A smallholder farmer level decision support system for climate resilient farming practices improves community level resilience to climate change. No 3: The smallholder farmer CRA decision support system

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Introduction

A current Water Research Commission adaptive research process entitled "Collaborative knowledge creation and mediation strategies for the dissemination of Water and Soil Conservation practices and Climate Smart Agriculture in smallholder farming systems" is exploring best practice options for climate resilient agriculture for smallholders and evaluating the impact of implementation of a range of these practices on the resilience of agriculture based livelihoods. Alongside this, a decision support methodology and system has been designed to assist smallholders and the facilitators who support them to make informed and appropriate decisions about choices of a 'basket of options' for implementation at a local level.

The research process is broadly divided into three elements for purposes of clarity, although all three elements are tackled concurrently:

1. Community climate change adaptation process design
2. Climate resilient agricultural practices and
3. **A decision support system**.

In this article we focus on the design of the farmer level decision support system.

The smallholder climate change adaptation decision support process

The decision support process focusses on a bottom -up approach, where individual farmers in a locality make decisions regarding the 'basket' of CSA/CRA approaches and practices most suited to their specific situation.

To do this in a way that also includes the concepts of social learning, innovation and agency the following decision support concept has been developed.

The process is designed to also support and assist the facilitator in their decision making, in support of the smallholder farmers; meaning that the facilitator accesses information such as the basic climate change predictions for the area, the agroecological characteristics including rainfall, temperature, soil texture etc) and an initial contextualised basket of CSA practices from which to negotiate prioritized practices with farmers. Practices are thus chosen by both facilitators and farmers.

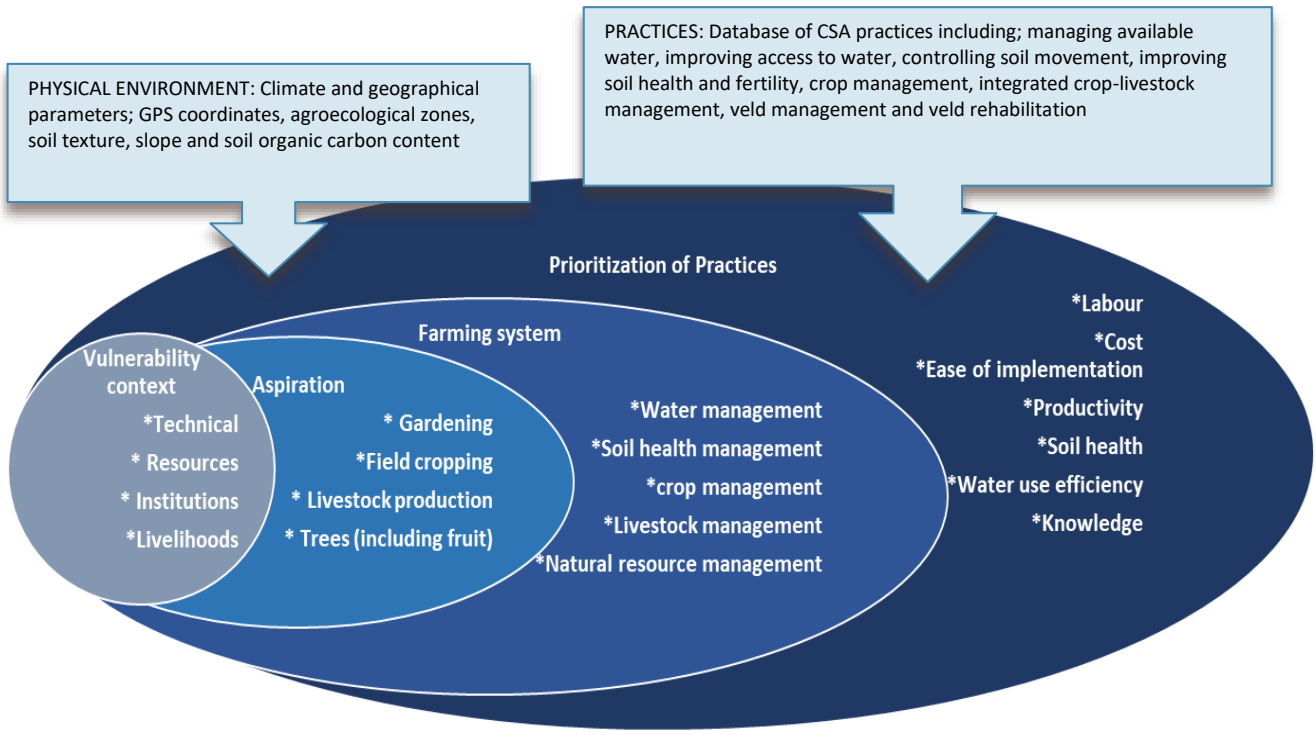


Figure 1: The smallholder CSA/CRS decision support model.

