preferences
- Have gained trust
- Know what they're likely to do
- Know the dynamics
- Better able to work for equal power dynamics, as we know the players
- Already have a profile
- Already connected to structures in the area, can connect with other players in the area Especially with the Departments who are not financially limited and can take things forward
- An overlap of participants between projects – helps with disseminating, embedding ideas
- Already have some technical information and know conditions and problems with soils for example and know the pitfalls
- Better sense of what's realistic to try because we know the area
- We have an understanding of cultural aspects, what is allowed, who does what in terms of labour
- Some people will not try until they see the new ideas – you know the people who will be your 'bait' - No one wants to be left out which creates a high rate of acceptance/interest

**CONS:**

- Researcher bias about who they like to work with
- Bring in baggage from previous experiences which can exclude some participants and which skews results
- Community members who had a bad experience with the research team in the past will not be willing to try new ideas
- If your powerhouse person doesn't show the results you wanted, others lose confidence
- Can have too many takers – how to do it without leaving people behind
- Competition over participants (Pers comm M Dlamini, K Mthethwa, T Mathebula 2017)

It may be easier to work with new groups in existing project areas, than in new communities, as people would have heard about the interventions in neighbouring villages. This may be a natural extension of working in existing communities. Starting in new communities have a number of drawbacks including

- It takes a lot of time and money to mobilize people and try to communicate the ideas
- It can be hard to convince people to try new ideas and
- There are lots of protocols working with traditional authorities and while one is busy with these issues, not much can be done on the ground.

Criteria for selecting participants have been suggested by the field work team as:

- Household level- rather than group based projects such as community gardens or cooperatives
- Participants should already be producing
- Participants should be selected in geographical clusters so that they are reasonably close to each other to facilitate their interaction
- Choices for participants should be gender inclusive
- The gardens/fields should be fenced: With regard to this criterium, they felt it is a good idea for the experimentation side of things but can cause issues of giving preference to better resourced individuals in the community. Sometimes these individuals are also not that keen to use their fenced land for the implementation.
- It would be an idea to set up a CoP that is open to all smallholders/ producers, but have central group or person such as a local facilitator, who liaises and organises, to divert power from the research team. CoPs need to become strong enough to help members address issues. These CoPs are also engaged in self monitoring a collecting and analysing data; according to the principles of Participatory Action Research
- Community members self- select to be part of a CoP using a list of criteria that they have been involved in setting up.
- There should be a selected number for inputs/data collection per site. It does not have to be everyone involved as long as the criteria for receiving inputs and doing data collection are clearly set out and are acceptable to the broader CoP.
- It is a good idea to map all the stakeholders involved with the CoP and to recognise the contribution of other organisations in the community – so that different organisations do not work at cross purposes in one area.
- It would also be an idea to create a participatory landscape map (with photos) – such as a transect walk, that represents the system, the issues, the adaptation and the successes of the CoP (pers comm M Dlamini, T Mathebula 2017).

## 3 TECHNICAL METHODOLOGIES

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By Jon McCosh

### 3.1 Draft method for evaluating the effect of CSA practices on soil, water and yield

This chapter provides an overview of the proposed research approach to evaluate the effect of CSA practices on soil quality, plant water and crop yield. Firstly, visual soil assessment indicators are discussed – these are qualitative indicators of soil health. Secondly, crop growth indicators are outlined. Thirdly, an overview of laboratory and instrument measurements that will be required are shown. Finally, we seek to link the visual soil indicators to the results from instrument and laboratory measurements to determine how qualitative indicators compare with the measured results to evaluate their suitability as indicators of key production and soil health parameters.

### 3.2 Visual soil assessment indicators

This section describes the approach to evaluating the effect of CSA practices on soil health and quality, soil water and yield. We start by considering various Visual Soil Assessment (VSA) methodologies. VSAs are used as indicators of soil health (also known as soil quality and soil condition), which can be defined as:

“... the capacity of a specific kind of soil to function within natural or managed ecosystem boundaries to sustain plant and animal productivity; maintain or enhance water and air quality; and support human health and habitation.” (USDA, 2001)

Soil physical properties (e.g texture, mineralogy) are largely dependent on the parent material from which the soil is derived as well as climate, topography and time. These properties are inherent soil properties and are unlikely to change in the short term. Soil quality on the other hand refers to the dynamic properties of the soil that can be affected by management practices, which should aim to improve soil quality. Consequently, the evaluation of soil quality attributes are most suited to comparing the quality of a given field or area over time, rather than comparing different fields, as soils have different inherent physical properties.

Various VSA methodologies are available for assessing soil quality. Three methodologies were reviewed:

- Visual soil assessment guide: field crops (FAO, 2008)
- Willamette valley soil quality guide by Oregon State University (Oregon State University, 2009)
- Guidelines for soil quality assessment in conservation planning (USDA, 2001)

Of the three reports reviewed, all had a similar set of components, namely (1) a set of indicators and descriptions of their relevance or importance, (2) a set tools and methodologies for assessment of indicators and (3) a scorecard.

The indicators are very similar across all methodologies as shown in **Error! Reference source not found.**Based on a review of the methodologies, the Oregon State University approach was chosen

as it was considered simplest to apply in the field, was co-developed with farmers, while still addressing the most important indicators. The single exception is that workability, which refers to ease of ploughing has been excluded as regular tillage operations are not indicated as a CSA practice.

**Table 8: A comparison of soil indicators across different VSA methodologies**

FAO (2008)	Oregon State University (2009)	USDA (2001)
Soil texture	Soil structure and tilth	Earthworms
Soil structure	Compacted layers	Soil organisms
Soil Porosity	Workability	Smell
Soil colour	Soil organisms	Surface organic material
Number and colour of soil mottles	Earthworm abundance	Residue composition
Earthworms	Plant residue	Compaction
Potential rooting depth	Plant vigour	Workability
Surface ponding	Root growth	Soil tilth / structure
Surface crusting and surface cover	Water infiltration	Porosity
Soil erosion	Water availability	Crusting
Soil management of annual crops		Water infiltration
		Drainage
		Water holding capacity
		Erosion
		Crop vigour / appearance
		Plant roots
		Root mass
		Salts
		Sodium

A brief description of each indicator, their relevance to soil health and how management affects the indicator is provided in 10.

**Table 9: Description of the relevance of each indicator and how management affects the indicator**

Indicator	Relevance	Management
<b>Soil structure and tilth</b>	Soil structure and tilth refers to how the soil particles are arranged. Ideally soils should have a good 'crumb' structure which means that there are sufficient spaces between the particles to allow the movement of water and air.	Increasing plant residue and soil organic matter improves soil tilth. Machinery operations that allow compaction and leaving bare soils over winter result in poor tilth and structure
<b>Compacted layers</b>	Compaction limits air and water movement, which in turn limits root growth. The lack of air also limits the number of soil organisms.	Compaction can be caused by machinery operations that compact the top layers of soil. In addition, plough pans from the action of the plough on the lower soils can compact the lower soil. Cover crops and organic matter addition can reduce soil compaction.
<b>Soil organisms</b>	A healthy soil food web has a high diversity of soil organisms. The different organisms all have a role to play in nutrient cycling in the soil as well as soil structure. A diversity of soil	Tillage and the use of pesticides disrupts and suppresses soil organism populations, while maintaining organic covers and organic residue promotes healthy and diverse organism populations.

	organisms also helps to suppress pests and diseases.	
<b>Earthworms</b>	Earthworms are recognised as important indicators of good agricultural soils. Earthworms increase the cycling of organic matter, mix up the soil and break up raw plant material. Their movements in the soil create passageways that improve aeration and water infiltration.	As with soil organisms above, tillage and pesticides suppress earthworm populations, while organic residues and cover crops promote earthworm populations
<b>Plant residue</b>	Residue of crops or added organic matter is critical for maintaining many of the soil health indicators described in this table.	Cover crops and addition of organic residues promotes organic matter formation and soil health. Healthy soils should have organic matter at different stages of decomposition, from whole plant parts, through to plant fibres and dark humus.
<b>Plant vigour</b>	Refers to the health of plants in the field, including uniform height, uniform healthy colour and reaching maturity at the same time.	While vigour can be difficult to assess because of management practices like fertiliser inputs and pests that may affect growth, healthy soils should show healthy plant growth of both crops and weeds.
<b>Root growth</b>	Roots provide anchorage for the plant and exchange nutrients from the soil. Good root growth indicates a diverse soil organism population, adequate soil aeration (porosity) and nutrient cycling. Good root growth also means that there are no compacted or impeding layers in the soil.	Practices that encourage good root growth include good tillage practices that don't result in compaction, promoting higher soil organic matter – factors that promote good plant vigour also promote healthy roots.
<b>Water infiltration</b>	Good infiltration means less runoff and erosion, while more water is available in the soil for the crop. Good infiltration also means that the soil drains quicker and that air can enter the soil. Note: soils inherent texture properties can limit infiltration, but this can be ameliorated with management practices.	Tillage should preserve soil structure. Cover crops and the addition of soil residues should improve soil aggregate stability and consequently infiltration.
<b>Water availability</b>	This refers to the water that is available in the soil for plant use (i.e. can be extracted from the soil by the plant). Good water availability also indicates that soil structure and organic matter are in a desirable state.	Practices that reduce compaction and lower bulk density improve water availability.

### 3.3 Crop development indicators

Building from the visual soil indicators, we have also included a set of plant indicators that have been derived through recent work with small growers through a GrainSA funded project (Kruger E. , Conservation Agriculture Farmer Innovation Programme: Final Report, 2016) .These are:

- **% soil cover at planting** (From 0% - no cover to 100% full cover; Cover of the soil looking from above- can be crop residue, weeds, mulch, grass etc)
- **% crop cover at 6-8 weeks** (From 0% - no cover to 100% full cover; Cover of the soil looking from above- crop cover/ canopy)
- **% Weed infestation** (0%- very high weed incidence, complete yield loss; to 100%- no weeds zero yield loss)

- **% Pest occurrence** (0%- very high infestation, complete yield loss, to 100%- no insect pests and zero yield loss)
- **% growth** (germination, colour, height, health)

The intention of these indicators is to find a way in which field observations can be used to assess the level of implementation, and change for each participant testing CSA practices. These criteria have been chosen to have a management element within them, although they would of course be sensitive also to environmental changes and conditions.

The criteria/indicators need to be robust enough to:

- Be easily observed or measured by;
- A number of different enumerators and
- Across different areas and sites;

But also, sensitive enough to show the effects of changes in management practices by participant smallholders. In this report, the indicators used thus far are assessed and discussed and recommendations are made for adaptations into the future.

### 3.4 Field research and laboratory measurements / indicators

In addition to the VSA and crop development indicators, a number of instrument-and laboratory based measurements will be required. These include soil physical and chemical properties, weather, soil water and yield, which are described in more detail in Table 11. Included in the table is an indication of how important the measurement is (necessary, preferred or optional) and the intervals at which measurements should be taken.

**Table 10: Key production parameters to be measured through instrumentation and laboratory analysis**

	<b>Importance (Necessary, Preferred, Optional)</b>	<b>Intervals</b>
<b>Soil Physical Properties</b>		
Texture	Necessary	Once off
Bulk Density	Necessary	At beginning and after each harvest
Saturated Hydraulic Conductivity - surface	Preferred	Once off
Saturated Hydraulic Conductivity - below surface	Preferred	Once off
Structure - Mean Weight Diameter	Optional	At beginning and after each harvest
Retentivity Curves	Preferred	Once off
<b>Soil Chemical Properties</b>		
Carbon	Necessary	At beginning and after each harvest
N,P,K	Necessary	At beginning and after each harvest
pH	Necessary	At beginning and after each harvest
Electrical Conductivity	Optional	At beginning and after each harvest
Exchangeable Bases / Cation Exchange Capacity	Preferred	At beginning and after each harvest
Soil health indicators*	Necessary	At beginning and after each harvest
<b>Weather</b>		
Automated Weather Station (AWS)	Necessary	Research duration - constant logging
Rain gauges	Necessary	Research duration - manual recording
<b>Water</b>		
Watermark sensor (nests of 3 at 300, 600 and 1200mm)	Necessary	Research duration - constant logging
Soil temperature sensors to go with watermarks	Necessary	Research duration - constant logging
Loggers to go with watermarks	Necessary	Research duration - constant logging
Manual Gravimetric water sampling	Necessary	During set phases of crop development
Hand moisture tests (numerical scale)	Necessary	During set phases of crop development
Runoff plots	Necessary	Research duration - regular manual recording
<b>Yield</b>		
Biomass (non-edible) - Dry Matter	Necessary	At harvest
Grain / edible component - Dry Matter	Necessary	At harvest
Leaf Area Index	Optional	During set phases of crop development
Leaf nutrients	Optional	During set phases of crop development

### 3.5 Linking the parameters

A matrix is provided in Table 12 of how the VSA indicators link to the soil physical and chemical properties and ultimately to yield. Important observations from the matrix are that:

- Bulk density is an important measurement across all VSA indicators. Compaction increases bulk density, which reduces soil aeration and consequently soil organisms. Higher bulk density equates to lower water infiltration and lower water availability. Conversely, high levels of plant residue and soil organisms should improve soil structure and consequently bulk density.
- Hydraulic conductivity is affected by soil structure – a good structure will improve hydraulic conductivity; compacted layers will reduce hydraulic conductivity, while a healthy soil organism population will increase hydraulic conductivity and in the A horizon.
- Carbon in the soil can provide information on soil fertility, available nutrients and soil organisms – this is an important measure for soil health.
- Exchangeable bases are an indication of the soil's ability to hold and exchange base nutrients. While this is largely dependent on clay content and soil pH (higher pH means more bases



available to plants), higher organic and soil organism presence would increase nutrient cycling and availability.

- Measurable yield is linked to all indicators – good soil health will result in higher relative yields, all other factors being equal.

**Table 11: Matrix of linkages between VSA and measured parameters**

Soil Physical Properties	Description	Soil structure and tilth	Compacted layers	Soil organisms	Earthworm abundance	Plant residue	Plant vigour	Root growth	Water infiltration	Water availability
Texture	Inherent soil property - relative proportions of sand, silt and clay									
Bulk Density	Lower bulk density means higher porosity and good structure									
Saturated Hydraulic Conductivity - surface	Rate at which water moves into soil surface under saturated conditions - the higher this is, more water in the soil and less runoff									
Saturated Hydraulic Conductivity - below surface	Rate at which water moves into below the surface under saturated conditions - the higher this is, more water in the soil and less runoff									
Structure - Mean Weight Diameter	Indicates how well formed the soil peds are - links to soil structure									
Retentivity Curves	Gives an indication of plant available water - largely an inherent soil property, but can be improved with better structure and organic content									
<b>Soil Chemical Properties</b>										
Carbon	Indicator of organic matter in the soil									
N,P,K	Indicator of soil fertility									
pH	pH affects the availability of plant nutrients									
Electrical Conductivity	EC indicates the concentration of dissolved salts in the soil									
Exchangeable Bases / Cation Exchange Capacity	This refers to the ability of the soil to hold bases (e.g. Ca, Mg, Phosphates) and exchange them with plant roots									
Soil health indicators										
<b>Weather</b>										
Automated Weather Station (AWS)	Provides rainfall, evapotranspiration information									
Rain gauges	Rainfall information									
<b>Water</b>										
Watermark sensor (nests of 3 at 300, 600 and 1200mm)	Gives an indication of plant available water by measuring the the matric potential of the soil									
Soil temperature sensors to go with watermarks	Used to calibrate watermark data									
Loggers to go with watermarks	Logs matric potential at regular intervals									
Manual Gravimetric water sampling	Manual sampling of gravimetric water content can be used to calibrate watermarks and will allow comparison against sites where watermark sensors are not installed									
Hand moisture tests (numerical scale)	During the gravimetric water sampling, participating farmers will be asked to give a numerical indication of their perception of soil moisture content (1 = dry, 5 = wet)									
Runoff plots	Used to indicate soil infiltration and erosion risk									
<b>Yield</b>										
Biomass (non-edible) - Dry Matter	This is the oven dried mass of a sample of biomass (i.e. stover)									
Grain / edible component - Dry Matter	This is the oven dried mass of a sample of the edible yield (i.e. grain, pulse)									
Leaf Area Index	An indicator of crop growth and canopy used to indicate crop growth rate									
Leaf nutrients	Can be used as a proxy indicator for plant available nutrients in the soil									

### **3.6 Way forward**

The proposed methodology for linking CSA practices on soil, water and yield will be developed further based on research team discussions to identify the critical parameters that the research should focus on to inform the Decision Support System.

