A smallholder level decision support process improves resilience to climate change

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Institute of Natural Resources

LIMA RURAL DEVELOPMENT FOUNDATION

WATER RESEARCH COMMISSION

GRAIN SA GRAAN SA

Rural Integrated Engineering (Pty) Ltd. 2001/027770/07 RIEng Systems for Sustainable Development

environmental LEARNING RESEARCH CENTRE

award

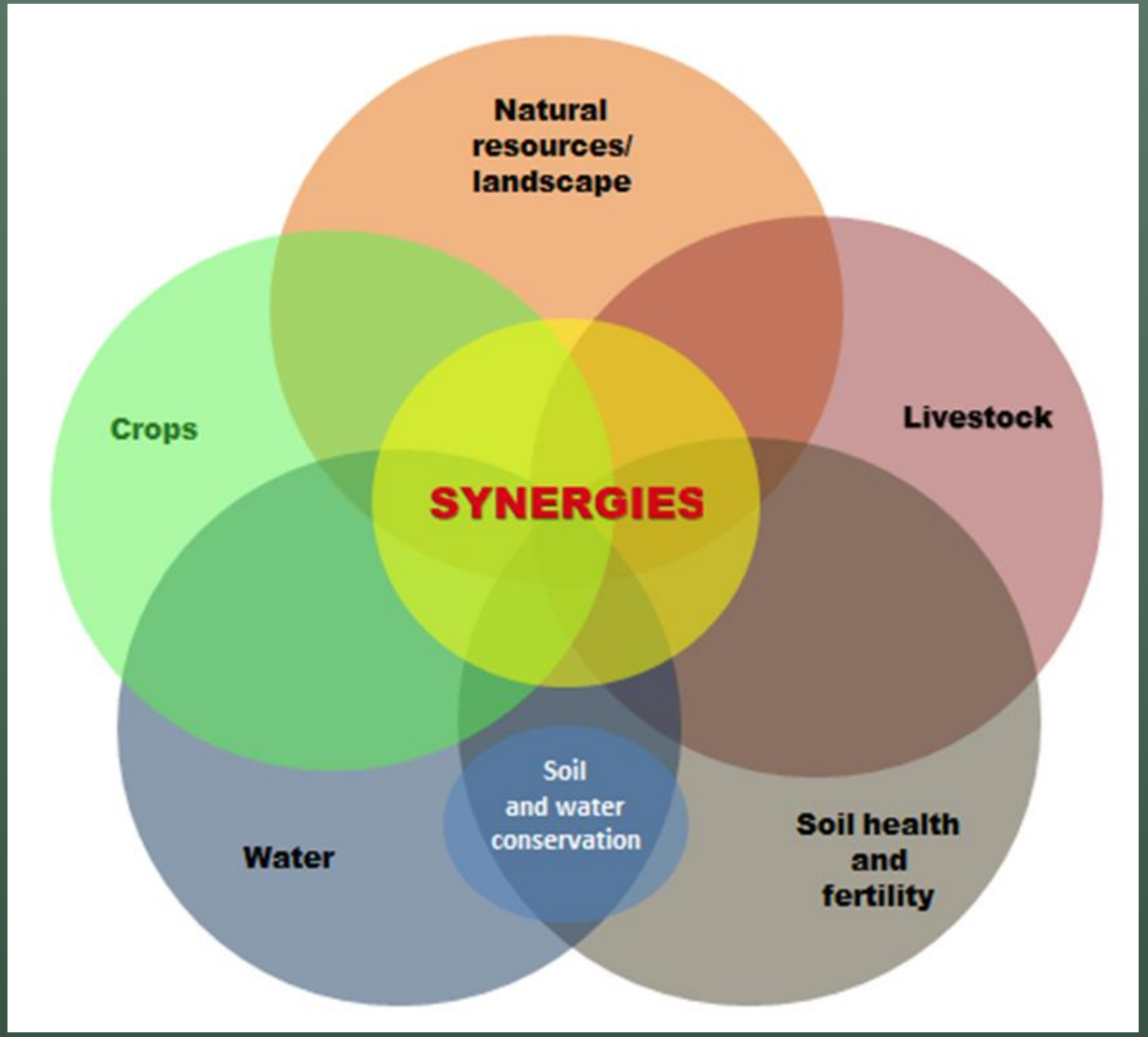
DSS Guiding principles

SOCIO-ECONOMIC

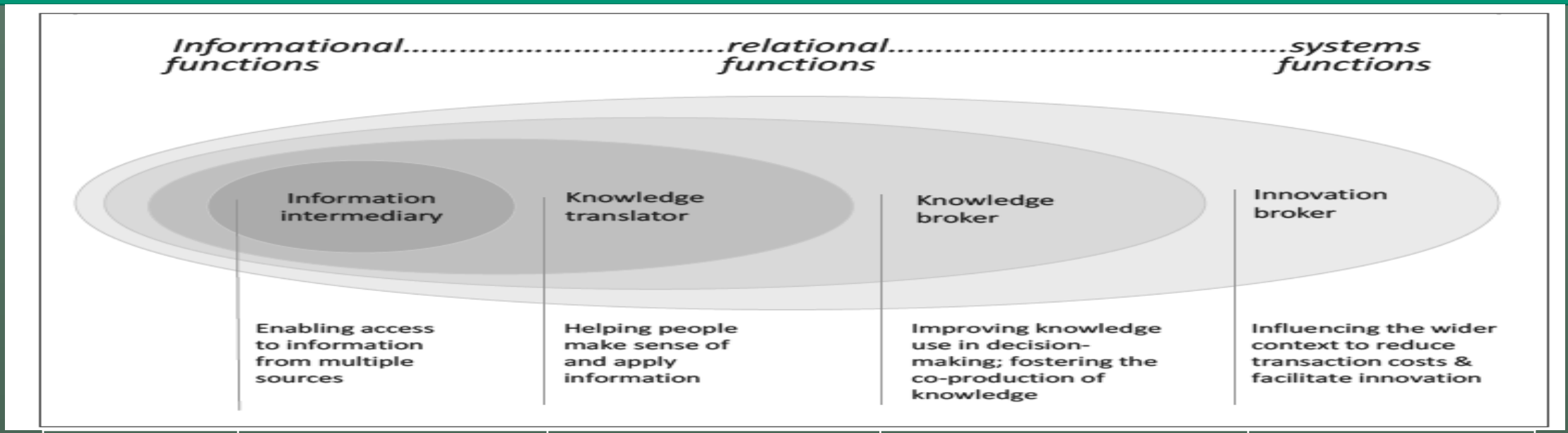
- Build on **community-based criteria**, indicators and priorities
- Generate **transitional strategies**
- Assess **costs and benefits**