Situation and vulnerability assessments

The model for vulnerability assessments used in this process provides for a combination of socio-economic (livelihood) and socio-ecological (access and utilization of natural capital) indicators, in a climate change context (wellbeing, adaptive capacity and governance). This is a new process design, built from elements of existing international best practice options.

The process consists of focus groups discussions, individual interviews (baselines) and household visits, or walkabouts as we call them – as they include a broad and initial assessment of the "lay of the land".

This information is pulled together into a database that has been put together to provide for a farmer segmentation/ farmer typology approach. Farmer typologies allow for differentiation between different levels of vulnerability in a community to target interventions/ practices more specifically.

The three typologies developed within this process are shown in the figure below

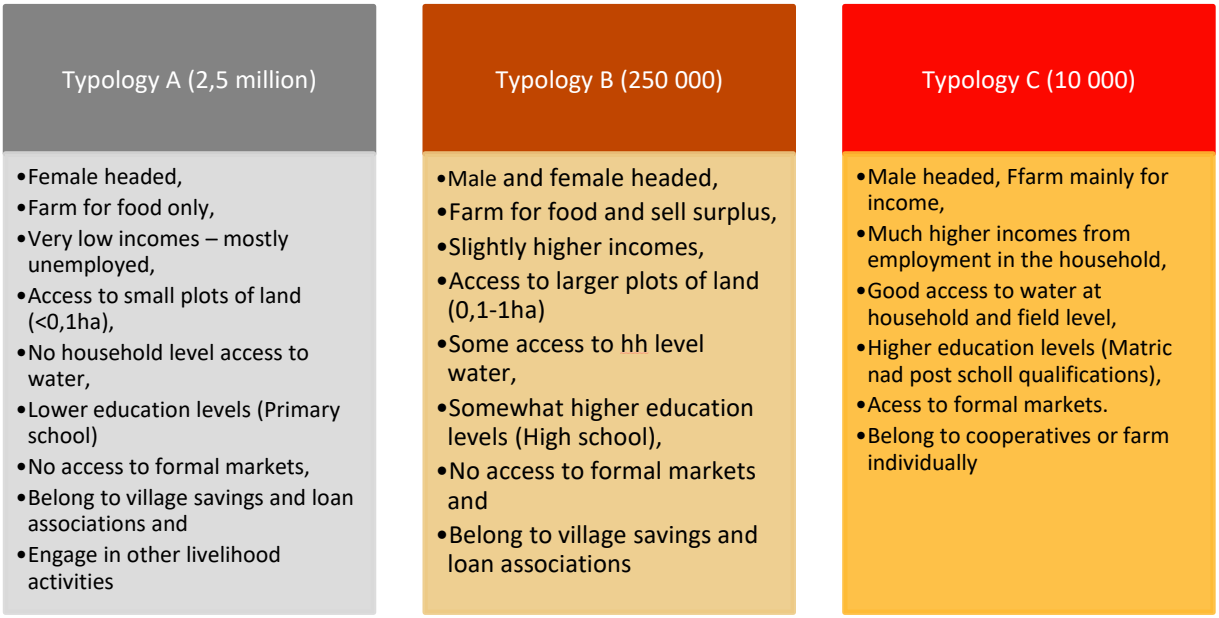
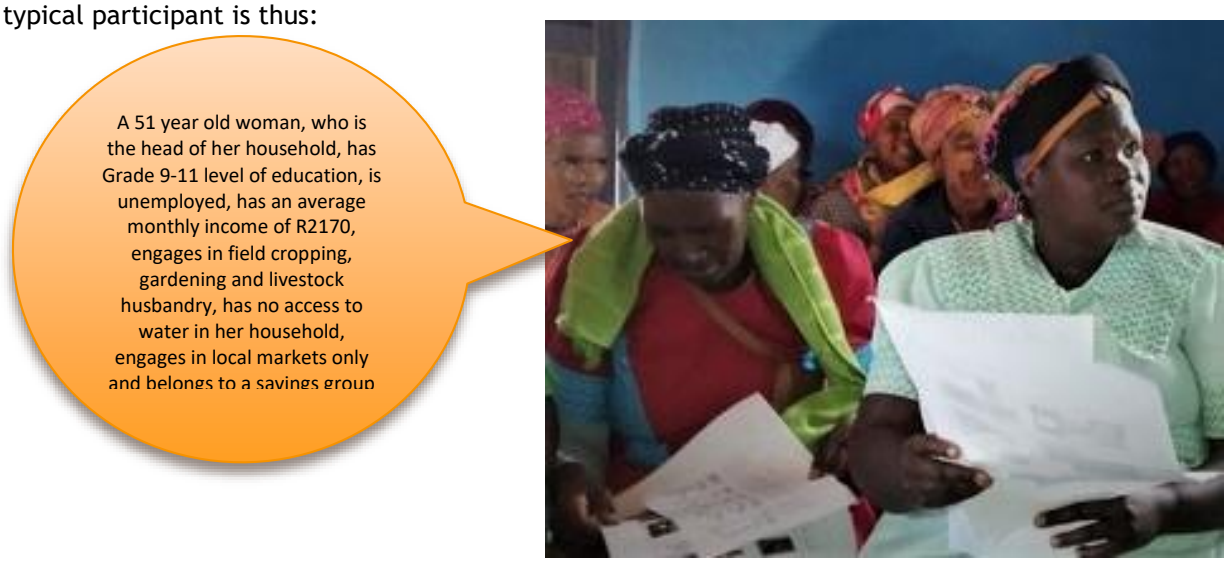