## 4 CASE STUDIES

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### 4.1 Climate Change Adaptation, Limpopo

By Erna Kruger

#### 4.1.1 Description of the programme

RESILIM-O is large multi-faceted, multi-stakeholder, cross-boundary programme to reduce vulnerability to climate change through building improved transboundary water and biodiversity governance and management of the Olifants Basin through the adoption of science-based strategies that enhance the resilience of its people and ecosystems through systemic and social learning approaches. The programme has been running for four years and is being implemented by AWARD (The Association for Water and Rural Development) with funding from USAID.

The Agricultural Support Initiative (AgriSI) was initiated as a sub-grant process within the larger programmed towards the end of 2016. This initiative works specifically with climate change adaptation processes with smallholder communities in the lower Olifants River basin. It is being implemented jointly by Mahlathini Development Foundation and AWARD.

The Agricultural Support Initiative (AgriSI) addresses two of the RESILIM-O programme objectives directly:

- i. To institutionalize systemic, collaborative planning and action for resilience of ecosystems and associated livelihoods through enhancing the capacity of stakeholders to sustainably manage natural resources of the Olifants River Basin under different scenarios
- ii. To reduce vulnerability to climate change and other factors by supporting collective action, informed adaptation strategies and practices and tenable institutional arrangements.

The overall aim of the Agricultural Support Initiative is to enhance the resilience of the people and ecosystems in selected villages (5-6) in the Lower Olifants River basin, using a systemic social learning approach, exploring the question: *What are you learning about the socio-economic and biophysical characteristics of your environment and how these are changing and how are you able to respond to that?*

The overarching objective of this work is to provide support for increased adaptive capacity and resilience to the effects of climate change for households involved in agriculture in select communities of the Olifants River Catchment through:

- Improved soil and water conservation and agro-ecological practices for increased food security;
- Livelihood diversification and supplementation through alternative climate resistant production; and
- Increased community empowerment as a result of self-organisation and collective action.

#### 4.1.2 Problem

A key vulnerability which was identified during Phase I of this programme is the potential for increasing food insecurity under climate changing conditions, especially for the poor in former

Apartheid bantustans into which many people were forcibly re-settled. Not only are poor land-use practices impacting production and ecological health and integrity but these impacts are likely to be greatly exacerbated under the hotter and more erratic rainfall conditions that are predicted for the Lowveld as a result of climate change. For example, with a 2°C increase maize farming and livestock production is likely to become marginal whilst with a 4°C increase both will be untenable (AWARD; internal reports 2016).

Small-scale farming is widely evident throughout communal lands ranging in scale from small, so-called 'backyard' gardens to larger plots of between 0.5 and 2 ha. All of these are individually farmed. These form an important component of livelihood security and in particular, offer important safety-nets in times of crises.

However, not only are current poor farming practices exposing farmers to unnecessary risks through loss of ecological health but these are likely to be highly exacerbated with climate change. Current practices typically do little to manage water movement and retention, soil health and loss and offer little resilience in terms of crop choices, for example. From a social and institutional perspective there is little evidence of farmers working together to learn from each other or others or to plan for the future. Collective action and the ability to self-organise are regarded as critical components of adaptive capacity. Furthermore, although some farmers have indicated that they have heard of climate change, none expressed a sense of urgency and few voiced any ideas about how to respond. This suggests that collectively they are not resilient in a way that the magnitude of the impacts of climate change might demand. Building adaptive capacity for food security is thus a key priority of the project.

### **4.1.3 Rationale**

Sound agro-ecological practices for soil and water conservation (SWC) and the ability to self-organise and act collectively are regarded as fundamental for building adaptive capacity and resilience. Not only do agro-ecological farming approaches require minimum external inputs – which may be expensive and increase dependency if subsidised – but they foster farmers' sense that they can build sustainable futures from local inputs and efforts. With knowledge about the potential impacts of climate change included in the learning journey, farmers can make purposeful decisions around practices such as seed and crop-type. This approach supports livelihood diversification – also fundamental for increased resilience – through 'value-added' associated activities such as seedling production, tree nurseries and bee-keeping.

The overarching objective of this work is to provide support for increased adaptive capacity and resilience to the effects of climate change for households involved in agriculture in select communities of the Olifants River Catchment through:

- Improved soil and water conservation and agro-ecological practices for increased food security
- Livelihood diversification and supplementation through alternative climate resistant production;
- Increased community empowerment as a result of self-organisation and collective action.

#### 4.1.4 Implementation of practices

Six villages were given priority due to their medium to high vulnerability status with respect to food security under climate changing conditions and the existence of already active and interested smallholders. These villages, shown in **Error! Reference source not found.**, are Botshabelo (Mabins A); Mametja (Mabins B); Lepelle; Willows, The Oaks and Finale.

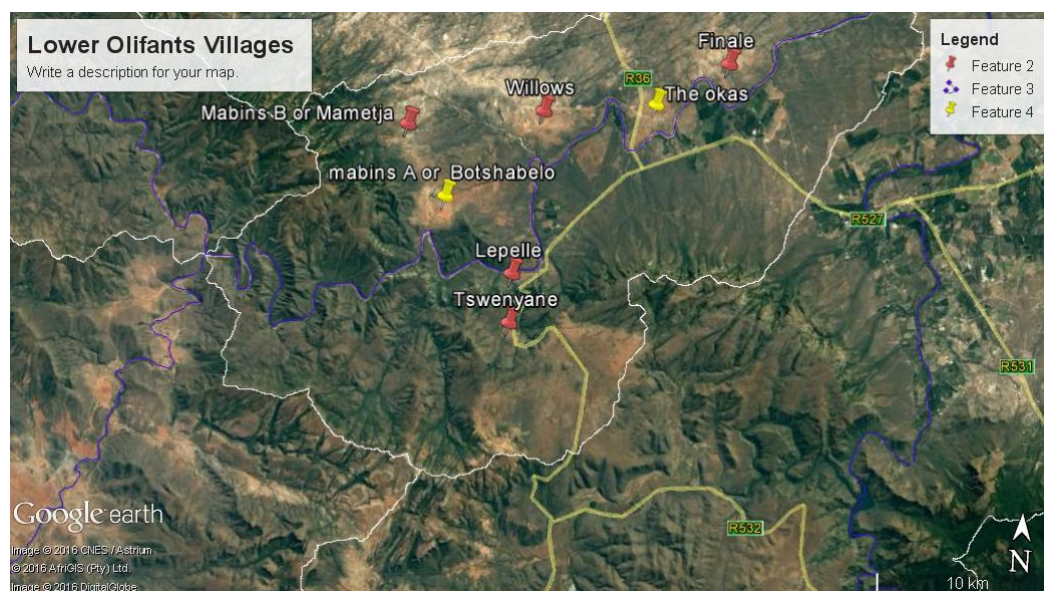


Figure 9: Map showing the location of the project site villages along the lower Olifants River

In each of the villages a CCA baseline was constructed through group explorations and discussions dealing with the present situation in the villages, past, present and future agricultural practices and present and future adaptations that could improve resilience, productivity and diversification.

In addition, a baseline household survey was conducted with 34 (of around 108) participants with the intention of using this baseline to track changes and livelihoods improvements. The majority of participants were women between the ages of 18 to 84 years. The household sizes average around 5 members and for the majority of participants (68%) reporting their monthly household income to be lower or equal to R3200/ month. This equates to around R20 per household member per day. Around 30% of respondents suggested a household income of between R3200-R6400/ month. See the figure below for the detailed breakdown.

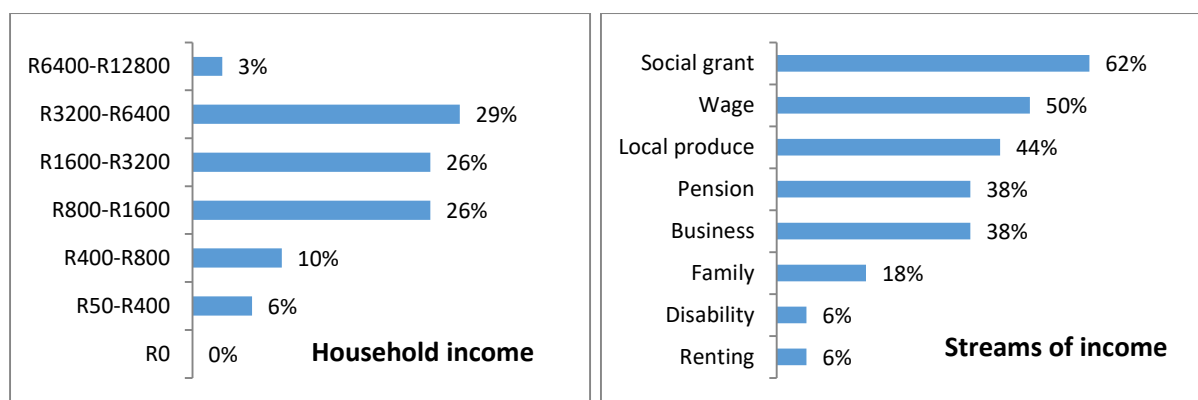


Figure 10 Ranges of household income and streams of income reported by participants.

Sources of income include social grants as the primary and most common source (62%). Wages from day labour, selling of local produce, small businesses, support from family members and rentals provide further sources of income in a descending order of contribution. It is interesting to note that sale of local produce provides and income source for almost half (44%) of the respondents – indicating smallholder farming as a central livelihoods’ component in these villages.

Nearly all respondents reported that they grew vegetables (94%) and fruit (4%). The majority also farmed field crops (91%), herbs and other multifunctional plants (86%) and livestock (68%). In terms of their diversification of farming enterprises; looking at the number of different products within these, there was far more diversification of vegetables and fruits than of field crops, livestock or herbs and other vegetation. Most of the households grew only one type of field crop; none grew more than 3. The same was true of livestock.

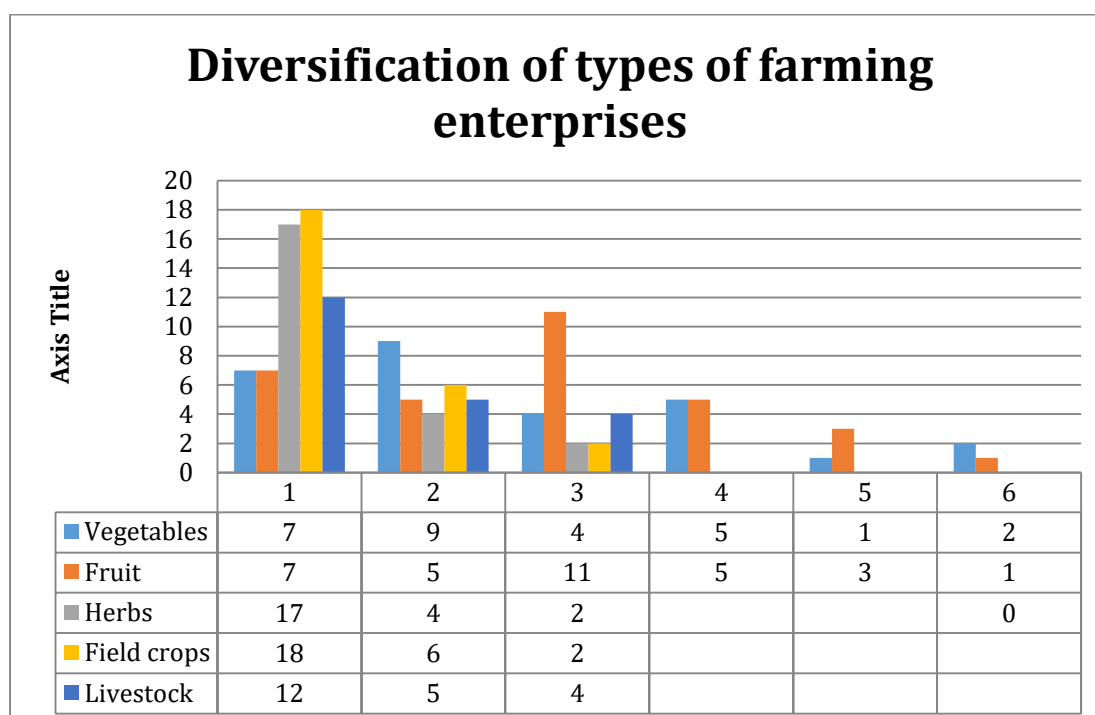


Figure 11 Number of participants with one or more type of produce for different types of farming enterprises

The diversity of types of vegetables, fruits, field crops, livestock and herbs and other vegetation that were reported are shown in Figures 6 to 8 below.

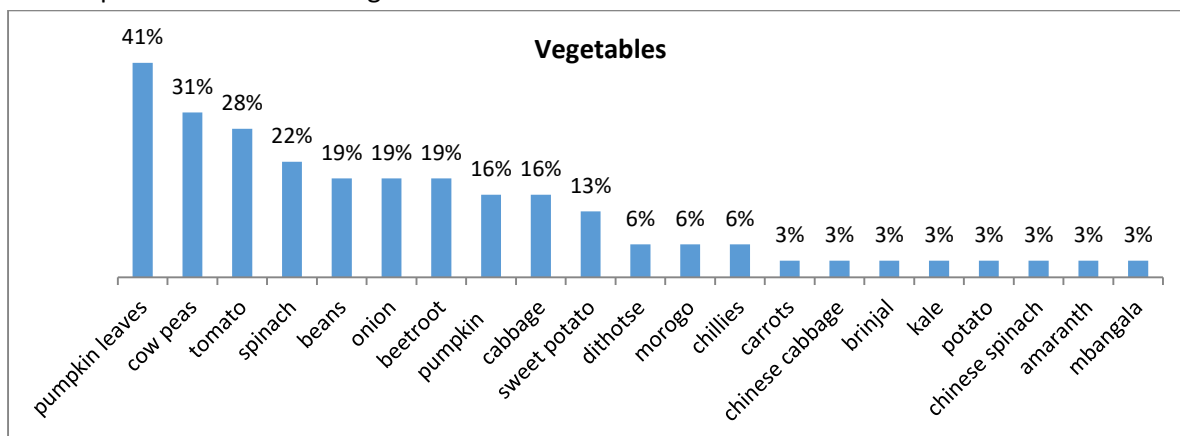


Figure 12: Percentage of participants who reported growing different vegetables

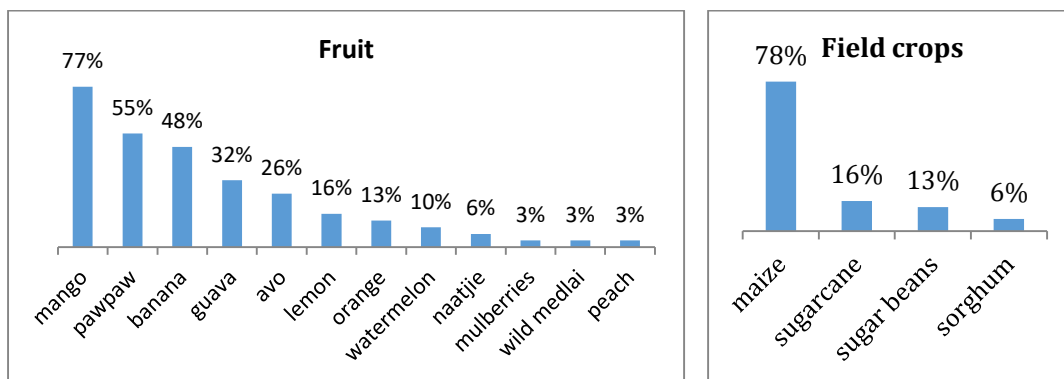


Figure 13: Percentage of participants who reported growing different fruit and field crops

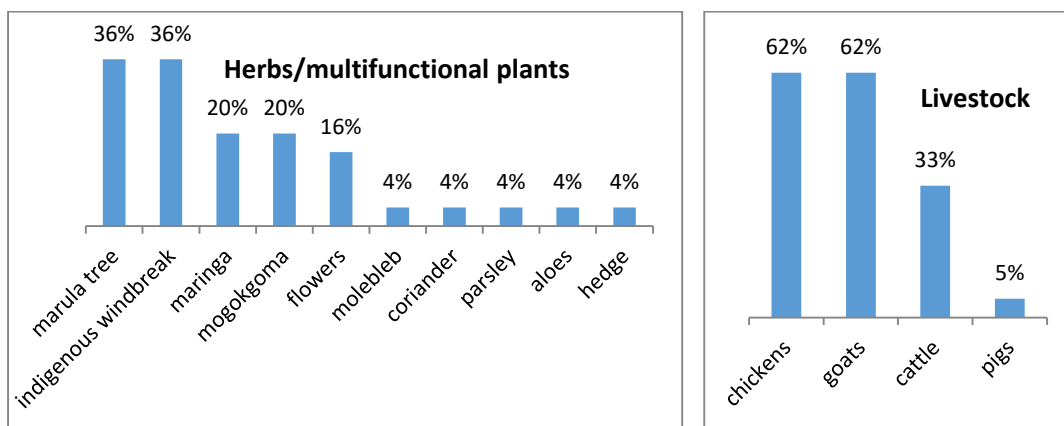


Figure 14: Percentage of participants who reported growing different herbs or multifunctional plants or raising livestock

Only 79% of respondents reported using any soil fertility management practices – meaning that 7 of the 34 respondents just plant their crops without addition of any soil fertility amelioration; believing that the soils can naturally provide fertility and that addition of manure can burn their crops. Of those respondents that do practice soil fertility management strategies, the application of livestock manure was by far the most common practice, reported by 75% of those using soil fertility

management practices. Other practices that were mentioned were the use of plant residues, use of legumes, commercial fertilizer, compost and sawdust .