- Link national and local **planning mechanisms**
- Strengthen **local networks**
- Promote **values other than financial** values
- Prioritize **locally appropriate** actions

SOCIO-ECOLOGICAL

- Encourage **crop diversity** and **continuity**
- Ensure **healthy soil**
- Protect **natural resource base** and **ecosystem services**
- Reduce external inputs
- Make the **most effective use** of water and land for all purposes
- Enhance understanding and skills in storage, value adding, and marketing – go beyond immediate markets



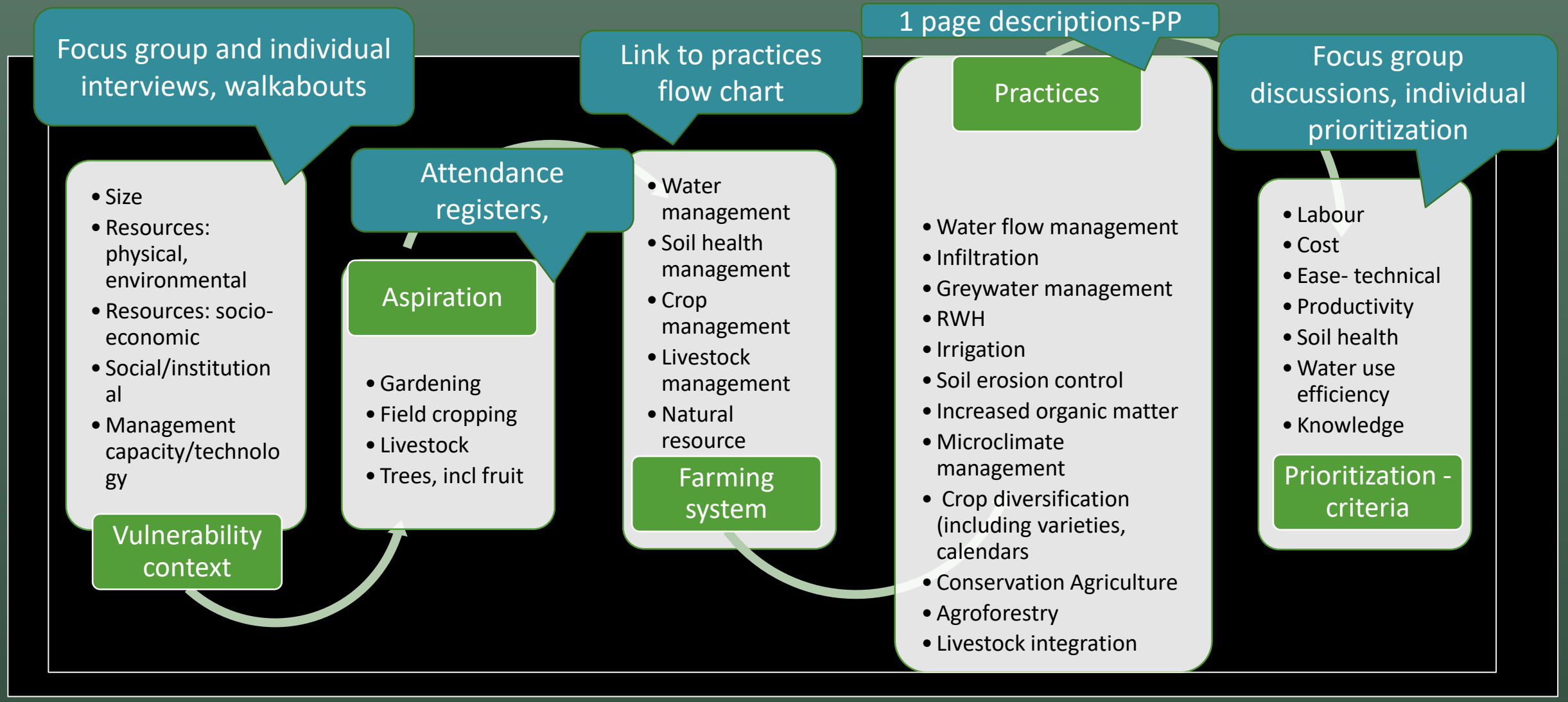
Smallholder CCA decision support system: individual and facilitated



