Sustainable Agricultural Intensification Research and Learning in Africa (SAIRLA)

Zambia National Learning Alliance

Social Learning on Sustainable Agricultural Intensification: Perspectives from the Conservation Farming Unit (CFU) Programme in Eastern Region, Zambia

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1. Background

The Sustainable Agricultural Intensification Research and Learning in Africa (SAIRLA) programme (2015 - 2020) seeks to generate new evidence and design tools to enable governments, investors and other key actors to deliver more effective policies and investments in sustainable agricultural intensification (SAI) that strengthen the capacity of poorer farmers, especially women and youth, to access and benefit from SAI. The programme is supported by the UK Department for International Development (DFID). It is implemented in six countries across Africa including Zambia.

In Zambia, SAIRLA has supported We-Effect to bring together a National Learning Alliance (NLA) – a network of stakeholders drawn from government, research and academia, private sector, farmer organisations, the media, non-governmental organisations and interested members of the public. The NLA is a platform for social learning around SAI research, best practices, and policy and investment processes. The NLA is organised around social learning themes; land equity, trade-offs – intensification vs extensification - and extension services. Each theme is led by a thematic group.

The trade-offs thematic group, that prepared this report, facilitated stakeholders to engage with evidence and tools on SAI using the case of Conservation Agriculture (CA) promoted by the Conservation Farming Unit (CFU) - an independent organisation which has been working in Zambia since 1996 promoting conservation farming (CF) or CA, and climate smart agricultural practices. An important reason for the NLA's engagement with such programmes is to facilitate sharing of evidence and learning with a wider community, ultimately including policy makers, civil society organisations, donors and the private sector.

1.1 Justification for the focus on trade-offs (intensification vs extensification)

Zambia, through its agriculture, forestry and environment policies, has noted the need for interventions to protect the environment (Second National Agriculture Policy 2016, National Forestry Policy 2014). Investments in capacity and technologies have been made by government, donors and NGOs. The Agriculture Status Report (Chapoto et al 2018) states that adoption of improved agricultural technologies by farmers can contribute to an economically efficient farm sector and to financial viability of farmers through improved production and productivity. However, production in smallholder farming systems is low (Gondwe and Nkonde, 2017; Agriculture Status Report, 2018) while the rate of deforestation is high. This is attributed to a number of factors that include extensive and unsustainable agricultural production practices and felling of trees for charcoal (Vinya et al., 2011; Matakala et al., 2015). In most African countries, increases in crop production have often been attributed to an increase in the area of land cultivated rather than to intensification (Wortman and Sones, 2017).

Farmers have traditional practices for soil and water management in Zambia (Gondwe and Nkonde, 2017, The African Centre for Biodiversity, 2015). Conservation basins are used to harvest water in Regions I and IIa[1]. Shifting of livestock pens is an indigenous practice to enrich the soil with excreted urine and faeces by confining a herd of cattle on a small piece of land at night for three to four days and then moving on. Farmers address acid soils in Region III[2] with the slash and burn practice known locally as chitemene. Farmers learned and shared these techniques amongst themselves, drawing on direct experience and experimentation. However, Gondwe and Nkonde (2017) argue that these practices are insufficient to maintain productivity under intensive cropping and need to be integrated with other practices. Such practices may include conservation tillage, crop rotation with legumes,

[1] **Region I**: Semi-arid includes southern, eastern and western areas. Rainfall 600 to 800 mm, growing season is 80-120 days long. **Region IIa:** Includes much of central Zambia, with the most fertile soils and most of the country's commercial farms. Rainfall 800-1000 mm, and the growing season is 100-140 days long

[2] **Region III:** constitutes 46% of the country's total land area to the north and receives between 1,000 mm and 1,500 mm of rainfall annually

improved soil cover with mulch, cover crops and crop residues, and application of manure (Gondwe and Nkonde, 2017).