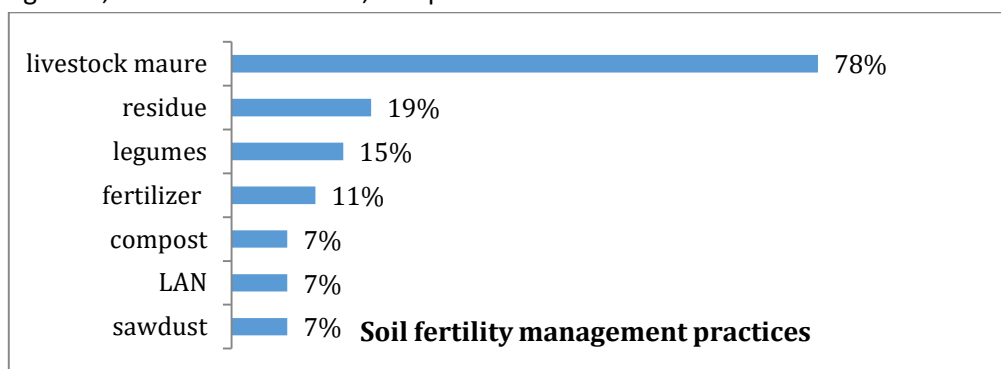


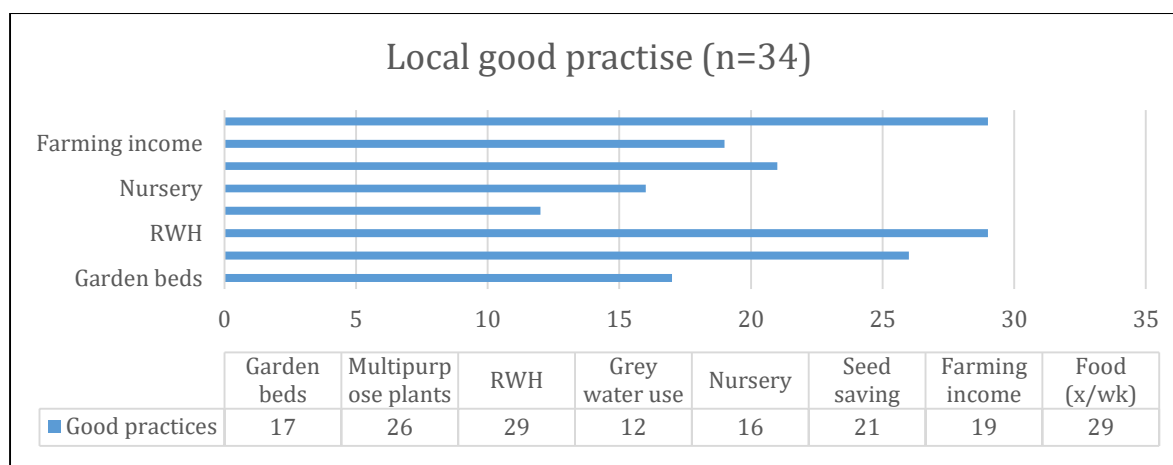
Figure 15: Soil fertility practices reported by participants

Present implementation of good farming practices was explored with the respondents. A number of different themes were explored See Figure 10 below. These included for example:

- The use of dedicated beds and specific bed design practices for soil and water management – such as the construction of furrows and ridges or planting basins (garden beds). Around 50% of respondents use these practices
- Water management in the form of use of greywater and rainwater harvesting (RWH) are being practiced by 85% and 35% of respondents respectively.
- Propagation in the form of seed saving and nursery management is being practised by 62% and 47% of respondents respectively
- And Multipurpose plants such as propagation of medicinal plants and growing and use of indigenous fruit trees (such as Marula and Makgogoba) are being practiced by 76% of respondents.

85% of respondents manage to eat produce from their gardens on a weekly basis, on average 3 times per week and harvesting between 1-3 different crop types in this time. 56% of respondents make a small income from their production practices- mostly from the sale of fruit and vegetables. They make an average of around R150-R300/month from sale of vegetables and as much as R6400/season for sale of mangoes and making of Marula beer, although the average is around R1 500 per season.





**Figure 16: Local good practice in farming activities**

Another outcome of this survey was the ability to design methodologies and practices for implementation that build on the local good practices and traditions and incorporate local innovations into the learning processes.

#### **4.1.5 Methodology**

The methodology of this project involves working with groups of interested farmers (learning groups) in selected villages by building a local picture of risk and resilience (socio-ecological) using a systems approach (vision and principles), scenario planning (farm design processes) and a spiral model of implementation (action and learning). Participants try out new ideas (farmer level experimentation) individually and jointly and through a process of reflection and adaptation of these ideas enhance their adaptive capacity.

Emphasis is being placed on methodologies and approaches for improved soil and water conservation strategies, livelihood diversification (increased and diversified production of vegetables, fruit and field crops and integration of small livestock) and value adds (such as entrepreneurial opportunities and diversification of income options).

Monitoring is important and in addition to monitoring being conducted by the facilitators (both trainers and local champions/facilitators) a local framework for self and peer assessment and monitoring of progress is employed using the 'five fingers' principles (developed by AWARD) for on farm practices, to enhance abilities for self-organisation and collective action. Local criteria for assessment of each 'finger' (things we are doing and changing) are to be developed alongside an easy scoring process to track implementation and progress. Each finger represents a principle as follows:

- **Water Management:** Manage water movement so as to slow down the water speed so as to reduce erosion and enhance infiltration
- **Soil management:** Manage soil movement so as to limit erosion and soil loss
- **Soil health:** Manage soil so as to maintain or improve soil health (nutrients and structure)
- **Plant (Crop) Management:** Manage plants and crops so as to ensure plants appropriate for the area and to meet the vision
- **Looking after indigenous plants:** Enhance practices that maintain indigenous fauna and flora and ecosystem health of the area

A key component of building adaptive capacity (resilience building) is strengthening peoples' ability to self-organise, to learn together and to act collectively. Aspects included in the design process are:

- The collaborative identification of champions/local facilitators in each village to act as local facilitators and motivators for change;
- Working with learning groups within and between villages;
- Networking and meeting with others (within group and external);
- Building locally appropriate collaborative activities (such as seedling production, small nurseries, village level savings groups, joint work parties, sharing resources and joint input supply and marketing processes)

Learning and innovation workshops have been held covering a range of themes within soil and water conservation, greywater management, intensive gardening techniques, micro climate management (tunnels) and improved irrigation practices.

The box alongside outlines a list of practices introduced in the learning groups for farmer experimentation and implementation.

Local facilitators were elected for each learning group to support the group and undertake the household-level garden monitoring for each participant.

The feasibility of implementation of new practices at a local level with available resources has been an important consideration. Thus, kits are provided for the tunnels, grey water filtration and drip irrigation that are constructed locally. For the underground storage tanks, support has been provided in terms of technical advice and materials, while the construction itself is done by local teams and individuals.

**Climate Smart Agriculture practices introduced in the AgriSI learning groups in the lower Olifants River basin.**

**Soil and Water Conservation**

- Cut off drains – ditches across a contour at top of garden/catchment
- Contours - measured with line level
- Diversion ditches - carry water to the garden
- Stone lines/bunds - made on contour
- Banana pits
- Improved furrows and ridges - made on contour with mulching and plantings

**Gardening practices**

- Dedicated paths and beds
- Mixed cropping; companion planting
- Mulching
- Trench beds
- Shallow trenches - an easier version of trenches incorporating manure and OM in a 30cm ditch or line, covering and planting on and next to that
- Eco-circles - combines double digging with bottle irrigation
- Incorporation of manure - large quantities
- Making improved manure - composting manure with grass and OM and inclusion of urine fraction from kraaling
- Making compost
- Liquid manures
- Pest control brews: Chilli-soap derivatives, onion-paraffin derivatives,
- Planting of herbs (mixed in veg beds, incl. coriander, parsley, fennel, chives, lemon balm, lavender, rosemary)
- Seed successions; seed beds with a range of seed (diversification) planted in succession for continual supply of seedlings, incl. okra, brinjal, green peppers, Amaranthus, mustard spinach, Chinese cabbage, kale, leeks, spring onions, broccoli, cauliflower, among others)

**Field cropping**

- Conservation agriculture; close spacing and inclusion of lime and bone meal with manure
- Diversified crops; maize, millet sorghum, sugar beans cowpeas
- Intercropping

**Associated practices**

- Greywater management and use; ash, tower gardens
- Greywater bucket filter
- Drip kits
- Small nurseries; propagation of fruit and indigenous crops and trees
- Tunnels
- RWH storage tanks (underground)
- Soil erosion control; check dams, stone packs...



Figure 17: Left: A group of participants from the Oaks and Lepelle construct a tunnel together. Right: A working tunnel in Sedawa, where the drip kits have also been installed and crops are planted in trench beds. Mulching is in evidence.

#### 4.1.6 Outcomes and learnings

An **implementation and learning review** was conducted in April 2017 for all learning groups to provide an opportunity for members from all 6 villages to visit a good working example of innovations and good practices in agroecology and soil and water conservation and review their practices. This also provided an opportunity to mentor the local facilitators and showcase the work to stakeholders such as AWARD and other NGOs, the local municipality, and representatives from government. The process and learnings from this review are presented below to illustrate the potential benefit of both CSA practices and the community based systemic approach.



Figure 18: Introduction of facilitators (left) and discussion of practices (right) at implementation review

The definition of the five fingers as broad principles in good practice for climate change adaptation was reviewed with the group. Participants named the five fingers (easily!!) and gave a few brief examples of what they meant. Good practices were elicited from the group and then assessed using the traffic light method for how well they are being implemented by the groups in each village. We arranged the scale as shown in the box alongside. The table below describes the outcomes of this exercise. Participants were fully engaged and really enjoyed this process.

**Scale used for assessment of practices and their implementation**

- **RED:** We know about this but have not done very much
- **YELLOW:** We have started implementing these practices, or a few individuals already use these, but there is room for expansion
- **GREEN:** These practices are implemented by most of the participants.

**Table 12: Summary of monitoring assessments for CSA and good practice implementation by learning group members**

Note 1: The percentages in the last column represent the number of participants who indicated they had implemented the practices. This is indicative only as there were community members present who had not yet been involved as well as a number of visitors.

Note 2: Practices highlighted in light grey are those for which participants felt they needed more input and mentoring.

Principles	Practices	Assessments (traffic light)	Percentage implementation in the group
Water Management	Cut off drains and swales	Red	Not yet implemented by most participants
	Diversion ditches	Yellow	~20% (10/52)
	Greywater (filtration, use)	Red	~8%
	Small dams	Red	~14%
	Organic matter (incorporation in soil)- leaves, bones, woodchips etc buried to increase water holding and fertility	Green	~60%
	Drip irrigation	Red	~6%
	Saving water; Rainwater harvesting in drums, management of leaks of communal stand pipes, no longer letting irrigation water run 24/7 - Lepelle	Green	All participants involved in some way in saving water
Control soil movement and erosion	Stone bunds	Yellow	~24%
	Banana basins and circles	Yellow	~22%
	Strip cropping (aloes, sisal) and planting grass to reduce run-off	Yellow	~8%
	Contours- water flow for collection	Red	Not yet implemented
	Ridges and furrows-planting of crops on ridges; sweet potato, sunflowers...	Yellow	~30%
	Sacks with sand for rehabilitation of gulleys	Red	~2%
Crop management	Planting in basins, mulching and direct watering of basins only	Green	~60%
	Close spacing in field crops and vegetables	Green	~20% - Not everyone agreed with this practice
	Planting to provide afternoon shade and planting windbreaks	Yellow	~22% - Not everyone agreed with this practice
	Crop rotation and intercropping	Green	~52%
	Natural pest control	Yellow	~18%
	Conservation Agriculture	Green	~36% - more ideas to be tried
Soil fertility	Trench beds	Green	~60%
	Mulch	Green	~60%
	Liquid manure	Yellow	~20%
	Compost	Green	~46%
	Application of manure (cattle, chickens)	Green	~70%
	Legumes; planting for food and soil fertility	Green	~68%
Looking after indigenous plants	Stop burning veld	Red	No one doing and not needed or all areas
	Don't chop whole trees- just cut branches	Green	Most participants
	Plant indigenous trees in the yards to protect and save them	Green	Most participants



Small group stations were set up for physical demonstration. The Local Facilitators ran the stations. The following stations were set up, each with a board of illustrative photographs:

**WATER MANAGEMENT:** Diversion ditches, waterflow line levels and making furrows and ridges on contour, planting on ridges and mulching were discussed.

**TRENCH BEDS:** The packing of trenches was discussed as was mixed cropping, mulching and a micro drip kit irrigation system. The use of herbs as pest repellent plants and for nutritional and medicinal purposes was also discussed and demonstrated.

**TUNNELS:** The Local Facilitators took participants through the construction process of the tunnel and discussed advantages and potential disadvantages of crop production in tunnels. The larger drip kit (210 L) was also demonstrated and discussed.

**CONSERVATION AGRICULTURE AND LIQUID MANURE:** the principles and practices of conservation agriculture including the use of hand planters for no-till situations, close spacing and the importance of soil cover and diverse crops. Liquid manure from animal and plant sources was explained.

A few other practices were also showcased during the review session including a selection of herbs and indigenous trees for planting, (such as lemongrass, num-num, marigolds, aloes and fennel. Well-tended banana circles (a local innovation) were also showcased.



**Figure 19: Demonstration stations at the implementation review workshops. Left: Tunnel and drip kit. Centre A well mulched trench bed with mixed cropping (okra, brinjal, onion and swiss chard) and close spacing. Right: A diversion ditch mulched with the ridge planted to sweet potatoes**

A selection of the feedback collected from participants on the workshop is provided below.

**General feedback on the day and process**

- This whole process has given people purpose. We are no longer just going to wander in the streets and gossip, but are going to be busy. We are going to see some health improvements in our communities.
- The way we taught ourselves was great - it opened our minds.
- I was a bit overwhelmed by gardening and the difficulties but from these examples shown today things look doable.
- I liked the idea of waterflows and harvesting water off the road for your fields. I never knew this was possible.
- I was afraid with this approach that I would be troubled by pests. I now realise I can use the resources I have to counter pests.
- This has built more relationships between farmers - we can talk about our issues together.

- (Newcomer) We learnt a lot and I was struck by the idea that one can improve the soil you have and do not have to rely on a bad soil.

**Practices: Water**

- I was bothered by my neighbour letting water run into my garden – now I realise I can use that water.
- I am impressed by the line level - that one can use simple methods like that to measure complicated things.
- What used to be a burden (gardening) now is going to become gold.
- I used to sweep up the leaf litter and throw it away. Now I will use it for mulch.