Activities and processes	Local good practice	Climate Change dialogues	Farmer level experimentation to test practices	CoPs and innovation platforms
	Best practise options	Impacts of CC	Introduction of new practices and ideas to try	Benchmarking for visual indicators
	Stakeholder engagements	Adaptive strategies	Learning and mentoring	
	Materials and information	Appropriate practices	Assessment of outcomes and impacts	
	Internet based platform		Cyclical, iterative learning and implementation	
Facilitator-Farmer Decision Support System				

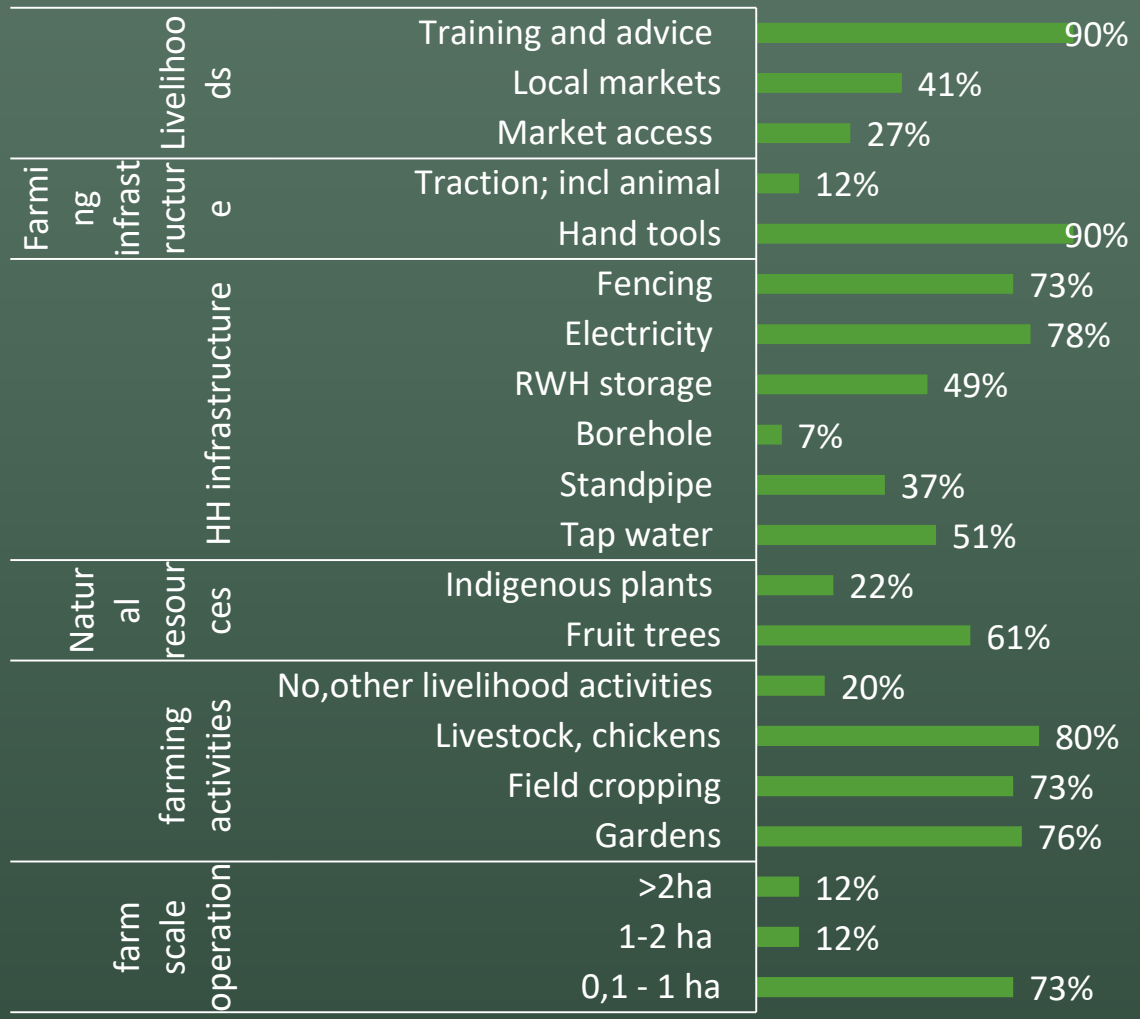
DSS outline

Start with desktop information re CC information for the locality and general farming information, then go on to focus group discussions and individual interviews



Individual interviews and walkabouts

Baseline information: Access to resources (N=41)
April 2019



- Lay of the land; land use patterns, ecological stresses, climate stresses
- Local adaptations

Ezimbovini (KZN) walkabout; Jan 2018 – shows heat and moisture stress in sweet potatoes, garden crops such as cabbages and CA intercropping trial with maize and beans

Baselines and farmer typologies

The typologies are briefly summarised below