Figure 2: Smallholder typology for a climate resilient farming decision support system.

A typical participant is thus:



These typologies are one of the input categories into the decision support system.

The web-based platform

The model is designed primarily as a participatory and facilitated process at community level. In support of this process, a computer-based model can be used alongside this methodology to provide further information and decisions support to the facilitator. It is also possible for a farmer to access this model independently to derive an initial basket of CSA practice options for themselves.

The computer model information flow is designed as shown in the figure below – and follows the same basic steps as the facilitated model shown in Figure 3 below.

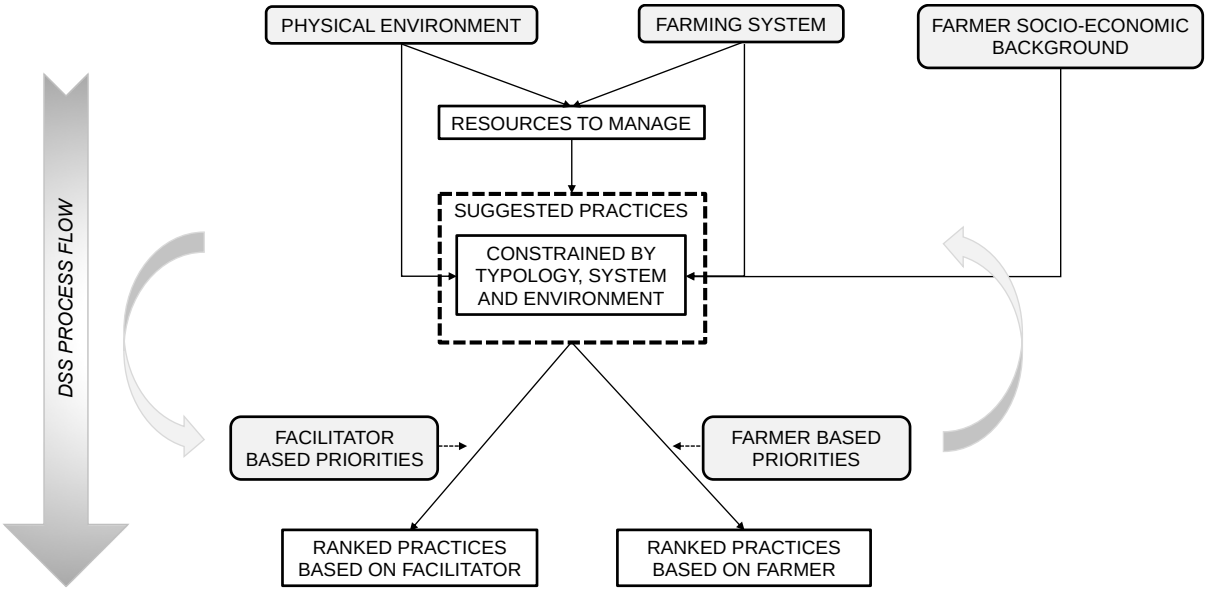


Figure 3: The computer-based model for the smallholder DSS.