**Practices: Trench bed**

- Regarding the use of top soil versus sub soil in the trench bed I see now that the top soil is more fertile and so it is good to use in the bed. I initially thought you just put the soil back as it came out.
- Trench beds are also a way of cleaning the yard.
- Combining the trench bed with the drip kit seems like a very good recipe for saving water.
- Now, with permanent beds, we will not be walking all over our beds and causing compaction.

**Practices: Tunnel**

- The relationship between the tunnel, the trench beds and the drip irrigation is now clear. Doing all three things together works well and reduces evaporation.

**Practices: Conservation Agriculture**

- We learnt how to plant maize using the MBLI hand planter. It works really well and then you won't need to plough.
- I have seen the importance of intercropping for soil cover.

The figure below provides an initial assessment (5 months into a 13 month process) of respondents' implementation of the new innovations and practices being promoted. This is a work in progress, but gives an initial indication of new practices introduced that respondents have already implemented and also in which areas more mentoring would be required.

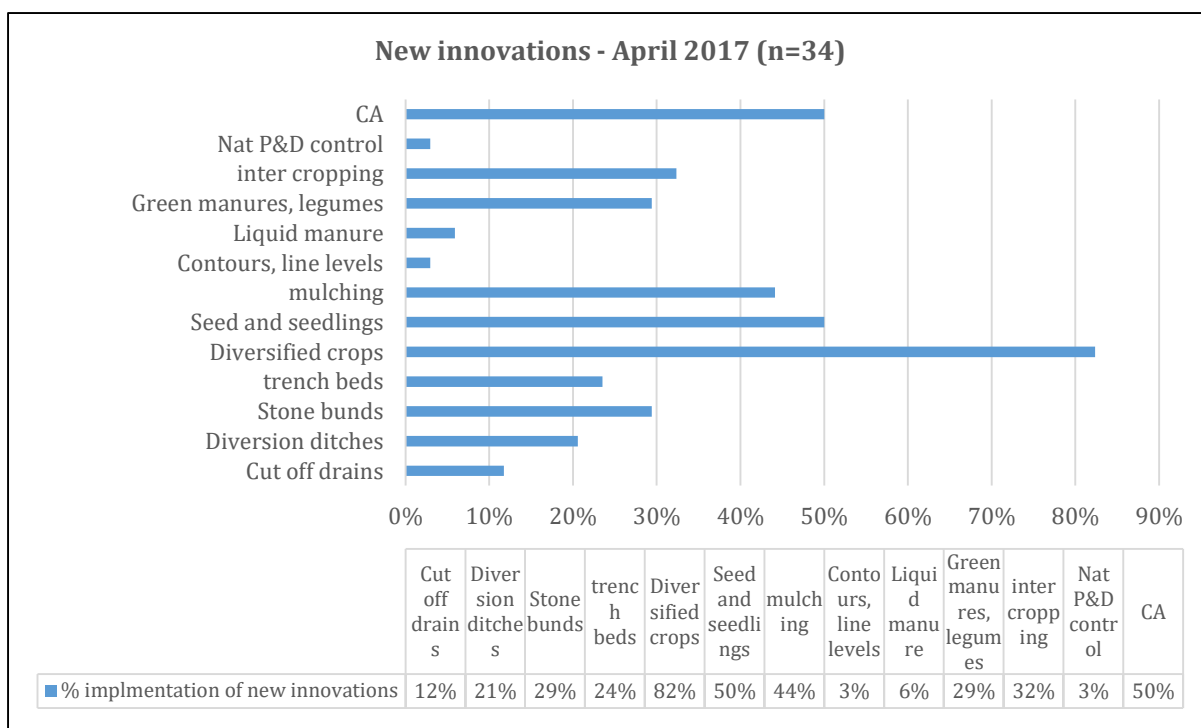


Figure 20: Implementation of new innovations by a selection of participants in the learning groups (n=34)

#### **4.1.7 Future planning**

Activities that were discussed for the winter season included:

- Learning sessions would continue in the various villages and specific attention would be given to topics participants had highlighted for more attention. A refresher mini-workshop would be held to include the new participants and bring everyone up to speed. Local facilitators would play an important role here.
- Local facilitators would begin to visit all participants to support and mentor them and also monitor their progress with implementation of the innovative practices.
- The winter season when people are at home is a good time to start on the collaborative erosion control efforts in and around the participants' homesteads.
- The implementation of a process for participants to access tunnels and drip kits was introduced. In both cases a limited number of kits can be provided by the implementation team. Participants are required to show their commitment by digging and packing the required trenches prior to receiving materials.
- For the piloting of underground RWH tanks it was suggested that participants who do not have access to municipal water in any form be prioritized. Also volunteers are required to do all the labour and demonstrate an active interest in gardening to be considered. These criteria were ratified by the group present as reasonable and acceptable.

#### **4.1.8 Suitability of this community as an implementation site for the CSA project**

The community level groundwork used in the AgriSi project serves as a good basis for working with a decision support system with the smallholders and their supporting originations and stakeholders: participants are already aware of many of the practices that can be included in a basket of options, they have experience with trying out a selection of these practices and some ideas about the potential benefit that each can offer and they are starting to appreciate the concept of synergies between practices to create a resilient farming system for themselves.

There is good basis for establishing a successful and meaningful community of practice in terms of organizational collaboration and synergies between programme outcomes.

Aspects of this process that could be useful in designing a decision support system include:

1. The villages are situated in a part of Limpopo that is feeling the effects of climate change; with increased heat and reduced precipitation already necessitating some adaptations. These can be recorded and analysed.
2. The traditional practices of the area are unique to these communities and the locality and will provide interesting options and some good practices examples to work with.
3. The impacts of different CSA practices and combinations of practices can be carefully compiled, as participants are already implementing some of the techniques and have shown a willingness and motivation to continue.
4. Participatory analysis learning and monitoring methodologies employed in this programme are innovative and unique and can be used to good effect in building an overall methodology.
5. Opportunities for scaling out and scaling up are available and important to consider in the decision support design process.

6. The impacts of certain technologies and innovations can be measured and criteria developed to be used in a decision support system.
7. Social organization and collective action and various methodologies and approaches to support these can be explored.
8. A good opportunity exists for meaningful stakeholder collaboration for building a CoP.
9. Synergies exist also with the Amanzi for Food networking process and options for embedding this learning into more formal learning processes at Agricultural training Institutes.

## 4.2 'Amanzi for Food'

*By Lawrence Sisitka*

This case study relates to Water Research Commission Project K5/2277: *Action oriented strategy for knowledge dissemination and training for skills development of water use in homestead food gardening and rain water harvesting for cropland food production*

### 4.2.1 Outline of the project

The Water Research Commission (WRC) contracted the Rhodes University Environmental Learning Research Centre (ELRC) to assist with the dissemination of information on rainwater harvesting and conservation (RWH&C) for food production, developed through a range of research projects funded over a number of years by the Commission.

The main focus of the Amanzi for Food project was to develop an action-oriented strategy for sharing the information on RWH&C contained in two (2) major WRC publications:

- 'Development of a comprehensive learning package for education on the application of water harvesting and conservation' (WRC Report No. TT 493/11 from Project No. K5/1776) [WHC materials]; and
- 'Participatory Development of Training Material for Agricultural Water Use in Homestead Farming Systems for Improved Livelihoods' (WRC Report No. TT 431/09 from Project No. K5/1575/4) [AWUHGS materials]

While the emphasis was on developing educational and social processes and appropriate platforms for sharing the information, the project inevitably became quite deeply involved in supporting others to understand and share practices involved in RWH&C particularly as these related to small-scale crop farming and homestead garden food production contexts.

The initial phase of the project extended for just over three (3) years; from March 2013 (although this was delayed due to contractual issues until June of that year), to end of July 2016.

The project had four (4) main aims:

- To review available knowledge products, with emphasis on agriculture water and food production learning materials developed with WRC funding, leading to the design of a possible training DVD and the design of related knowledge products.
- To pilot and design knowledge mediation processes through intensive engagement with selected Agricultural Colleges to inform a national strategy that will target a wider group of learning and training organisations.



- To pilot and design a mass media strategy leading to a listing of contents of a radio / low cost media content manual for the effective inclusion of available agriculture water knowledge into existing low cost media channels.
- To develop a national strategy for agricultural water knowledge dissemination for smallholder farmers and food-growers using the tools and processes developed in the project. This will enable a large scale roll out of the knowledge dissemination processes of targeting food-growers, particularly women, directly and learning organisations who are involved in the training of extension officers and rural-development workers in the field of food-security and smallholder agricultural production.

In the process of achieving these aims the project embarked on a wide-ranging series of activities:

- Conducting an in-depth review of the core WRC materials;
- Conducting more superficial reviews of other associated WRC materials;
- Conducting reviews of agricultural college curricula; in particular to identify any existing coverage of RWH&C, and identifying elements of the curricula which could lend themselves to the integration of RWH&C components;
- Engagement with selected agricultural colleges and university agricultural faculties to gauge their interest in the incorporation of RWH&C components into their curricula;
- Identification of potential audiences for the WRC materials, other than the agricultural colleges, and including: the agricultural extension services; farmers and homestead food producers; agricultural high schools and universities with agricultural faculties; Non-governmental Organisations (NGOs) and Community-based Organisations (CBOs) working with farmers; and agricultural research institutes;
- Development and facilitation of a Training of Trainers (ToT) Rhodes University certificated course to support educators, trainers and farmers to use the WRC materials in training processes for RWH&C practices in both formal and informal contexts;
- Supporting the establishment of a Learning Network involving a wide range of agricultural trainers and practitioners, working together to learn about and introduce RWH&C practices (most of the original members of this network took part in the first ToT course);
- Exploring and developing a range of media possibilities for the sharing of RWH&C information from the WRC materials. This included: local and provincial radio; community newspapers; developing a website - [www.amanziforfood.co.za](http://www.amanziforfood.co.za) - with associated Facebook page, and a WhatsApp group linking the Learning Network with the ELRC and others.
- Supporting the development of 'productive demonstration sites' where specific practices were implemented as an example for others to learn from
- Adapting and enhancing the original WRC materials to ease access to the critical information they contained. This involved the development of a 'Navigation Tool' to guide readers to specific practices described in the materials, and the production of short summaries of key practices in the form of info-cards. For a few practices, those implemented at one key productive demonstration site, posters and videos were developed.

#### **4.2.2 Practices**

The Amanzi for Food project drew strongly on theories of social learning and transformative change in the design of the ToT course and in working with the course participants and other members of the Learning Network. The course itself offered options to engage at either National Qualifications

Framework (NQF) level 5 (mostly farmers and extension officers) or level 6 (mostly lecturers and more senior extension personnel), or alternatively to simply participate in the course with no expectation of certification (mostly farmers). This enabled participants with very different educational and experiential backgrounds to work through the course and learn together and from each other. The Learning Network brought together a range of agricultural trainers and practitioners into a mutually supportive learning collaboration, which has continued to operate effectively even after the end of the initial project. This experience suggests that the establishment and support of such Learning Networks represents a real opportunity for sharing and collaboration in relation to all agricultural approaches and practices, including those concerned with Climate Smart Agriculture (CSA).

While the Amanzi for Food project was concerned primarily with the teaching and learning processes involved in the sharing of knowledge on RWH&C, there was inevitable engagement with the practices themselves, in particular the development of 'productive demonstration sites' as practical learning centres. Sites were established in farmers' own food gardens, in a collective vegetable garden, and in the agricultural college farm and grounds, providing a wide range of different circumstantial and practice-focussed demonstrations. Also while these practices were not specifically articulated as being CSA-oriented, there is little doubt that the principles of low-input practices, with careful and relatively sustainable use of rainwater for food production, and adaptation to climate variability are entirely compatible with CSA approaches.

The RWH&C practices, involving collection and storage of rainwater through the use of simple channels and ponds, and improving infiltration and retention of water in the ground through the use of mulching and traditional practices such as 'Gelesha'<sup>1</sup> are indeed central to many of the CSA approaches. This suggests that the information provided in the WRC materials which formed the focus for the Amanzi for Food activities can and should play a major role in developing understanding of these approaches. There is indeed a place for every one of the RWH&C practices as described in the various materials and shared on the Amanzi for Food website and elsewhere to provide a strong knowledge foundation for the CSA project.

### **4.2.3 Learnings, /outcomes/ results**

#### ***Key Learnings***

The Amanzi for Food project adopted an empirical approach in that, although informed by a strong and clear social learning and change orientation, it avoided being too pre-emptive in determining the precise path the project would take. This path would be determined by the needs and aspirations of the project partners, including the college lecturers, extension officers, and mostly the farmers themselves. This was a deliberate formative intervention approach to expansive learning that intended participatory learning related to farmers' and colleges' relational contexts to take

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<sup>1</sup> Gelesha is a traditional practice involving post-harvest 'ripping' or shallow cultivation of croplands in preparation for receiving and infiltration of the first rains, prior to planting. This is in contrast to the more conventional practice where the cultivation takes place following the first rains, when much of the water is lost through both run-off from hard-packed soil, and through evaporation as the soil is turned.

place rather than 'top down' intervention with pre-conceived solutions. While there was inevitably some risk involved in taking such an approach, it did provide some guarantee that the project would respond to and resonate with the requirements of the key beneficiaries. Indeed, the outcomes suggest that it was this responsiveness to the realities of farmers' contexts which enabled them to connect so strongly with the project.

Similarly the project avoided making assumptions regarding the ways in which farmers acquired information, rather undertaking research into learning processes with which the farmers were involved, and the media platforms with and through which they made most connections. While the outcomes of this research were generally fairly predictable, there was more use made of internet-based social media such as Facebook and WhatsApp than might have been predicted in rural areas, even among older farmers, and perhaps less use made of radio for sharing of information except for fairly passive listening. However, when the opportunity was made available for farmers and others to share their experiences with others through a series of radio programmes, they found this a stimulating and empowering exercise.

It became clear that a multimedia approach, linking live, interactive radio broadcasts to Facebook and website visits, combined, where possible, with personal visits, proved the most effective means of establishing positive and productive relationships between the farming community and others in the sector. Of all the means of communication available, however, nothing came close to face-to-face interaction for generating interest and stimulating collaboration, and it is unlikely that without such personal engagement that real supportive relationships can be built, although these can be maintained subsequently to a large degree through more 'distant' communication channels, such as WhatsApp. In using the latter it was found important to always remember to connect differently with those that are in danger of being excluded by electronic media because of the digital divide.

The establishment of the productive demonstration sites proved very central to the project in terms of in bringing people together to develop the sites and providing physical evidence of practices in use. Interest in the practices themselves was certainly stimulated considerably by such involvement and the evidence of their contribution to improving water availability.

The experience of the Amanzi for Food project does however suggest that while such practices are extremely valuable in relation to buffering the worst impacts of existing and climate change-related water-stress situations, they cannot, on their own, provide any permanent solutions to the ongoing issues of lack of adequate water for food production in all areas of the country. In other words, while making a real contribution, they cannot on their own provide any guarantee of food security, especially in highly water-stressed contexts. It is therefore essential that the potential benefits are not overstated, and that the expectations of project partners, including most importantly the farmers themselves, are not over-inflated.

### **Outcomes**

Some substantial outcomes emerged from the project, laying a strong foundation for future work in this field:

- Establishment of the Imvotho Bubomi Learning Network, in the Amathole District of the Eastern Cape, centred on the Fort Cox Agricultural and Forestry Training Institute (former College of

Agriculture and Forestry). The network is now self-sustaining with members providing each other with support in a variety of activities, including, most recently, coming together to repair a network member's plastic tunnel damaged by high winds. This action provided ATI students with the opportunity for field-based learning around a farm structure the college did not have but that a farmer possessed.

- The establishment of the Amanzi for Food website; making much information generated around RWH&C by the WRC readily accessible to many more farmers, providing a platform for sharing of other related materials and information.
- The development of the Training of Trainers course to support curriculum development and change in the formal agricultural education sector, and strengthen information sharing in the less formal extension sector and between farmers. The course also provided the opportunity for participants to work with and learn with and from each other, developing strong supportive relationships which previously had not existed.
- The establishment of a number of productive demonstration sites supporting food production in a variety of contexts, from the college, to individual farmers' lands, and a vegetable gardening collective. These demonstration sites have become catalytic in that marketing connections have emerged out of them as they were used to mediate further expansive learning; and new relations developed between experienced small-scale farmers and youths through working and learning together at these sites.
- Developing the use of local, community radio, as a medium for sharing information on a range of agricultural issues and challenges. At the same time supporting farmers and others to develop their skills for using this and other media for information sharing and self-reflection.
- A strengthened understanding of the processes of information sharing and learning within the small-scale farming sector, both between farmers and between them and their training and support network. This understanding has considerable implications for sharing information across the sector in relation to any and all agricultural practices, including those connected with CSA.