TYPOLOGY A: (2,5million); Female, farm for food only, very low incomes – mostly unemployed, access to small plots, no hh level access to water, lower education levels and no access to formal markets.
Belong to VSLAs, engage in other livelihood activities

TYPOLOGY B: (250 000) Male and female, farm for food and sell surplus, slightly higher incomes, some access to hh level water, somewhat higher education levels and no access to formal markets
Belong to VSLAs

TYPOLOGY C: (10 000); Male, farm mainly for income, much higher incomes from employment in hh, good access to water, higher education levels and access to formal markets.
Belong to cooperatives or farm individually

51 years, woman headed hh, Grade 9-11, unemployed, Ave monthly income R2170, field cropping, gardening and livestock husbandry, no access to water in hh, local markets only, savings groups

Typology A- 49%
Typology B – 27%
Typology C – 24%
A good spread of different community members involved in the Adaptation responses

FOCUS GROUP DISCUSSIONS:

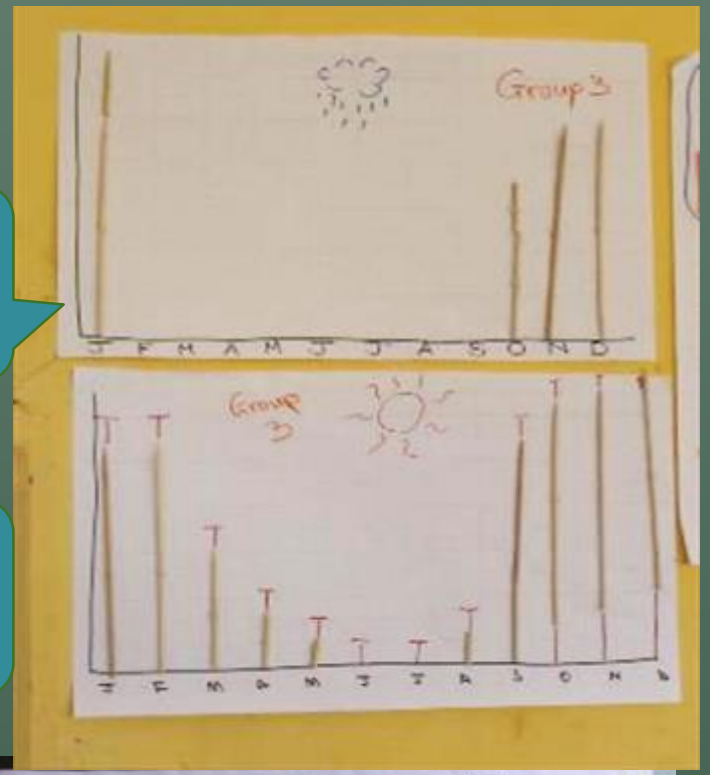
CC dialogues – effects (past, present, future), seasonality, impacts, practices, prioritization criteria