Most small-scale farmers in sub-Saharan Africa apply little or no fertilisers to their crops and according to Rware et al (2017) this is due to financial constraints and other socio-economic factors. In Zambia, about 60% of farmers apply fertiliser, mainly to maize. The average rate of fertiliser application is 100 kg/ha while recommended rates ranges from 200 – 300 kg/ha basal and the same amounts of top dressing (Agriculture Status Report, 2018). However, Gondwe and Nkonde (2017) state that *"decisions on choices of amount of each fertiliser to apply to each crop are very complex if the intent is to maximise potential for profit and if the farmer prefers to have several different crops"* and go on to conclude that *"the recommended rates of fertiliser application (RECs) in Zambia are high compared with the economically optimal rate (EOR) determined from field research in 28 of 31 comparators. Across all crop nutrient recommendations, the current RECs were, on average, 112% more than the EOR. Farmers who apply at REC are therefore over-applying fertiliser and missing much profit opportunity as compared to using rates nearer to EOR"*.

According to a study conducted using macro panel data download from FAOSTAT, the African agricultural sector follows an extensive and unsustainable production pathway (Nkamleu, 2011). As the options for expansion of agricultural land in Africa are limited, agricultural intensification is needed in order to increase agricultural production (Nkamleu, 2011). Zambia's agricultural sector remains one of the main causes of land degradation. Increased opening of more land for cultivation is a key factor in the country losing approximately 275,000ha of forests annually (Vinya et al., 2011; Matakala et al., 2015). The current agricultural production systems threaten the sustainability of the environment and the situation is considerably worsened by the emerging issues around climate change.

Given the increase in population, climate change and other factors, there are on-going concerns about the sustainability of agricultural systems in Zambia. Hence it is important to seek alternatives such as sustainable agriculture intensification (SAI). SAI has been defined as producing more output from the same area of land, while reducing the negative environmental impacts and at the same time increasing contributions to natural capital and the flow of environmental services (Pretty et al., 2011). A further definition of SAI is practices that aim at increasing food production in response to demands of the growing population, reduce vulnerability to shocks and stresses while conserving critical ecological services (Masumba et al., 2017).

The Zambian government has set out to create a conducive policy environment that can support implementation of sustainable production systems. The threats posed by unsustainable production systems are recognised in several policy documents, including the Second National Agriculture Policy.

The Second Agricultural National Policy has clear objectives that support Sustainable Agriculture:

i. Promote sustainable land management technologies (including conservation agriculture, appropriate stock densities);

ii. Promote characterisation, conservation and sustainable utilisation of indigenous animal genetic resources including climate change resilient indigenous breeds (establish bio-diversity conservation centres)

As much as the aim is to increase production efficiency, farmers and other stakeholders need to better understand under what conditions agricultural practices can either complement or detract from biological processes and ecosystem services (Pretty et al., 2011). For example, even though conservation agriculture (CA) has been promoted in the country and included in agriculture policy documents as a climate smart approach, yields of major crops such as maize have not increased on a per area basis (Agriculture Status Report, 2018). A variety of reasons have been identified. For example, two of the three principles of conservation agriculture; residue retention and crop rotation (the third being minimum tillage), have been a challenge due to communal grazing and lack of legume markets (Final evaluation of CASU project, 2018).

It is important to understand the trade-offs involved. In multifunctional agricultural landscapes trade-offs occur within agricultural systems, between agricultural and broader environmental or socio-cultural objectives, across time and spatial scales, and between actors (Klapwijk et al., 2014). For example, deciding whether to use crop residues to feed livestock or the soil is a classic example of a trade-off and such trade-offs are ubiquitous when land is managed with multiple objectives (Klapwijk et al., 2014).

An understanding of the systems dynamics that produce and alter the nature of trade-offs to achieve a sustainable and food secure future is vital (Garnett et al., 2013). This can be achieved through trade-off analysis, an approach for evaluating system level outcomes of agricultural production and prioritising and targeting management interventions in multi-functional agricultural landscapes (Klapwijk et al., 2014).

A study by Klapwijk et al (2014) concluded that if stakeholders are not involved in the trade-off discussions and analysis, then these are of little use for informing practical decision-making. The approach to involve stakeholders in this work has been through a social learning process. Social learning has a range of interpretations, but involves *"change in understanding that goes beyond the individual to become situated within wider social units through social interactions between actors within social networks"* (Reed at al., 2010). It involves two types of learning:

i. Instrumental learning (acquiring knowledge and skills that are task and performance oriented), and

ii. Communicative learning (understanding what others mean when they communicate with us and understanding their purposes, values and intensions) (Diduck et al., 2012).