In our case the set of criteria (proxies used as indicators for the complex reality) that helps to make informed decisions on management practices are:

- The current farming systems; gardening, field cropping, livestock production and natural resource management (NRM) (including trees),
- The physical environment: agroecological zone, soil texture, slope and organic soil carbon and
- The socio-economic background of the farmer; demographic information (gender HH head, age, dependency ratio), level of education, sources of income (unemployment vs. external employment, own business, grants, farm, etc.), total income, access to services, infrastructure, technology (Electricity, water (tap, borehole, rainwater harvesting, etc.), irrigation (buckets, standpipes, etc.), fencing and farming tools (hand vs traction/other), social organisation, market access (formal vs. informal), farm size and farming purpose (food vs. selling).

Besides this, the resources and related management strategies as well as a list of practices need to be provided as input to the system. All information, except the physical environment; i.e. climate, soil and topography, and the resources and management strategies, are derived through the use of a range of participatory processes. Data on the physical environmental conditions have been taken from datasets freely available online. This information can however be customised by the DSS user, in case more appropriate information is available for the specific farmer concerned.
For the Facilitator-Farmer DSS the resources and related management strategies are discussed and negotiated in the participatory process. For the computer based or Individual Farmer DSS these are provided as an input into the model using the following framework:

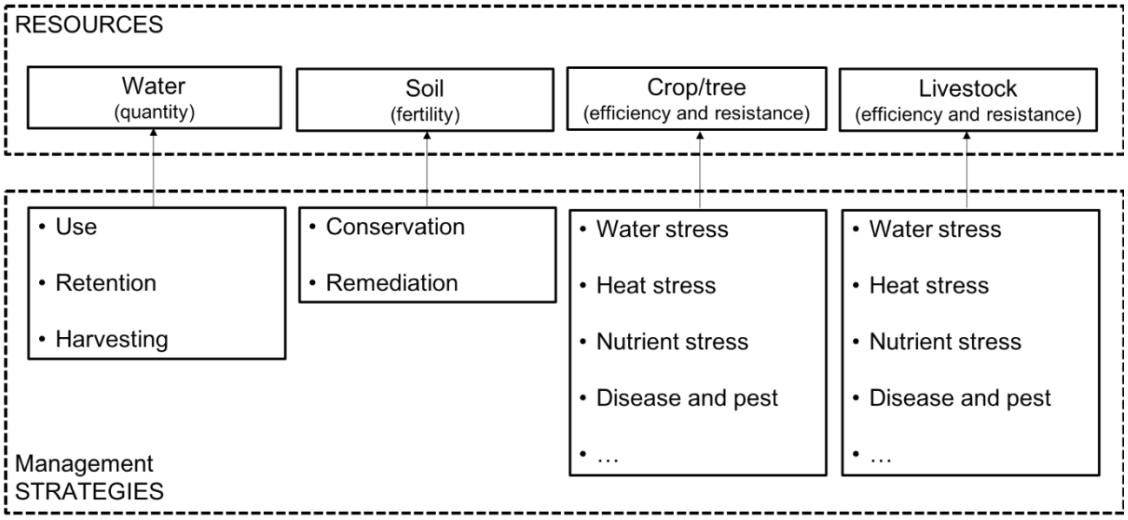


Figure 4: Resources to manage and their associated management strategies.

Once all the information is inputted into the model an initial list of practices is suggested for each individual farmer. The model has been tested and refined, through comparison of this computed based process with the participatory process and assessing how closely these two processes are aligned.

Below is an example for 1 farmer in each of the three provinces where the model has been tested.