### **Results**

Almost certainly the main result of the project, in addition to the intended achieved outcomes, was the recognition by the WRC itself that the fairly complex processes of social learning and change followed by the project are almost essential for effective information sharing among and between small-scale farming communities and their support networks. This recognition has led to the WRC funding a second phase, including additional materials and information, and with a more national focus.

Linked to this is the clear recognition of learning in such situations as being both a social and an individual process, where a few individual farmers have developed their own understanding and skills to a large extent independently, while others developed these collectively. The individually motivated and capacitated farmers subsequently become leaders within their farming communities, willing to share their learnings and experiences with others. Understanding of the power of a combination of individual and collective learning should help inform how information is shared within the CSA project.

#### **4.2.4 Summary of potential issues to include; including the potential contribution to a decision support process**

As previously discussed, almost every aspect of the Amanzi for Food project, including the information sharing processes and the agricultural practices, are entirely compatible with CSA approaches. The CSA project can therefore draw on almost every aspect of the earlier project. In addition, the Navigation Tool (on [www.amanziforfood.co.za](http://www.amanziforfood.co.za)) provides a valuable model for helping farmers and others find specific information in complex sets of materials. The Tool was in itself developed as a decision support process, as it enables farmers to select practices which are appropriate for their farming situation, their type and scale of operations, their access to financial and technical resources and their levels of skills and understandings. It is intended to expand the reach of the Navigation Tool to cover the additional materials to be included in phase 2 of the Amanzi for Food project, and such an extension could be readily developed for the decision support process within the CSA project. In addition the co-engagement process itself within a learning network context was found essential as it brought different stakeholders in regular dialogue with each other enabling relational thinking. For example the agricultural colleges were able to learn more about and appreciate the small-scale crop farmer and homestead food producers' contexts of work by engaging with them closely, leading them to notice and seriously consider the climate-adaptation absences regarding water in their own curricula. This way collaboration decision making and empathetic decision support were possible.

The outcomes of the project show that on the ground farmers, agricultural colleges, extension officers and LED farmer development facilitators are keen and able to work together in more productive ways than are otherwise utilised according to mandates. This suggests that more support is required through decisions at provincial extension offices level that can help extension workers to integrate CSA in their daily work in supporting small-scale farmers.

#### **4.2.5 Analysis of a potential implementation site**

Although any of the productive demonstration sites developed under the Amanzi for Food project could be considered potential sites for CSA practices, the most secure, in terms of long-term management and maintenance, are almost certainly the site at Fort Cox Agricultural and Forestry Training Institute, and those on the lands of the individual farmers (such as in Matole Basin and Lloyd Village demonstration sites in Amathole District of the Eastern where rain-fed systems are seriously endangered by increasing drought conditions). The farmers' sites are working closely with Fort Cox ATI. It can be expected that the Agricultural Training Institute (college) and the farmers would welcome the opportunity to showcase CA practices.

In addition, as Phase 2 of Amanzi for Food takes off, with Training of Trainers courses and associated Learning Networks planned for Mpumalanga and North-West Provinces, there will certainly be further potential for synergies between the projects, and potential sites in these other provinces where interest has already been shown.

### 4.3 Rainwater harvesting and conservation (RWH&C) in Muden and Ntshiqo Case study (Implemented by Institute of Natural Resources)

By Zinhle Ntombela and Jon McCosh

This was a Water Research Commission (WRC) funded project implemented over a period of five years. The objectives of the project were to identify, test and evaluate rainwater harvesting and conservation systems (RWH&C) in communal areas at two sites. The research approach was a combination of participatory action research (PAR) and empirical physical sampling of yield, soil water content to input into crop water use models. The PAR methods used included farmer experimentation, stakeholder workshops, focused group discussions, farmer field days and learning exchange visits. The focused group discussions were used to evaluate how farmers view the technology, while farmers days were used to showcase results obtained from farmers experimentations.



Figure 21: PAR methods used during the rainwater harvesting study

Ntshiqo, in the Eastern Cape and Muden, KwaZulu Natal were selected as the research sites. At the Ntshiqo site, five individual farmers tested RWH&C in their homestead gardens. In Muden, RWH&C was tested with the Mxheleni Women's Group, a community garden arrangement. A participatory process was conducted whereby a variety of micro-catchment (in-field) RWH&C options were presented to farmers, who selected their preferred techniques for testing. In Ntshiqo in the Eastern Cape, the six farmers who participated in the study selected contour as their preferred RWH&C technique. Contour bunds were spaced at three metre intervals and maize crops were planted above and below the contours. Each farmer had an RWH&C treatment and a control, which was current practice (usually broadcasting seed and ploughing in).





Figure 22: Shows the RWH&C treatment on the left and a control on the right

The yield results suggest that RWH&C is one of the cropping systems that can be adopted to improve production in low yielding rainfed areas. The empirical research showed that in overall; the RWH&C treatments in Ntshiqo had higher water productivity and generally higher yields compared with the controls, suggesting that RWH&C is a viable option in dryland maize production areas. It was noted, however that while farmers acknowledged the benefits from higher yields, particularly in drier years, it was found that farmers were unlikely to adopt this practice. The main reasons for this were firstly the high labour and machinery requirements associated with land preparation costs. Preparing the contours had to be done on an annual basis, as contours were damaged by rainfall as well as livestock trampling in the winter months. Secondly, because of the wide spacing between the maize rows, manual weeding was an ongoing requirement. Farmers considered this to be an onerous task compared to their current practice of dense planting of maize and a single weeding when the plants were at knee height, after which the canopy prevent further weed growth.

#### **Massive Food Production Project (MFPP) in Ntshiqo**

*While conducting RWH&C experiments in Ntshiqo, the team recorded various government subsidised massification (MFPP) projects that had been implemented in cropping fields. Over a period of approximately ten years, MFPP projects under a variety of names were implemented.*

*During the time the research team was working in the area, 54ha of subsidised maize was planted in two successive years, using glyphosate tolerant varieties. In the third year, the subsidised production came to an end and only 2ha of maize was planted in these fields. When asked why there was such a substantial reduction in production; farmers indicated that they considered it too risky from a cost perspective, given the uncertainty regarding rainfall in the summer months.*

In Muden, stone contour bunds were the RWH&C technique selected. As with Ntshiqo, generally higher yields and water productivity was observed in the RWH&C treatment compared with the control. In addition, substantial amounts of soil, which would have been washed away, was found to be contained by the stone bunds (Figure 24).



Figure 23: Stone contour bunds in Muden



Figure 24: Sediment deposition behind stone contour bunds

The Mxheleni group acknowledged the benefits of RWH&C, but during a post-project visit, it was observed that planting was no longer taking place. This was attributed to a lack of resources (inputs) and problematic group dynamics.

While this research project demonstrated to farmers that there were alternative ways of storing water in the soil profile, with resultant yield benefits, the addition cost and labour burdens in Ntshiqo prevent wider uptake of the RWH&C technique selected, while in Muden, access to inputs and group dynamics limited ongoing use of the practice introduced.

### 4.3.1 Learnings, /outcomes/ results

- Rainwater harvesting and conservation was found to be labour intensive especially in areas where stone contours are not an option. Contours require to be rebuilt every planting season. This factor limited the upscaling of RWH&C from home garden to crop fields; farmers mentioned that they could manage to redo contours on their home garden but they would not upscale to their fields due to amount of work required by this technology. Although yield improvements were observed with RWH&C; labour requirements outweighed the benefits.
- Contours were associated with a lot of weed infestation due to wide spaces between them. Recommendations made were to plant on the runoff collecting area to provide good cover and eliminate the need for multiple weeding, while still maintaining soil and water conservation in the homestead gardens.
- In Ntshiqo a decline in the use of arable fields was noted, when farmers no longer received subsidies for production in fields, there was a significant decline in production in the fields.



### **4.3.2 Summary of potential issues to include; including the potential contribution to a decision support process**

Farmer experimentation is a great way of demonstrating new farming technologies, however, farmers can be careless in terms of handling the experiment. For the individual farmer experiments at Ntshiqo, there was a lack of weeding on the experimental plots. The project team had to improvise a plan and employed people to do the weeding. Muden was no different; some women in the Mxheleni woman's group were not fully committed and did not participate on weeding. Those who did would eventually lose interest since this was a communal garden. This has a negative impact on plant growth due to competition. Lesson learnt from this experience was that there needs to be a backup plan when conducting farmer experimentation; risks of not obtaining results are very high with this methodology.

### **4.4 No-till and agroforestry practices at Ixopo, Highflats case study (implemented by Institute of Natural Resources)**

*By Zinhle Ntombela and Jon McCosh*

The Institute of Natural Resources is implementing an Agroforestry project funded by the Water Research Commission (WRC) over a period of five years. The project includes both controlled scientific research experiments and PAR with farmer experimenters and farmers days to share findings and learnings. The Agroforestry concept was introduced by the project team to the Ubuhlebezwe livestock association in Highflats, KwaZulu-Natal where a number of farmers chose to test agroforestry at a small scale at their homesteads. These farmers include the Chief Dlamini of Amazizi K, Mam Joyce Dlamini, Mr TV Dlamini, Mr Mtshali and Mr MKhize. This case study focusses on one farmer, Mrs Joyce Dlamini (Mam Joyce).

Mam Joyce is part of the Ubuhlebezwe livestock association. She is a subsistence farmer; farming both livestock and crops for home consumption. In winter she grows vegetables such as spinach, cabbage, carrots, and in summer she plants field crops including maize, potatoes, beans and pumpkins for her family. When the team further engaged with Mam Joyce, it was learned that she practices no-till farming on her bigger fields of maize. She is a proactive farmer and heard about the no-till farming and its benefits from a farmers' meeting she attended. She considers no-till to be better because of the lower labour requirements. Before planting field crops she hires a tooth harrow to open rows and plant by hand, which is much cheaper compared to ploughing. For weed control, she uses glyphosate before planting and manual weeding once the crop is established. She retains her own open pollinated varieties (OPVs) as a seed bank. Where certain parts of the field are not inherently fertile and she uses chemical fertilisers to improve soil fertility. Her interest in agroforestry lies in the fact that it could improve soil health and fertility in her no till cropping area using legume species, while also providing livestock feed.

Mam Joyce is participating in a farmer experimentation investigating the impact agroforestry in soil fertility. The experimentation has two components i.e. intercropping with agroforestry species (pigeon pea and *Sesbania sesban*) and biomass transfer. Mam Joyce reports that she has recognised that *Sesbania* trees drop their leaves and create a very rich, fertile environment in the soil. For biomass transfer, tree branches are cut and laid on adjacent plots to decompose and improve the soil fertility. This exercise has been performed twice at Mam Joyce's experiment at different tree

growth stages. She is enthusiastic about the process thus far, and wants to plant more trees in the future and use them for fodder. She hopes to save money on fertilizer and fodder with agroforestry species, and plans to sell any excess fodder.

This site can be considered as a potential implementation site because Mam Joyce is already taking part in two CSA practices (Conservation Agriculture and Agroforestry). She is an enthusiastic farmer and she is always eager to learn new things.

#### **4.4.1 Learnings/outcomes/results**

- With respect to agroforestry, there have not been results yet; biomass transfer benefits are expected to be observed in 2017 planting season.
- Mam Joyce observed improved yields after adopting conservation agriculture. Her theory with these improved yields is that due to the fact that nutrients are found in the top soil profile. Conventional tillage turn the top soil upside down, while with CA there is limited soil disturbance and nutrients are readily available to the plant.
- Mam Joyce states that she recognised that conservation agriculture saves money in the context of land preparation costs. Conventional ploughing costs R750/ha; she used to pay R1500 for her 2 ha. With CA she buys Glyphosate chemical ( $\pm$ R200 per L) while the cost of opening rows with a tooth harrow is R250/ha.
- Spreading kraal manure into the fields in winter is a method that Mam Joyce uses to save fertiliser costs; when the first rains come, the nutrients infiltrates the soil and when she is planting, she does not have to apply a lot of fertiliser.
- In terms of climate change Mam Joyce indicated that they are recognising the impacts of climate change; however she has not figured out new techniques of dealing with it. She indicated that in 2014 the drought beat them, they tried to change planting dates in 2015 plant season, but this also did not work.
- She made an example of planting potatoes; at Ixopo they normally plant their potatoes in August and they would be ready by December, and this is all rainfed. However, in the recent years the rainfalls are late and temperatures are too high; the potatoes would lose their leaves very early before bearing underneath the soil. People residing next to the rivers have started investing on irrigating but that is because they have water access; whereas this is a challenge for Mam Joyce since her fields are far from the river.

#### **4.4.2 Summary of potential issues to include; including the potential contribution to a decision support process**

- The decision support tool should consider the costs of implementing the technology being presented. Rural farmers are poor and do not adapt to technologies requiring them to pop extra money than their traditional methods.

#### **4.4.3 Analysis of a potential implementation site**

Ixopo is located approximately 85km south east of Pietermaritzburg and is strategically located at the intersection of four major provincial routes leading to Pietermaritzburg, the Drakensberg, the Eastern Cape and the South Coast. The area is under the leadership of Amazizi K and B, Emawusheni

and Majikane Traditional Authorities. Ixopo is an area composed of a community of people who are very keen on farming and learning new things.

Mam Joyce is an active member of the Ubuhlebezwe Livestock Association engaging in mixed farming i.e. livestock, vegetable and field crop production such as maize and potatoes with land size of approximately 2 ha. She relies heavily on rainfed agriculture which has been quite challenging for her with recent weather variability. Mam Joyce is quite observant and proactive, she is always open to learn from other people and also share what she has learned with other farmers. This site has great potential in terms of CSA implementation; it is easily accessible and characterised by keen farmers, who are already engaging in some forms of climate smart agriculture.

#### 4.5 Conservation Agriculture in Bergville: A Case Study

*By Mazwi Dlamini*

Bergville; in the upper Drakensburg; is a strong maize growing area both commercially and in the smallholder context. Maize is an important staple with a large amount of arable fields under dry land maize production. The Grain SA Smallholder Farmer Innovation Program (SFIP) has been going for five seasons now, started back in the year 2013 with the aim of sustaining maize production in the area. Conventional methods of production have seen a decline in yields resultant of the exploitative nature of production.

The overall goal of the CA SFIP implemented through support from GrainSA and the Maize Trust, is promote the use of CA (conservation agriculture) to increase farming production and profitability, to improve the natural resource status and quality allowing sustained crop production / intensification and to promote systems for providing appropriate infrastructure.

Specific objectives of this research includes:

- Promoting the implementation of CA in the smallholder field cropping systems
- Increasing the sustainability and efficiency of CA in the study areas
- Scaling out of sustainable farming system scenarios that include livelihood and environmental criteria of assessment.
- And building local innovation platforms

Farmer level experimentation is central to the process as is learning together in the village level groups. These learning groups focus on a value chain approach that includes joint action in analysis and planning of activities, local level savings groups, bulk buying, labour and equipment sharing, local marketing and milling and integration of livestock (poultry and cattle) through fodder production.

Volunteer farmers have been participating in the CA approach through a Grain SA funded initiative. The work involves trying out CA in each of the participant's plots alongside control for direct comparison. In the first year trials are designed and participants see them through, this is to allow participating farmers to get used to CA as an approach. During the second year, farmers have additions to the list of seeds, different type legumes including summer cover crops, early versus late plantings and the use of specific fertilizer regimes as per the soil sample results. By the third year farmers are designing their own experiments within the focus areas of early planting, intercropping versus crop rotation among others. Below is a protocol from the 1<sup>st</sup>, 2<sup>nd</sup> and 3<sup>rd</sup> years.