WORKSHOPS OUTLINE (CCA workshops 1-3)

1. What we are seeing around us, what has been happening (nature, economy, society, village, livelihoods, farming) *(list main issues (biophysical, social, economic) – with ranking of vulnerability, organisational mapping, financial flows and services mapping,*
2. Past, present, future of farming activities and livelihoods *(timelines and trends*)
3. Climate vs weather *(role play)*
4. Scientific understanding of climate change (*Power point input)*
5. Seasonality diagrams of temperature and rainfall – generally what it is, what is changing (*seasonality diagrams)*
6. Reality maps (choose temp, or rainfall): draw up mind maps of impacts *(Impact mapping)*
7. Turn impacts in to priority goals (positive statements) and think through adaptive measures that we know of or think could work (Adaptation strategies)
8. Introduce a range of practices (facilitation team) related to these goals to broaden potential adaptive measures *(A4 picture summaries and power point presentations)*
9. Walkabouts and individual interviews (*transect walks, key informant interviews, mapping of local innovations/adaptations)*
10. Prioritization of practices – matrix using farmer level criteria for assessment *(matrix ranking and scoring)*
11. Planning of farmer experimentation, learning sessions and implementation of practices (*Individual experimentation outlines, lists)*

Seasonality diagrams; rainfall, heat

Impacts; reality map



Climate Change impacts as discussed by smallholders

Climate change impacts on livelihoods and farming			
	KZN	EC	Limpopo
Water	Less water in the landscape; streams and springs dry up, borehole run dry, soils dry out quickly after rain	Less water in the landscape; streams and springs dry up, borehole run dry, soils dry out quickly after rain	Less water in the landscape; streams and springs dry up, borehole run dry, soils dry out quickly after rain
	Dams dry up	Dams dry up	Dams dry up
	Municipal water supply becoming more unreliable	Municipal water supply becoming more unreliable	Municipal water supply becoming more unreliable;
			Need to buy water for household use – now sometimes for more than 6 months of the year
			RWH storage only enough for household use.
Soil	More erosion	More erosion	More erosion
	Soils becoming more compacted and infertile	Soils becoming more compacted and infertile	Soils becoming more compacted and infertile
			Soils too hot to sustain plant growth
Cropping	Timing for planting has changed- later	Timing for planting has changed- later	Can no longer plant dryland maize
			All cropping now requires irrigation – even crops such as sweet potato
			Drought tolerant crops such as sorghum and millet grow=- but severe bird damage
	Heat damage to crops	Heat damage to crops	Heat damage to crops
	Reduced germination and growth	Reduced germination and growth	Reduced germination and growth
	Seeding of legumes becoming unreliable	Seeding of legumes becoming unreliable	Seeding of legumes becoming unreliable
	Lower yields	Lower yields	Lower yields
			Winter vegetables don't do well - stress induced bolting and lack of growth
	More pests and diseases	More pests and diseases	More pests and diseases
	Loss of indigenous seed stocks		Loss of indigenous seed stocks
Livestock	Less grazing; not enough to see cattle through winter	Less grazing; not enough to see cattle through winter	Less grazing; not enough to see cattle through winter
	More disease in cattle and heat stress symptoms	More disease in cattle and heat stress symptoms	More disease in cattle and heat stress symptoms
	Fewer calves	Fewer calves	Fewer calves
	More deaths	More deaths	More deaths

Climate Change impacts as discussed by smallholders – continued.

Natural resources	**Fewer trees; too much cutting for firewood**	**Fewer trees; too much cutting for firewood**	**Fewer trees; too much cutting for firewood**
	Decrease in wild animals and indigenous plants	Decrease in wild animals and indigenous plants	Decrease in wild animals and indigenous plants
	Increased crop damage from wild animals such as birds and monkeys	Increased crop damage from wild animals such as birds and monkeys	Increased crop damage from wild animals such as birds and monkeys
	Availability of indigenous vegetables has decreased		No longer able to harvest any resources due to scarcity
			Increased population puts pressure on resources
Social	More diseases	More diseases	More diseases
	Increased poverty and hunger	Increased poverty and hunger	Increased poverty and hunger
	Increased crime and reduced job opportunities	Increased crime and reduced job opportunities	Increased crime and reduced job opportunities
			Increased food prices
			Increased conflict
			Inability to survive

We are being punished by God for not living correctly

Climate change is a reality and we will need to find different ways to do thing to survive

It feels as if the end of the world is coming

POTENTIAL ADAPTIVE MEASURES:

In all villages farmers had some ideas, or many, of potential practices for CCA

Area	Village	Natl resources/ landscape	Water (manage and increase available water)	Soil health and fertility (incl Manage soil movement)	Crops	Livestock	Other
Bergville	**Thamela**		RWH		Mulching		Savings groups
No previous exposure to improved practices					Manure and fertilizer		bulk buying
Bergville	**Ezibomvini**		Spring protection	Compost	Natural P&D control	Plant fodder	
CA learning groups; 3-4yrs (MDF)			RWH storage tanks; Jo-Jo tanks	Furrows	Conservation Agriculture	Fodder supplementation	
			Infield rainwater harvesting	Contours	Mulching		
			Drip kits	Diversion ditches	Tunnels		
			Greywater; tower gardens	Stone bunds			
			Infiltration pits/ banana circles				
			Small dams				

Suggestions for Natural resource management lag behind for most groups

1 pager
Conservation Agriculture

- Rainfall: >350mm/year
- Temperature: >5°C
- Topography: 1,5&-15%
- Soil: all types –

- Gardens, fields
- <0,1ha, 0,1-1ha, >2ha
- Medium cost (Seed, fertilizer, agrochemicals), planters, local resources
- Labour intensive

DESCRIPTION

- Minimal soil disturbance- no ploughing
- Soil cover – through stover, mulches and cropping cycles
- Diversification; intercropping, relay cropping, cover crops (legume- brassicas and grain mixtures)

Planting furrows and basins by hand using hand hoes and MBLI planters – without ploughing

A maize and bean intercropped plot- using tramlines (double rows) and close spacing

A small mixed plot – peanuts, pumpkins and maize

Winter cover crops; saia/black oats, forage sorghum and fodder radish

Summer cover crops; sunflower, millet and sunn hemp

Different planters; Haraka (Wheel), Matracca (jab) and animal drawn planters, (Knapik-insert)

PRIORITIZATION OF PRACTICES:

Oaks, Lepelle, Finale – Limpopo – Criteria used to assess impact of implementation of different practices

Oaks, Finale, Lepelle: Impact of CSA practices								
SCALE: 1=low; 2 = medium, 3= high (agreement between participants)								
CRITERIA PRACTICES	Easy to do	More food	Better growth	Good water man	Better soil fertility	Score	Rank	COMMENTS
Trench beds	1	3	3	3	3	13	5	Very good for growth, soil health and water management. The best practice- but difficult to dig
Mulching	3	3	3	3	3	15	2	Less irrigation providing more food
Furrows	2	2	3	3	3	13	4	more moisture, better growth, carries some fertility in the water
Rock bunds	2	3	3	3	3	14	3	deep irrigation, catches more fertile soil
Adding organic matter to the soil	3	3	3	3	3	15	1	easier than trench beds
Crop varieties	1	1	1	1	1	5	7	we do not have the knowledge- but will be easy once we know
Planting times	2	1	1	1	1	6	6	would be nice to have a calendar to remember.

Communities of practice

Province	Site/Area; villages	Demonstration sites	CoPs	Collaborative strategies
KZN	Ntabamhlophe	- CCA workshop 1,2,3,4,5 - Monitoring and PIA	-Farmers w NGO support (Lima RDF)	- Tunnels and drip kits - Individual experimentation with basket of options
	Ezibomvini/ , Eqeleni	- CCA workshop 1,2,3,4,5 - Water issues workshops 1,2 -Water issues follow-up -Water issues continuation -Monitoring, PIA - Fodder and supplementation learning process	-CA open days, cross visits (LandCare, KZNDARD, ARC, GrainSA), LM Agric forums, No Till Club, StratAct ….	- Tunnels (Quantitative measurements - CA farmer experimentation (Quantitative measurements) – case studies -Individual experimentation with basket of options; monitoring review and re-planning - Livestock integration learning group and experimentation focus
	Swayimane	- CCA workshop 1,2,3,4 - Monitoring, review and re-planning	-CA open days -Umgungundlovu DM agriculture forum	- CA farmer experimentation - gardening level experimentation; tunnel, trench beds drip kits etc.
	Madzikane	-CCA workshop 1,2,3	-CA open days - Madzikane stakeholder forum	-CA farmer experimentation - gardening level experimentation; tunnel, trench beds drip kits etc
Limpopo	Mametja (Sedawa, Turkey)	- CCA workshop 1,2,3,4,5 -Water issues workshops 1-2 -Water issues follow-up - Poultry production learning and mentoring - CA learning and mentoring - Monitoring, review and re-planning	-Agroecology network (AWARD/MDF, 15 organisations) -Maruleng DM	-Review of CSA implementation and re-planning for next season Tunnels (Quantitative measurements - CA farmer experimentation (Quantitative measurements) – case studies - Individual experimentation with basket of options -water committee, plan for agric water provision
	Lepelle	Water issues workshops 1-2	-	-water committee, plan for agric water provision
	Tzaneen (Sekororo-Lourene)	- CCA workshop 1,2 -Monitoring	Farmers learning group	-Tunnels and drip kits
EC	Alice/Middledrift area	- CCA workshop 1,2,3,4,5 - Monitoring, review and re-planning	Imvotho Bubomi Learning Network (IBLN) - ERLC, Fort Cox, Farmers, Agric Extension services, NGOs	- Monitoring and review of implementation of CSA practices and experimentation - Training and mentoring _CA, furrow irrigation, …. -Planning for further implementation and experimentation and quantitative measurements