Table 1: Basket/list of practices recommended for version 2 of the DSS

Province	**KZN**	**Limpopo**	**EC**
Village	**Ezibomvini**	**Sekororo**	**Mxumbu**
Name and Surname	**Phumelele Hlongwane**	**Chenne Mailula**	**Xolisa Dwane**
Drip irrigation	0	0	0
Bucket drip kits	0	0	0
Furrows and ridges/ furrow irrigation	0	0	0
Greywater management	1	1	0
Shade cloth tunnels	1	1	0
Mulching	1	1	0
Improved organic matter (manure and crop residues)	1	1	1
Diversion ditches	1	0	0
Grass water ways	0	0	0
Infiltration pits / banana circles	1	1	0
Zai pits	1	0	0
Rain water harvesting storage	1	1	1
Tied ridges	0	0	0
Half- moon basins	0	0	1
Small dams	0	0	0
Contours; ploughing and planting	1	0	0
Gabions	0	0	1
Stone bunds	0	0	0
Check dams	0	0	1
Cut off drains / swales	0	0	1
Terraces	0	0	0
Stone packs	1	0	0
Strip cropping	1	0	0
Pitting	1	1	0

Woodlots for soil reclamation	1	0	0
Targeted application of small quantities of fertilizer, lime etc	1	0	0
Liquid manures	1	1	0
Woody hedgerows for browse, mulch, green manure, soil conservation	1	0	0
Conservation Agriculture	1	0	0
Planting legumes, manure, green manures	1	0	0
Mixed cropping	1	0	0
Planting herbs and multifunctional plants	1	0	0
Agroforestry (trees + agriculture)	1	0	0
Trench beds/ eco circles	1	1	0
push-pull technology	1	0	0
Natural pest and disease control	1	0	0
Integrated weed management	1	1	1
Breeding improved varieties (early maturing, drought tolerant, improved nutrient utilization),	1	1	1
Seed production / saving / storing	1	1	1
Crop rotation	1	1	1
Stall feeding and haymaking	0	0	0
Creep feeding and supplementation	1	0	0
Rotational grazing	1	0	1
De-bushing and over sowing	1	0	1
Rangeland reinforcement	1	0	1
Bioturbation	1	1	1
Tower garden	1	1	0
Keyhole beds	1	1	0
No of practices recommended	**35**	**16**	**14**

For the KZN participant, this means that around 88% of the full list of practices have been recommended for her. She has a wide range of recommendations being a farmer in Typology B (fewer restrictions) and engaging in gardening, cropping and livestock production. Although this is quite high, it is understood that the farmer level ranking is still to take place and these practices can then be prioritized and narrowed down further. For the Limpopo and EC participants, around 1/3 of practices have been recommended in their basket of options. Ranking can be undertaken first by the facilitator, or can be done directly by the farmer depending on the circumstances. Below is the ranking exercise undertaken for Phumelele Hlongwane (Ezibomvini, KZN).The practices shown in green are those that Phumelele are already implementing. This ranked list then provides options for inclusion of further ideas and practices

Table 2: Ranking of CRA practices recommended for Phumelele Hlongwane

(KZN; Bergville)Phumelele Hlongwane: List of practices scored by facilitator				
Practices	**Field cropping**	**Vegetable gardening**	**Livestock**	**Natural resources and trees**
Shade cloth tunnels		8		
Mulching		9		
Improved organic matter	11	11		11
Diversion ditches	9	9		9
Infiltration pits		10		
Zai pits	10	10		
RWH storage	9	9	9	9
Stone packs	9	9		9
Strip cropping	11			
Pitting	11		11	11

Woodlots for soil reclamation	9		9	9
Targeted fertilizer application	8			
Liquid manure		7		
Woody hedge rows	10		10	10
Conservation agriculture	11	11	11	11
Planting legumes, manure, green manures	8	8		8
Mixed cropping	9	9		
Planting herbs and multifunctional plants	9	9		
Agroforestry (trees + agriculture)	11	11	11	11
Trench beds/ eco circles		9		
push-pull technology	7			
Natural pest and disease control	7	7		7
Integrated weed management	7	7		7
Breeding improved varieties (early maturing, drought tolerant, improved nutrients),	7	7	7	7
Seed production / saving / storing	6	6		6
Crop rotation	9	9		
Stall feeding and haymaking				
Creep feeding and supplementation			7	
Rotational grazing			9	
De-bushing and over sowing			9	
Rangeland reinforcement			9	
Bioturbation	9	9	9	9
Tower garden		10		
Keyhole beds		10		

Below are a few indicative photographs of Phumelele's CRA practices.

Above clockwise from top left: A view of Phumelele Hlongwane's vegetable garden, a newly constructed tower garden, trench beds planted to a mixture of vegetables in her shade cloth tunnel, a plot of Dolichos in her CA field and a plot of summer cover crops- sunnhemp and millet.

Conclusion

The decision support system for climate resilient agriculture implementation by smallholder farmers is an important new innovation in the field of community-based climate change adaptation and can be scaled up as a framework in research, learning and implementation in this field.