#### 4.5.1 Design of farmer level experiments

##### Year 1(1<sup>st</sup> level) trial outlines

Experimental design is pre-defined by the research team (based on previous implementation in the area in an action research process with smallholders). It includes a number of different aspects:

Intercropping of maize, beans and cowpeas

Introduction of OPV and hybrid varieties for comparison (1 variety of maize and beans respectively)

Close spacing (based on Argentinean model)

Mixture of basin and row planting models

Use of no till planters (hand held and animal drawn)

Use of micro-dosing of fertilizers based on a generic recommendation from local soil samples

Herbicides sprayed before and/or at planting

Decis Forte used at planting and top dressing stage for cutworm and stalk borer

Planting of cover crops; winter mix in Autumn

Experimental design includes 2 treatments; planter type (2) and intercrop (2)

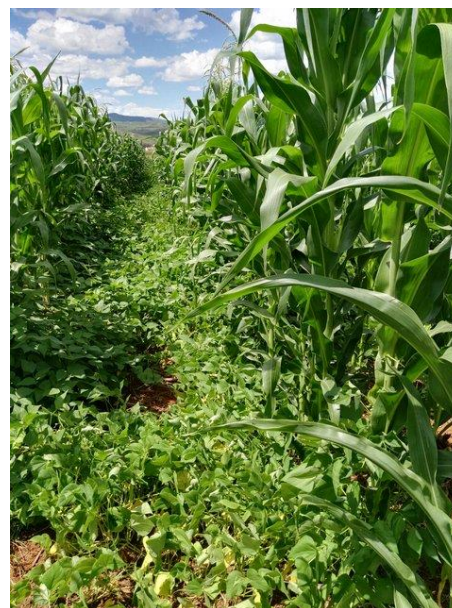


Figure 25: An example of a variation on the basic maize and legume intercropping design on Mrs Smephi Hltashwayo's plot in Egeleni. She has planted a local variety of runner beans in between tramlines of maize (2016)

##### Year 2 (2<sup>nd</sup> level) trial outlines

Based on evaluation of experiment progress for year 1, this includes the addition of options that farmers choose from. Farmers also take on spraying and plot layout themselves:

A number of different OPV and hybrid varieties for maize

A number of different options for legumes (including summer cover crops)

Planting method of choice

Comparison of single crop and inter cropping planting methods

Use of specific soil sample results for fertilizer recommendations

Early planting and

Own choices.



Figure 26: An example of a summer cover crop (sunflower, millet and sun hemp) experimental plot planted by Phumelele Hlongwane in Ezibomvini.

##### Year 3-7 (3<sup>rd</sup> level) trial outlines

Based on evaluation of the experimentation process to date this protocol includes issues of cost benefit analysis, bulk buying for input supply, joint actions around storage, processing and marketing. Farmers design their experiments for themselves to include some of the following potential focus areas:

Early planting; with options to deal with more weeds and increased stalk borer pressure.

Herbicide mix to be used pre and at planting (Round up, Dual Gold ,Gramoxone)

A pest control programme to include dealing with CMR beetles

Intercropping vs crop rotation options

Spacing in single block plantings

Use of composted manure for mulching and soil improvement in combination with fertilizer, or singly.

Soil sample results and specific fertilizer recommendations

Planting of dolichos and other climbing beans

Summer and winter cover crops; crop mixes, planting dates, management systems, planting methods (furrows vs scatter)

Seed varieties; conscious decisions around OPVs, hybrids and GM seeds

Cost benefit analysis of chosen options and

Farmer level monitoring of trials for selected individuals.

#### 4.5.2 Expansion or out scaling of the farmer innovation process

The adaptive trials are also used as a focus point for the broader community to engage through local learning events and farmers' days. Stakeholders and the broader economic, agricultural and environmental communities are drawn into these processes and events. Through these events, Innovation Platforms (IPs) are developed for cooperation, synergy between programmes and development of appropriate and farmer-led processes for economic inclusion. These IPs also provide a good opportunity to focus scientific and academic research on the 'needs' of the process.

As learning groups mature they engage in a number of additional processes within the value chain that build social capital and cohesion. VSLAs (Village savings and loan associations) are set up to provide a mechanism for payment for inputs and for setting up bulk buying groups for production inputs. Farmer centres are set up and managed locally (at village and nodal level) to provide for local access to inputs through negotiated agreements with local suppliers and agribusiness, management of shared tools and advice and mentoring in CA. Learning group members also negotiate joint decisions around their crop production planning and marketing and engage with stakeholders and support organisations. To support this process a social compact agreement has been designed to outline roles and responsibilities of the various role players in these forums.

**Table 13: Summary of farmer involvement in farmer level experimentation in Bergville, KZN; 2013-2017**

BERGVILLE Villages	Year started with CA				Total	COMMENTS
	2013	2014	2015	2016		
Emabunzini				10 (8)	10 (8)	Intercropping with hand hoes and MBLI planters; Maize, beans, cowpeas
Emangweni-Engodini			12 (14)	7(2)	19 (16)	1 <sup>st</sup> and 2 <sup>nd</sup> level experimentation; intercropping
Emangweni-Emaqeleni				(5)	(5)	1 <sup>st</sup> level experimentation; intercropping
Eqeleni	9 (5)	13(3)	7(4)	(1)	29 (13)	1 <sup>st</sup> , 2 <sup>nd</sup> and 3 <sup>rd</sup> level experimentation; MBLI's hand hoes and animal drawn planters; intercropping crop rotation summer and winter cover crops, late season beans
Ezimbovini		1 (6)	8 (4)	(10)	19 (20)	1 <sup>st</sup> , 2 <sup>nd</sup> and 3 <sup>rd</sup> level experimentation; MBLI's hand hoes and animal drawn planters; intercropping crop rotation summer

						and winter cover crops, late season beans
Magangangozi		10(7)	1		11(7)	1 <sup>st</sup> and 2 <sup>nd</sup> level experimentation; intercropping
Mhlwazini			17(5)	12(13)	29(18)	1 <sup>st</sup> , 2 <sup>nd</sup> and 3 <sup>rd</sup> level experimentation; MBLI's hand hoes, intercropping crop rotation summer and winter cover crops, late season beans
Ngoba			6(6)	4(5)	10(11)	1 <sup>st</sup> , 2 <sup>nd</sup> and 3 <sup>rd</sup> level experimentation; MBLI's hand hoes and animal drawn planters; intercropping crop rotation summer and winter cover crops, late season beans
Nsuka-Zwelisha				11(12)	11(12)	Intercropping with hand hoes and MBLI planters; Maize, beans, cowpeas
Okhombe		11	6(3)		17(3)	1 <sup>st</sup> and 2 <sup>nd</sup> level experimentation; intercropping
Potshini					1(1)	3 <sup>rd</sup> level experimentation
Stulwane	7(7)	14(4)	3(2)	(2)	24(15)	1 <sup>st</sup> , 2 <sup>nd</sup> and 3 <sup>rd</sup> level experimentation; MBLI's hand hoes and animal drawn planters; intercropping crop rotation summer and winter cover crops, late season beans
Thamela				11(12)	11(12)	Intercropping with hand hoes and MBLI planters; Maize, beans, cowpeas
Thunzini				20(24)	20(24)	Intercropping with hand hoes and MBLI planters; Maize, beans, cowpeas
Vimbukhalo		(7)	7(5)	12(12)	19(23)	1 <sup>st</sup> and 2 <sup>nd</sup> level experimentation; intercropping
Ndunwana			14(15)	9(0)	23(15)	1 <sup>st</sup> and 2 <sup>nd</sup> level experimentation; intercropping
Emazimbeni				10(10)	10(10)	Intercropping with hand hoes and MBLI planters; Maize, beans, cowpeas
Grand Total	19(12)	59(27)	81(55)	106(115)	263(212)	~13-14 ha

Note 1: The numbers in brackets are the number of farmers who have managed to complete their trials and realise harvests

Note 2: Villages indicated in grey boxes, are new villages brought on board in this season; 2016-2107

Horizontal expansion from village nodes to surrounding farmers and villages in the area, working with organised farmer groups in collaboration with stakeholders in the region, has shown great promise for expansion of interest in and longer-term sustainability of the implementation of CA practices among smallholders. Successes in the last four years include the following:

- Implementation has expanded from 2 to 17 villages in the Bergville area,
- Direct farmer participants in the CA experimentation process has expanded from 24 to 263 participants,

- 12 Farmer participants have now implemented CA for 4 successive years 27 for 3 successive year and 55 for 2 successive years,
- 115 farmer participants have started CA in the last season,
- Implements have been supplied for sharing within learning groups; 57 hand hoes, 55 MBLI hand planters, 8 Matraca jab planters, 2 spear planters, 1 Haraka wheel planter, 8 oxen drawn planters and 38 knapsack sprayers,
- Average maize yields have improved for farmer participants (from 1,24 tons/ha to 2,8 tons/ha (2016 season results), with yields of more than 11 tons/ha achieved by some. Average sugar bean yields have improved by about 25%,
- 3 Bulk buying groups have been set up for purchasing of inputs (Eqeleni, Stulwane and Ezibomvini),
- 8 Villages savings and loans associations have been established for production input support,
- Relationships have been strengthened with input suppliers, seed suppliers and equipment providers to improve access and local transport arrangements and
- Support has been garnered from a number of stakeholders including KZN DARD, the FAO, The Siyazisiza Trust and ETC-Netherlands.
- Awareness raising and exposure events have been held; over 1 000 smallholder farmers and many role players including UKZN, CEDARA, the ARC, KwaNalu, NGOs such as Farmer Support group, Lima RDF, Zimele, Siyazisiza, SaveAct, Farming for the future, Growing Nations, as well as agribusiness role players such as Afritrac, Inntac Trading, Eden Equip, Pannar, Capstone Seeds, Cover Crop Solutions and Soil Health Systems have been involved,
- Publications have been produced for SA Grain (newsletter) and a book chapter has been written for CABI - Conservation Agriculture for Africa: Building Resilient Farming Systems in a Changing Climate.
- Presentations have also been made at the Stellenbosch sustainable soil management symposium, KZN no till conference and the DARD LandCare conference.

### **4.5.3 Farmer centres**

The growing numbers of farmers warrant for inputs to be supplied locally by learning groups through farmer centres. These farmer centres are aimed at promoting local value chains and allows for farmers to afford inputs better at reduced quantities and prices. There has been great frustration with inputs and their transport where they are brought from Bergville and Winterton.

Farmer centres mainly supply inputs such as seed and fertilizer and the idea is to sell these off in smaller weights i.e. from 1kg going up to a whole bag. Dealing with herbicides becomes trickier and requires that local facilitators provide necessary assistance in using inputs bought effectively; which is a service rendered as a bonus by the farmer centre. Security of cash and inputs is still a threat, even more so as the farmer centre is run by women. Due to relations in the area, the farmer centre at times sells inputs on credit which is a problem when they have to restock and again transport is an issue in the absence of the organization. Having inputs locally available helps both program

participants; sourcing inputs for their control plots; as well general community members not affording bags of inputs.

Extension staff has been doing a lot in getting suppliers to deliver in the villages but order amounts do not warrant for such. Extension staff has been working with and promoting other farmer centers where they will order together to build up order quantities and eligibility for local deliveries. Farmer centers have become victims to seasonality and owners have made use of stakeholder relations to overcome this. Groups of farmers also work with other institutions inclusive of the local Department of Agriculture where the department has been working with the farmers' centers to provide off season services such as sweet potato vines, seedlings and potato seed. All this is coupled with promoting Village Saving and Loan Associations (VSLA) which are local institutions for financing agricultural activities and promoting bulk buying of inputs, to date a total of 8 VSLA's have been established in Ezibomvini, Eqeleni, Ndunwane and Emabunzini.

#### **4.5.4 Research in the farmer innovation process**

Along with the development of visual indicators for CA to be used in the learning groups and by local facilitators and support staff (as mentioned in section 3.3 above been measured over time.

These include:

- Yields
- Soil fertility status; including specific experiments for the impact of liming on crop growth and yields
- Soil health status; across different experiments such as intercropping, crop rotation and inclusion of cover crops (both summer and winter cc mixes) and
- Rainfall; linked to runoff and infiltration (for control and trial plots, suing run off plots and single ring infiltrometers).

The table below provides an example of soil health test results for the farmer level experiments conducted by Phumelele Hlongwane in Ezibomvini, as an example



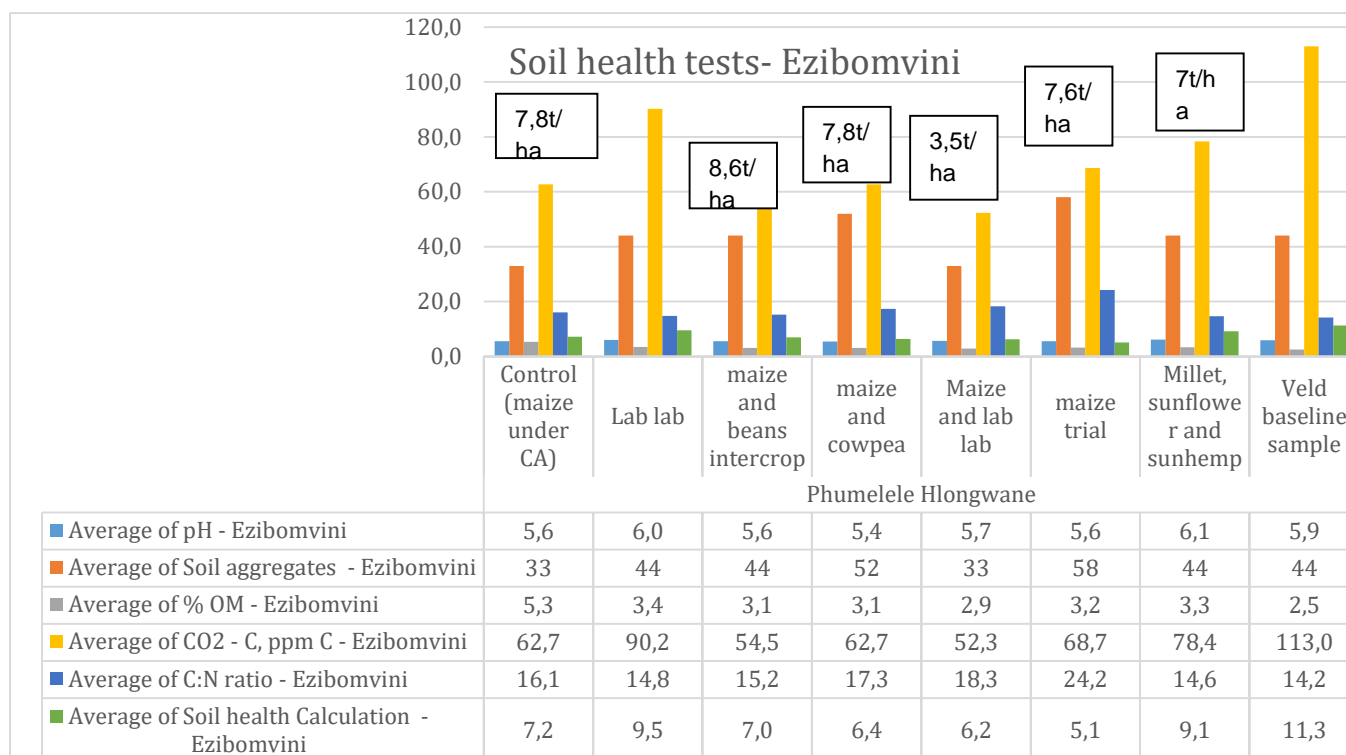
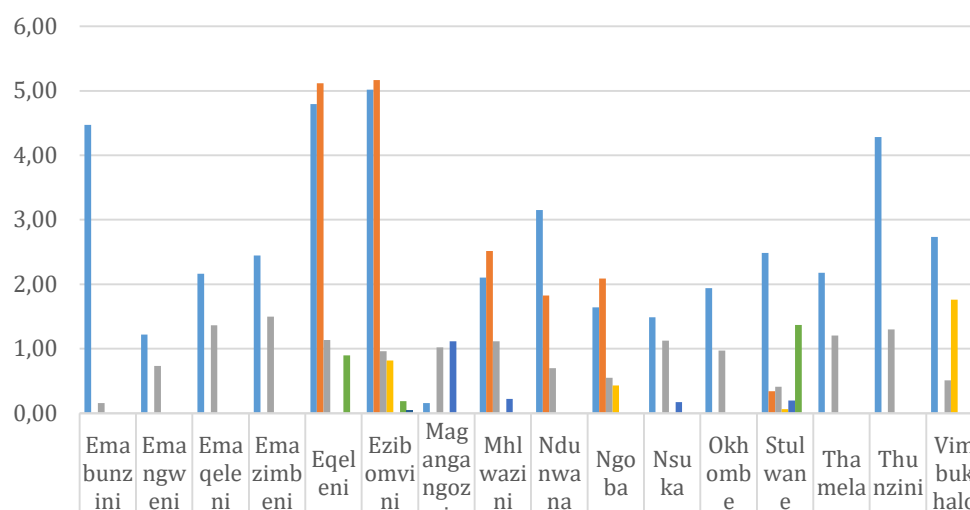


Figure 27: Phumelele Hlongwane's soil health test results for different cropping practices within the CA system for the 2015-2016 cropping season. Yields of maize are indicated in the square text boxes for each practice.