CRA implementation summaries; Limpopo










CRA implementation summaries; Kwazulu- Natal












Assessing the outcomes: Quantitative

Table 1 : Measurements taken for the gardening trials

Parameter	Instruments	Dates
Evapotranspiration (Et_0)	Davis weather station	ongoing
Soil moisture	Chameleon water sensors	On going
Amount of water applied	Measuring cylinder	On going
Rainfall	Rain gauge	On going
Weighing of the harvest	Weighing scale	On going
Rand value of the harvest	Local market price	At harvest

Table 2 : Measurements taken for the field cropping trials

Parameter	Instruments	Dates
Evapotranspiration (Et_0)	Davis weather station	ongoing
Soil moisture	Gravimetric soil water samples	4x in growing season
Bulk density	Sampling	Once towards end of the season
Soil fertility	Sampling for analysis at CEDARA soil Lab	End of growing season
Soil health	Sampling for analysis by Soil Health Solutions	End of growing seaosn
Rainfall	Rain gauges installed in 5 sites	On going
Infiltration	Single and double ring infiltrometers	Once during the season
Run-off	Run-off plots installed in three sites	On going
Weighing of the harvest	Weighing scale, including grain and biomass (lab analysis)	At end of growing season- for Maize only
Rand value of harvest	Local market price	At harvest

Qualitative indicators; visual proxies

Above Left-Right: Doing the bulk density test using a knife blade. A clod of earth showing good aggregation, organic matter and fine root system. A soil sausage showing the high clay content of the soil.

Above left to right: Examples of the shatter test for soil structure – showing good soil structure; with porous loos soil with irregular aggregates of a dark colour indicate of higher organic matter – an intermediate or moderate soil structure – With a larger proportion of clods that break up into unaggregated soil, but also larger clods staying intact and Poor Soil structure with a large clod showing very little root penetration and few macro pores.

Table: New redesigned VSA Indicator sheet for 2018

Visual indicator of Soil Quality	Visual Score (VS)	Weight	Comments
Soil Structure (clods, aggregates)	0 = Poor conditions; 1 = Moderate conditions; 2 = Good conditions	× 4	Shatter test
Soil porosity (macro pores, clods)		× 5	Coarse pore content
Soil colour (dark, average, light and uniformity (mottles)		× 3	Incl mottles and organic matter
Soil surface (crusting, siltation, runoff)		x 3	Assessment of soil surface texture
Earthworm counts		× 2	
Soil cover (0-15%;15-30%; >30%)		× 3	Revised scale, using quadrant
Soil depth (penetration resistance to rod into soil)		× 2	
Bulk density		× 2	Using knife tip penetration in a small pit.
Root growth and development		× 2	New scale
Ranking Score (sum of VS rankings) Max =52			

Water productivity; Gardening

Table : Water productivity for gardening practices for two participants from Bergville; July-Aug 2018

Bgvl June-Sept 2018	Simple scientific method (ET)			Farmers' method (Water applied)		
Name of famer	water use (m^3)	Total weight (kg)	WP (kg/m^3)	water use (m^3)	Total weight (kg)	WP (kg/m^3)
Phumelele Hlongwane trench bed inside tunnel	1,65	21,06	12,76	1,85	21,06	11,38
Phumelele Hlongwane; trench bed outside tunnel	0,83	5,32	6,45	1,75	5,32	3,04
Ntombakhe Zikode trench bed inside tunnel	1,65	17,71	10,73	2,37	17,71	7,47
Ntombakhe Zikode; trench bed outside tunnel	0,50	3,35	6,76	0,53	3,35	6,33

Table: Water productivity for gardening practices for two participants from Limpopo (Sedawa); April -July 2018

	Simple scientific method (ET)			Farmers' method (Water applied)		
Name of famer	water use (m^3)	Total weight (kg)	WP (kg/m^3)	water use (m^3)	Total weight (kg)	WP (kg/m^3)
Christina Thobejane (Tunnel; trench beds, with mulch)	0,8	48,9	65	1,10	48,9	56,7
Christina Thobejane (Furrows and ridges with mulch)	0,5	24,5	46,4	3,91	24,5	5
Christina trench outside	0,8	14,7	18,4	2,93	14,7	11,3
Nora Mahlako (Tunnel; trench beds without mulch)	0,8	19,6	26	9,47	19,6	5

WP for trench beds substantially higher than "normal bed". WP in tunnels substantially higher than outside; around 5 x more in Limpopo and around 3 x more in KZN

Linking all the observations to assess impact

- Different types of criteria/ indicators in a socio-ecological system
- Need to be measurable; link initial assessments and baselines with potential impact measurements

VULNERABILITY

Socio-Economic

- Economic: Income (types, amounts), savings (types amounts), markets (formal/informal)
- Social: Gender, household head, social organisations,
- Human: education level, access to information

Access to resources

- Resources and infrastructure: Access to water, electricity, equipment
- Farming activities: Gardens, fields, livestock
- Market access: Sales, food

RESILIENCE

- Economic: Income (types, amounts), savings (types amounts), markets (formal/informal)
- Social, social organisations,
- Human:, access to information
- Physical: Access to water, electricity, equipment, farming (gardens, fields, livestock)
- Increased farming activities, continuity, increased productivity, increased water use efficiency (RWH, access, availability, efficiency), Soil fertility and soil health….

Impact: Resilience snapshots; Individual interviews

Resilience indicators	Increase for Limpopo	Increase for KZN	Comment
Increase in size of farming activities	Gardening; 1% Field cropping; – 98% Livestock; 6%	Gardening – 18% Field cropping – 63% Livestock – 31%	Cropping areas measured, no of livestock assessed Dryland cropping has reduced significantly due to drought conditions and infertile soil
Increased farming activities	No	No	All involved in gardening, field cropping and livestock management
Increased season	Yes	Yes	For field cropping and gardening- autumn and winter options
Increased crop diversity	Crops: 21 new crops Practices: 11 new practices	Crops: 12 new crops Practices: 8 new practices	Management options include; drip irrigation, tunnels, no-till planters, JoJo tanks, RWH drums,
Increased productivity	Gardening; 120% Field cropping: 15% Livestock: 6%	Gardening – 72% Field cropping – 79% Livestock – 25%	Based on increase in yields (mainly from tunnels and trench beds for gardening CA for field cropping
Increased water use efficiency	45%	25%	Access, RWH, water holding capacity and irrigation efficiency rated
Increased income	13%	13%	Based on average monthly incomes, mostly though marketing of produce locally and through the organic marketing system
Increased household food provisioning	Vegetables; 7-10kg/week Fruit; 5-10kg/week Dryland crops (maize, legumes, sweet potatoes); 5-10kg/week	Maize- 20kg/week Vegetables – 7kg/week	Food produced and consumed in the household
Increased savings	Not applicable	R150/month	Average of savings now undertaken
Increased social agency (collaborative actions)	2	2	Learning groups, farmer centres, local water committees
Increased informed decision making	5	5	Own experience, local facilitators, other farmers, facilitators, extension officers
Positive mindsets	2-3	2-3	More to much more positive about the future: Much improved household food security and food availability

Impact: Participatory impact assessment

	Soil; health and fertility	Money; income and savings	Productivity; acceptance of practice, saving in farming – equipment, labour	Knowledge; increased knowledge and ability to use	Food; how much produced and how healthy	Water; use and access	Social agency; Support, empowerment	Total
Conservation Agriculture	22	21	26	28	18	23	18	156
Savings	6	15	14	15	12	11	15	88
Livestock	19	11	18	7	5	12	11	83
Gardening	14	15	12	13	15	17	21	107
Crop rotation	16	12	13	12	12	15	10	90
Intercropping	12	13	15	12	11	11	9	83
Small businesses	11	17	15	10	20	11	9	93

In KZN positive impact of CRA and associated practices in order of importance: CA, gardening (tunnels, agroecology) , small businesses (farmer centres, poultry), savings, livestock (integration – fodder, health)

Individual decision support process

- Online model using the same decision support process; environmental, physical, vulnerability, aspirations and farming systems to
- Select a basket of appropriate practices

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Conclusions

- Systemic approach
  - Grounded in local contextualisation
  - For appropriate community led implementation and
  - Participatory impact assessment for
  - Incremental and cyclical improvements and behaviour change

Effective model for CCA; locally contextualised and owned

Appropriate for partnering in different contexts

LET's COLLABORATE

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Thank You