The figure and small table below summarise the average yields across all the villages in Bergville for this present season. 2016-2017

Yield averages across all villages in Bgvl 2016-2017



	Ema bunzini	Ema ngweni	Ema qeleni	Ema zimbini	Eqel eni	Ezib omvini	Mag angangozi	Mhl wazini	Ndu nwana	Ngo ba	Nsu ka	Okh ombene	Stul wane	Tha mela	Thu nzini	Vim bukhalo
■ Average of Maize-trial (2016)	4,47	1,22	2,16	2,45	4,80	5,02	0,16	2,11	3,15	1,64	1,49	1,94	2,49	2,18	4,28	2,73
■ Average of Maize-Control (2016)					5,12	5,17		2,52	1,83	2,09			0,34			
■ Average of Beans (2016)	0,16	0,74	1,37	1,50	1,13	0,96	1,02	1,12	0,70	0,55	1,13	0,97	0,41	1,21	1,30	0,51
■ Average of Late Beans (2016)						0,82				0,43			0,07			1,76
■ Average of Cowpeas (2016)							1,12	0,23			0,17		0,20			
■ Average of Sunflower (2016)					0,90	0,19							1,37			
■ Average of Millet (2016)						0,05										

Table 14: Yield averages in Bergville, 2016-2107 for the CA control and trial plots

YIELDS 2016-2017	Maize - Trial n=141	Maize Control n=29	Beans Trial n=137	Beans late n=13	Cowpeas n=14	Sunflower n=10	Millet n=1	Sunn hemp n=1
Average	2,80	2,82	0,91	0,76	0,52	0,97	0,05	0,20
max	11,74	9,69	2,44	2,10	2,80	2,95	0,05	0,20
min	0,28	0,34	0,02	0,07	0,05	0,05		

#### 4.5.5 Potential of the CA programme as an implementation site for this research process

This is a well developed farmer innovation programme, with research support that contains a number of elements of interest for the present process. These include:

- Farmer innovation platforms, stakeholder forums, learning groups and village savings and loan associations as working examples of CoPs
- Broad based and ongoing farmer level experimentation in various aspects of implementation of a CA system
- The development of indicators, scales and benchmarks for assessment of impact of implementation of CA and the beginnings of a design of an incentive system based on PES (payment for ecosystem services)

- An implementation process based on the whole value chain for improvement of food and livelihoods security
- And inclusion of quantitative data collection for a selection of participants.

There is potential also to include other elements of CSA practices into these processes; such as soil and water conservation, intensive vegetable production techniques and livestock management – given the existing and extensive organisational base in the community.

## 5 METHODOLOGY OF THIS PROJECT

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By Erna Kruger

### 5.1 Stakeholder engagement and site selection; social considerations

The planned Communities of Practice are likely to be set up and worked within at a number of levels.

- **A Stakeholder CoP:** Involving implementers, government officials and researchers is to be set up for each site. The main focus for this CoP will be working with the CSA-DSS to design and implement learning and implementation activities at community level. This would involve sharing workshops on methodologies and practices, sessions for introduction, review and refining the CSA-DSS tools and processes, discussions around implementation options and possibilities, joint implementation and review sessions. It would also involve discussions around feeding these processes into existing programmes and the link back to strategies to implement policy briefs.
- **A facilitation team CoP:** Working with field staff, students and facilitators at each site, to learn about CSA practices and the complexities and nuances of facilitation of processes working with a decision support framework/system.
- **Community level CoPs for each site:** Taking the form of learning groups exploring climate change, adaptation and sustainable land use management through a PID process, as well as Savings group where applicable ...

Bridging between the CoPs and flow of information between farmers, facilitators and stakeholders will be crucial to the success of the process.

It is envisaged that the process at each site will be managed as a partnership between Mahlathini Development Foundation and another implementing organisation such as Lima Rural Development Foundation and the Institute of Natural Resources (KZN – Bergville, Ixopo), Association for Water and Rural Development (Limpopo), Environmental and Rural Solutions (EC-Matatiele) and Fort Cox Agricultural Training Institute (EC- Alice). Through these associations the sites and actual villages for implementation are to be negotiated. Broadly speaking participants are to be drawn from existing implementation processes run by these organisations.

Other implementers in the areas are to be drawn in through local networks and existing stakeholder platforms- to set up the CoPs. And the stakeholder Cops will draw from their organisations and networks to set up the facilitation team CoPs. In this way staff from a number of different organisations (including government departments) can become involved in the learning processes and be provided with assistance and mentoring in implementation of the CSA-DSS at community level.

#### 5.1.1 Site selection and community level engagement

As mentioned, site selection is to be finalised in partnership with stakeholders involved in the CoP and entry into the community is to be facilitated through existing relationships between organisations and communities. Care needs to be taken to ensure that community members are somehow representative of most to all interests in the community are engaged. This may require

some conversations and introductions with different community level stakeholders, groups and individuals. Care will be taken also not to politicise the process and to ensure that community members are brought on board through interest and their engagement in agricultural activities in the area.

### **Livelihoods, vulnerability and capability assessments**

This is to be the entry point into the community level processes. These assessments would entail a combination of focus groups discussions (minimum 25 people) and individual interviews. Presently the combination of the AWARD and RECOFTC processes developed through USAID (AWARD, 2017) (RECOFTC , 2016) appear to hold the most promise as they include systemic socio-ecological approaches, livelihoods framework components, risk, vulnerability and capability assessments and a way to link impacts and possible adaptive measures into a clear methodological framework.

The process designed by AWARD, called DICLAD – Dialogues in Climate Change and Adaptation provides as very useful entry point for discussions on climate change and adaptive practices for all the CoPs envisaged. The aim is to create informed awareness and agency within groups to tackle the issues by themselves, rather than to await directives from experts or government. These ‘field-based’ experiences need to inform the wider discourses at both provincial and national level. The current discourse lacks any systemic, strategic framing and is deeply fragmented in nature, thus treating adaptation responses on a sectoral basis with little recognition of the linkages between different sectors and elements in a social-ecological system.

The empirical data for these conversations is based on localised data for the relevant municipalities provided by the Climate Systems Analysis Group, based at the University of Cape Town.

The outline of the present DICLAD process is provided in the schematic diagram below. The modules are one day interactive workshops that include:

- Presentations and pictorial reviews of present issues in the area (such as lack of water, erosion, crop failure, etc) to provide contextual information and explore climate change concepts.
- Groupwork using participatory methodologies such as seasonality diagrams for exploring rising temperatures and rainfall variability,
- Role plays and games for exploring concepts such as projections and probability for example.
- Systems analysis using systems diagramming tools, for exploration by small groups of the potential impacts of climate change for a focus sector (e.g agriculture, water) and then using this map to further collectively explore of where vulnerabilities, threats and resilience lie in this system and to compile potential ‘composite’ action plans for the focus sector.

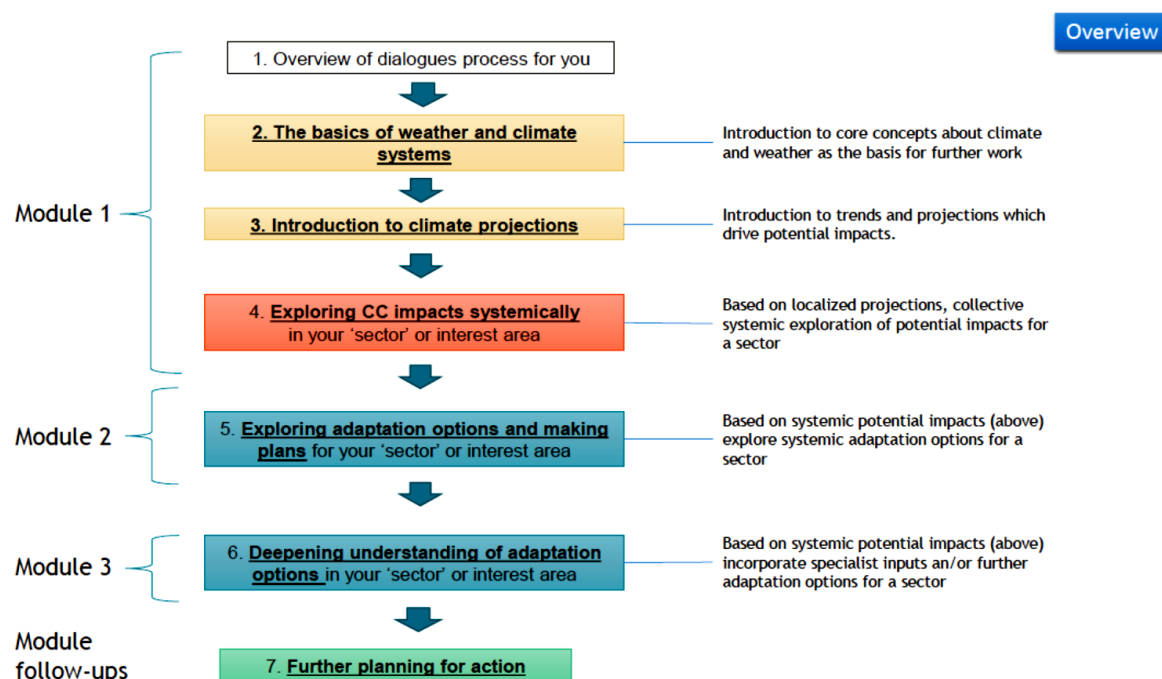


Figure 28: Schematic diagram for DICALAD modules, (AWARD, 2017)

The work done by REFCOTC in Nepal, deepens these exploration and provides a framework within which climate change impacts and adaptation options can be further explored. The four matrices mentioned in section 2.7, are copied here.

1. Matrix 1 - Identifying climatic threats and impacts.
2. Matrix 2 - Assessing Threats and impacts through a livelihood asset lens.
3. Matrix 3 – Identifying vulnerabilities and
4. Matrix 4 - Identifying response options to vulnerabilities.

## 5.2 CSA framework and processes

Once the broad response options have been outlined for a community grouping, then an exploration can start around assessing these options for implementation. Criteria for assessment of options need to be collaboratively defined and used to assess viability and impact of the prioritised options. Local innovations and other CSA practices are linked to the prioritised options and again assessed for viability and impact. Here the design of the decision support framework will be central to facilitate these processes.

Indicators are to be directly linked to vulnerability and resilience. Attention will be given to three types of indicators; biophysical, social and economic. They would need to be attributable to the particular interventions and or based on impact or effect and based on qualitative benchmarks. As such indicators need to be of a nature that can be assessed collectively and by smallholders themselves This can be achieved through a coherent farmer level experimentation process.

### Recommendation for a CSA DSS

A reasonable approach would be for this research process to develop a DSS in which the full range of options for CSA practices is made readily available and accessible to farmers, with all necessary details provided. The farmers can then provide their own input in terms of their understanding of their needs, aspirations, resources and contexts through which to analyse the suitability of the practices for their situation. Regional climate vulnerability information can be provided through use of the SARVA portal, and local livelihood vulnerability assessments by use of an adapted CGIAR/CCAFS vulnerability toolkit. This DSS could be both internet-based, using a site similar to the Amanzi for Food website to access information, or the CSA information could be packaged into a printed document, in whatever languages are necessary, for the farmers to use directly in making their decisions. In addition, the external qualitative information in regard to the practices, if not provided by the materials, will need to be provided by the project, and eventually a supplementary information source dealing with the variables, and questions to be asked should be developed

### 5.3 Reflective processes

Communities of practice can be viewed as social learning systems where they exhibit characteristics such as an emerging structure, complex relationships, self-organisation and ongoing negotiation. Social learning may be described as the process of iterative reflection that takes place when people share their experiences, ideas and environments with others (Kroma, 2003). In the context of social learning, engagement involves a dual process of meaning making. This entails learning through physical participation or by experience as well as learning through words, tools, documents and links to resources that reflect the shared experience. Through active participation and dynamic negotiation a practice is formed by those who engage in it (Wenger, 1998) The figure below depicts the learning process as depicted in social learning theory and also the version of the learning cycle to be used iteratively in the CoPs within this research process.



Source: (Wenger, 1998 p.5)

Figure 29: Social learning attained in CoPs

In terms of this research project, nurturing a CoP to allow for more effective interaction and information dissemination can be achieved through platforms such as community learning networks, e.g. farmer learning groups, which are connections formed and maintained by local people with the aim to share information and for mutual learning. Field workers can use these platforms for

workshops and demonstrations and in turn participants assist each other in implementing what was learnt. However, farmer learning groups are not effective when there is lack of trust between members.

Events such as farmers' days and cross visits which are open to the larger community will also serve as platforms for information dissemination and will also create a space for increased interaction. These networks are important in bringing together local people, development practitioners, researchers and other role players together to access and share resources and information that can encourage communities to take up improved practices (Steeple & Jones, 2002).

#### 15: Social practices which can support CoPs

Practices	Functions
<b>Farmer Learning Groups</b>	Formed by local people with aim of mutual learning and information exchange, as well as to assist each other in terms of labour
<b>Farmers' Days</b>	Platform for practitioners and researchers to disseminate information. Also includes field visits.
<b>Cross Visits</b>	Cross visits between communities that employ similar practices for learning and sharing, through practical observations.
<b>Stakeholder platforms:</b> e.g. inception meetings, stakeholder engagement meetings, workshops	<p>Researchers, practitioners and local government etc. have regular meetings to engage in dialogue on similar subject Encourage collaboration between researchers, practitioners and community participants</p> <p>Researchers can capitalise on knowledge by practitioners to ensure that the problems they are working on are relevant</p> <p>Provide an environment for reflection, interpretation and feedback between diverse stakeholders.</p> <p>Practitioners focus mainly on facilitation and knowledge dissemination based on understanding of participants' needs and capabilities.</p>

## 5.4 Social and technical considerations for site selection

*By Erna Kruger, Jon Mc Cosh, Sylvester Selala*

As the research process will track the socio-ecological processes and systems linked to the CSA practices as well as the impact/effectiveness of the practices themselves, sites need to be chosen for both social and technical considerations.

On the social front, the following decisions have been made by the research team to assist with site selection:

1. We will focus on *rural communities in communal tenure land ownership situations*. The parameters for private land ownership and also land reform communities are quite different and as concepts of ownership and agency can vary too substantially here to be comparable. Also, those smallholders in communal tenure areas, represent the majority of rural dwellers.
2. We will focus on areas where *smallholders engage in gardening, cropping and livestock management*, to ensure that the diversity within the smallholder systems and the range of activities and farming practices used are included.
3. We will work in *villages that a considered reasonably typical for a particular area* in terms of composition and number of homesteads, layout of infrastructure and access to natural resources, access to services and access to economic opportunities.



4. We will work with *individuals in these villages* who are interested to be involved, are active smallholder farmers, who belong to different subgroupings within the community such as youth, older people and women, who live in reasonably close proximity to each other and where social economic, political or religious barriers to not preclude them from communicating with each other and working or learning together.

The technical considerations are likely to be far more constraining as at least some of the indicators chosen are to be measurable. The first level of decision making here is whether to work in contrasting bioclimatic regions (such as KZN and Limpopo) or work in bio-climatically distinct areas which may or may not be contrasting, but will be different (such as KZN and the EC).

**Decision 1: Start in bio-climatically contrasting areas with measurable indicators in year 1 (KZN, Limpopo) and include a 3<sup>rd</sup> site for measurable indicators in another distinct site (EC) in year 2**

The next level of decision here is to decide which practices to compare across sites quantitatively. It is not physically possible to generate quantitative results for all practices chosen by farmer participants across all sites, or even within one site, given that within one site there would need to be at least 3-5 farmer participants from whom measurements are taken.

The table below, shows the criteria used to think through the prioritization of the sites. These criteria were based on the risks associated with each of the sites in terms of items shown in the table. The scale of risks is used as follows; with 10 being the highest risk and 1 being the lowest risk.

**Table 16:Criteria for site selection**

Criteria	KZN	EC	Limpopo
Climate (chances of total crop failure due to extreme weather conditions, e.g. drought)	3	5	7
Farmer management (ability of farmers to keep records and run well managed farmer level experiments)	5	7	5
Uncertainty (in terms of who will be involved and how it will be managed- both at organisational and community level)	3	8	4
Security (for equipment)	3	4	4
Costs associated with monitoring (related to distances to be travelled, personnel at field level)	2	6	5
<b>Total risk</b>	<b>16</b>	<b>30</b>	<b>24</b>

Ideally, it would be good to run the experiments in all three sites (KZN-Limpopo-EC) from the start. However, there is a high risk and a high level on uncertainty associated with the EC sites. KZN and Limpopo have relatively lower risk and lower level of uncertainty.

Possible options or suggestions to reduce the risk in EC include:

- To find a post graduate student who can be linked to the Fort Cox Agricultural training Institute, one of the Amanzi for Food implementation sites, to focus on managing the quantitative measurements of the CSA practices there. If this process can be linked into the

curriculum development processes presently being undertaken by the Institute, that would be very beneficial for all involved.

- To spend time with developing strong CoPs in the EC to leverage resources to assist with the implementation (both for the UCPP – Umzimvubu catchment Partnership Programme in Matatiele and the Amanzi for Food processes through ELRC in Grahamstown).

As it stands, KZN (Ixopo) and Limpopo (Mametja villages) are the most likely options. INR has site in Ixopo, were they are not particularly taking any measurements but have identified potential participants (Mom Joyce and Chief Dlamini).

**Decision 2: Set up quantitative measurements for 2 different practices (e.g. tunnels, SWC) for 3 participants per site across two sites in year 1 and expand to the 3<sup>rd</sup> site in year 2.**

The understanding is that measurements will be taken by collaborating partners for their particular focus areas in each of these sites; notably CA for MDF and Agroforestry for INR and that these results could be combined in the analyses to good effect.

Some preliminary suggestions can also be made for which practices to focus on and which particular quantitative measurements would be possible or ideal for these practices.

**5.4.1 Proposed Farmer level experiments with CSA practices**

**1. Practice 1: Planting in a tunnel (shade netting structure) vs. planting outside a tunnel**

Treatment 1: Planting in a tunnel and irrigate using a watering can (or furrows)

Treatment 2: Planting in a tunnel and irrigate using a drip kit

Treatment 3: Planting outside the tunnel and irrigate using a drip kit

Control: Planting outside the tunnel and irrigate using a watering can / furrows

Parameters to be measured:

Expected results / out come	Measurements	Equipment / instrument
Saves water	Amount of water applied	Calibrated container
Controls pests	Pest types counts	Net and a holder
Improves yields	Record yields	Scale, pen and record book, cost-benefit analysis
Reduces labour	Time spent in the garden	Record book, cost -benefit analysis
Allows year round planting	Plant in both seasons	Record book
Water productivity	Air temperature, rainfall, wind speed, wind direction, relative humidity, solar radiation, rain gauge and soil temperature measurements	Weather station

**2. Practice 2: Conservation agriculture / Agro forestry**

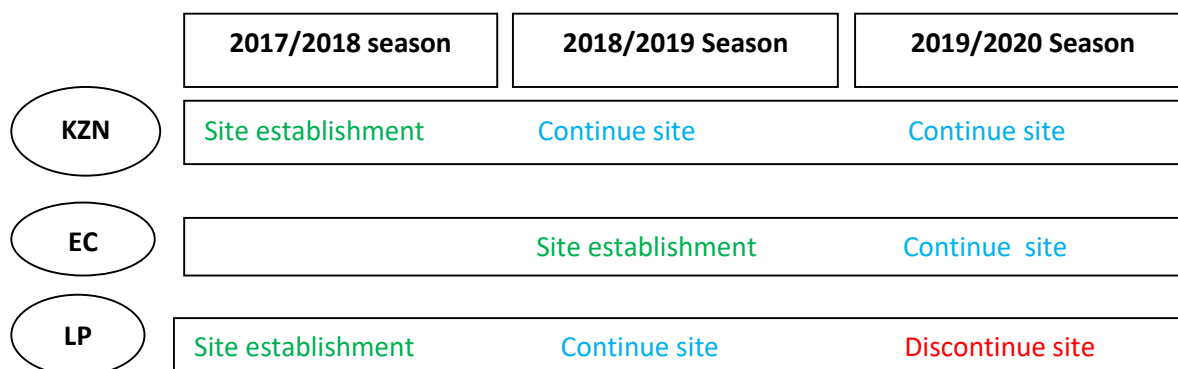
The choice was between AF and CA, but it was agreed that AF is argued to be a form of conservation agriculture. Furthermore, if water productivity (WP) is to be determined, available models for estimating WP are mostly calibrated for intercropping (e.g. maize and beans) rather than AF (e.g.

maize and pigeon pea). Therefore, CA was chosen as a second practice to be tested. The full weather station mentioned above would also be required for this practice

Parameters to be measured:

Expected changes	Measurements	Instruments / equipment required
Reduces erosion	Runoff and sediments	Runoff plots
Improves soil health	Soil microbial activity	Lab test
Improves soil structure	Bulk density, porosity, particle size distribution, soil fertility	Lab measurements
Improves water infiltration	Infiltration measurements	Single or double Infiltrometer
Suppresses the weeds	Weed count	Square
Improves soil water holding capacity	Volumetric water content, gravimetric water content	Water mark sensors/ TDR sensors, graph permeameter
Improves yield	Biomass/ harvest index/ Leaf area index (LAI), yield measurements	LAI measuring device, scale
Water productivity	Air temperature, rainfall, wind speed, wind direction relative humidity, solar radiation, rain gauge and soil temperature measurements	Weather station

The diagram below shows, seasons for establishment of sites and how each could potentially run. The KZN site is proposed as the main site which will run from three seasons, while Limpopo and EC will run for only two seasons. The results for the 2018/2019 are comparable across the three sites, while in the 2017/2018 season results from KZN site can be compared with those from the Limpopo site and in the 2019/2020 season KZN and EC sites can be compared.



In summary, two sites (Limpopo (Mametje) and KZN (Ixopo/ Bergville) have been selected to do farmer led experimentation on two practices (CA and tunnel (controlling micro climate). EC sites are to be developed and then included in the 2<sup>nd</sup> year of implementation. These experiments will be manageable if the number of treatments are kept to a minimum of three treatments (farmers) per site. The experiments are to be overseen and managed as part of a doctorate study, for which Sylvester Selala is to register within the present financial year. He will manage data collection in both KZN and Limpopo. Given the two distinct sites, measurements are to be taken regularly (2x/month).

In any one year it is suggested that there is a main site, which will include all necessary quantitative measurements and an indicator site where a selection of quantitative measurements will be

implemented to augment the main site - to ensure that the research remains manageable and cost efficient. The table below outlines the suggested measurements for each site.

**Table 17: Proposed quantitative measurements across sites**

Proposed quantitative measurements across sites							
	Importance	Main site	Indicator site	Intervals	Field / Lab	Instrument	Location
<b>Soil Physical Properties</b>							
Texture	Necessary			Once off	Lab	Hydrometer	UKZN
Bulk Density	Necessary			At beginning and	Lab	Cylindrical	UKZN
Saturated Hydraulic Conductivity - surface	Preferred			Once off	Field	Double ring infiltrometer	UKZN
Saturated Hydraulic Conductivity - below surface	Preferred			Once off	Field	Geulph permeameter	UKZN
Structure - Mean Weight Diameter	Optional			At beginning and after each	Lab		UKZN
Retentivity Curves	Preferred			Once off	Lab	Suction sand table / pressure pots	UKZN
<b>Soil Chemical Properties</b>							
Carbon	Necessary			At beginning and after each harvest	Lab	Soil Sample	Cedara
N,P,K	Necessary			At beginning and after each harvest	Lab	Soil Sample	Cedara
pH	Necessary			At beginning and	Lab	Soil Sample	Cedara
Electrical Conductivity	Optional			At beginning and	Lab	Soil Sample	UKZN
Exchangeable Bases	Preferred			At beginning and	Lab	Soil Sample	UKZN
Cation Exchange Capacity	Optional			At beginning and	Lab	Soil Sample	UKZN
Soil health indicators	Necessary			At beginning and after each harvest	Field	Soil Sample	Field
<b>Weather</b>							
Automated Weather Station (AWS)	Necessary			Research duration - constant logging	Field	Davis Weather Stration	INR / Davis
Rain guages	Necessary			Research duration - manual recording	Field	Rainguage	Shop
<b>Water</b>							
Watermark sensor (nests of 3 at 300, 600 and 1200mm)	Necessary			Research duration - constant logging	Field	Watermark	Cobus Pretorius
Soil temperature sensors to go with watermarks	Necessary			Research duration - constant logging	Field	Temperature Sensor	Cobus Pretorius
Loggers to go with watermarks	Necessary			Research duration - constant logging	Field	Logger	Cobus Pretorius
Manual Gravimetric water sampling	Necessary			During set phases of crop	Lab	Oven and scale	UKZN
Hand moisture tests (numerical scale)	Necessary			During set phases of crop	Field	Field based	
Runoff plots	Necessary			Research duration - regular manual recording	Field	Field based	
<b>Yield</b>							
Biomass (non-edible) - Dry Matter	Necessary			At harvest	Field	Field based physical measurement	
Grain / edible component - Dry Matter	Necessary			At harvest	Field	Field based physical	
Leaf Area Index	Optional			During set	Field	LAI indicator	UKZN
Leaf nutrients	Optional			During set	Lab	Lab	UKZN

A rough budgeting exercise has been done for the above-mentioned measurements and is shown in the small table below.

Table 18: A proposed budget for equipment to conduct quantitative measurements proposed

Equipment				
Item	unit price	Quantity	Total	Cost share
Hydrometer	R 0,00	1	R 0,00	UKZN
Cylindrical cores	R 0,00	1	R 0,00	UKZN
Double ring infiltrometer	R 2 000,00	3	R 6 000,00	
Geulph permeameter	R 0,00	1	R 0,00	UKZN
Watermark sensors	R 855,00	40	R 34 200,00	
Temperature Sensors	R 996,00	15	R 14 940,00	
Loggers	R 135,00	7	R 945,00	
Hobo Pro Software and USB cable	R 2 200,00	2	R 4 400,00	
Davis Weather Stration	R 25 000,00	3	R 75 000,00	
Raingages	R 125,00	15	R 0,00	GrainSA
Runoff plots	R 3 500,00	18	R 63 000,00	
Soil fertility test	R 90,00	70	R 0,00	GrainSA
soil health indicators	R 1 000,00	20	R 0,00	GrainSA
			<b>R 198 485,00</b>	

#### 5.4.2 Potential sites for CoPs

These are focussed around arrangements put in place with a number of organisations to engage in this process and are in some ways focussed thematically according to the project focus areas of these organisations. This process is the larger DSS process within which the farmer level experimentation and measurement of indicators will be embedded. Training and learning events for facilitators and farmers are to be central as would be meetings for analysis, planning and monitoring for the CoPs at all levels.

Table 19: Practices and organisations involved

Provinces	PRACTICES			
	CA	Agroecology	Agroforestry	Grazing Management
KZN (S)	MDF	Lima	INR	
KZN ( C)	MDF	Lima		
KZN (N)	MDF	Lima		
EC	MDF	ELRC, UCPP		UCPP
Limpopo	MDF	AWARD		UCPP

#### Conservation Agriculture

Mahlathini Development Foundation is the national implementer for the GrainSA CA Smallholder Farmer Innovation Programme. This process is in its fourth year of implementation and will continue for another 2-3 years. It is envisaged as a long term implementation strategy, renewable presently on a three year contractual basis.

This programme is built on an innovation systems model for awareness raising and scaling out of implementation of CA in a smallholder context. In addition, research is being conducted to fine tune the CA implementation processes for smallholder contexts, to deal with some of the complexities of implementation and to find appropriate indicators, benchmarks and proxy indicators to evaluate the impact of implementation and to design an incentive scheme (based on PES parameters) for this process. The approach focusses on the whole value chain, including inputs, production, harvesting storage and sales and as such also includes bulk buying schemes, village savings and loan associations, farmer centres, local milling operations and joint marketing initiatives. The primary focus is on farmer led experimentation both for the learning and the research. Some aspects of the research include soil fertility, soil health status, water holding capacity (infiltration and run-off), close spacing, intercropping, crop rotation and cover crops. Attention is given to the supply and use of appropriate machinery and equipment.

#### PRESENT SITES

- Eastern Cape: Matatiele – 4 villages - Nkau, Mqhobi, Sehutlong and Khutsong
- KZN, Southern region: Ixopo- Nokweja, Spinrgvalley, Madzikane, Ofafa
- KZN central region;
- KZN central region: Bergville – 17 villages including Ezibomvini, Stulwane, Eqeleni, Nudnwane, Mhlwazini and Ngoba

#### **Agroecology**

MDF and AWARD (Association for Water and Rural Development) are working in partnership under the USAID sponsored Resilience in the Olifants Basin programme to support smallholders in the implementation of agroecological farming practices within a process of community based climate change adaptation in the lower Olifants region of Limpopo.

The programme has been running for 1 year and is to continue for another year and has included a systemic analysis of understanding of climate change and impacts in the area, an analysis of vulnerabilities and adaptation options and farmer level experimentation with CSA practices. Farmer learning networks have been established in 6 villages in the area (Botshabelo, Sedawa, Willows, The Oaks, Finale and Lepelle). A baseline has been done for the villages and criteria have been developed with farmers for choosing and working with particular CSA practices. In addition, work is in progress for assessment of the impact of these practices.

MDF and Lima Rural Development Foundation are working in partnership on the Aerelemeng food security programme sponsored through Wesbank. In this process MDF has been involved primarily in design of the programme and in training of the facilitator across three provinces (EC, KZN and Limpopo). Training has included the promotion of various CSA practices at food security level both for vegetable production and field cropping and implementation of soil and water conservation practices in addition field staff have been introduced to facilitation processes for inclusion of nutrition and value adding as well as village savings and loan associations.

A further small brief through the First Rand Foundation Innovation fund will now allow the teams to focus on climate change and adaptation as part of the food security programming. Sites to be

involved include KZN (Swayimane and Thabamhlope) and Limpopo (Sekhororo). This process is to continue to focus on capacity building for Lima field staff and the farmers they are working with.

MDF has also been in contact with the ELRC and the Amanzi for Food implementation team in the EC. There is considerable interest for this research process to link with the Amanzi for food process at the Fort Cox Agricultural Training Institute and the surrounding villages through their farmer learning network there and to incorporate the model and CSA practices into the activities of the network as well as the curriculums of the college and there is good potential for development of a practical site or implementation there.

Also in the Eastern Cape, MDF has presented this research process for the Umzimvubu Catchment Partnership. They are interested in promoting and supporting any programmes implementing landscape based socio-ecological approaches in the catchment area and have recently set up a CoP around research for this partnership. The details of which specific organisation within the partnership could partner in this implementation and how it can be done still need to be considered.

### Agroforestry

The INR (Institute of Natural Resources) have agreed to work alongside MDF in the agroforestry focus areas and projects that they are presently implementing and to share expertise and results with this research process. This provides a way to include the agroforestry focus area within CSA into the overall programme and to be involved in a joint farmer level experimentation process in their site in Southern KZN (Nokweja).

The small table below summarises present involvement and stakeholder, facilitator and farmer level CoPs to be established

**Table 20: CoPs to be established in year 1 of the research process and their thematic focus areas**

CoPs	MDF	MDF, AWARD	MDF, INR	MDF, Lima	MDF, ELRC
Limpopo – Lower Olifants		Agroecology, CA			
KZN (S) - Nokweja			Agroforestry, CA		
KZN (N)- Bergville	CA, Agroecology			Agroecology, CA	
EC – Fort Cox ATI (Alice)					Agroecology (SWC)

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