The Zambia NLA works with stakeholders at community, district, provincial and national levels to engage in generating and sharing evidence through social learning to support decision making in policy and investment. The NLA is premised on engaging stakeholders that have an interest in or influence on sustainable agriculture in the country.

In Zambia there are several agricultural approaches and practices that may be considered to contribute to SAI, these include CA, agroforestry, and integrated soil fertility management. CA has been widely promoted in the country for some years, however as noted above, widespread sustained use has been a challenge despite possible benefits.

The Zambia NLA sought to facilitate a social learning process to explore the contribution of the CFU programme and CA to SAI in Zambia. Hence the social learning event focused on the CFU programme in Eastern Region aimed to provide a platform and an opportunity for the programme's stakeholders to engage in social learning around promotion of CA and achieving sustainable agricultural outcomes. The CFU programme is being implemented in 45 districts and is one of the biggest conservation agriculture programmes in Zambia.

1.2 The Conservation Farming Unit (CFU)

1.2.1 Introduction[3]

The CFU is an independent organisation that has been working in Zambia since 1996 promoting conservation farming (CF) or CA and climate smart agricultural practices. According to the CFU the CF approach is generally defined as a management system based on three principles that should be applied in unison in a mutually reinforcing manner; minimum physical soil disturbance, permanent soil cover with live or dead plant material (e.g. crop residues), and crop diversification (e.g. crop rotation, cover crops or intercrops with legumes). In many parts of Africa, stagnant agricultural productivity, population pressure, environmental degradation, and the threat of climate change suggest a bleak future for millions of African families whose livelihoods depend on farming. Converting from traditional and conventional farming methods to CF practices can reduce the environmental impact of farming and increase yields. The CFU make the case that CF has already worked for thousands of families, so they are committed to promoting these practices as vigorously and widely as possible. The CFU-CSAZ project 2016-2021 has a budget of GBP 25 million covering 45 districts in Zambia. The aim is to have 995,000 farmers (of which 45% are women)

3 The information in this section comes from the CFU website: https://conservationagriculture.org/

trained in climate smart agriculture practices. The project also aims to have 188,600 new adopters and 157,600 sustained adopters of CA practices following attendance at CFU training sessions. The main thrust of their work is hands-on extension training, using lead farmers in their own farming communities. The CFU achieves this spread through a network of six regional offices, 100 dedicated field staff and a cohort of nearly 3,000 lead farmers.

The CFU also works directly with in-country partners in other countries in Africa: Uganda (Rural Enterprise Development Services – REDS); Kenya (Participatory Approaches for Integrated Development – PAIFD and Tanzania (CFU-Tanzania) and has over the years provided technical assistance to organisations in countries as diverse as Madagascar, Mozambique, Malawi, Mali, Ghana, Zimbabwe and Botswana.

According to the CFU, it has reached over 200,000 farmers each year in the last ten years. In the last two years, over 54% of the farmers who were trained went on to adopt conservation agriculture practices for the first time, registering an 88% yield increase above those who did not adopt. The CFU estimates that each farmer who has been trained in CA is able to increase production value by $187 per hectare/year.

1.2.2 Extension and Advisory Services

The CFU predominately concentrates on providing extension support and practical training on CF/ CA to farmers on the ground, through a team of field staff who repeatedly engage with a cohort of carefully selected lead farmers. The lead farmers in turn work with their communities to train several groups, usually attracting about 100 individuals apiece, which tallies up to over 200,000 farmers each time in Zambia alone. This extension system is used to deliver several modular lessons on the different aspects of CF and associated management and business skills and is repeated 2 or 3 years in a row in any given area, at no cost to the farmers attending.

1.2.3 Building a market for conservation farming to flourish

In addition to providing extension training, the CFU works to stimulate the demand for and supply of necessary CF tools, inputs and services, through relationships with tillage service providers and private sector agro input supply companies, both at the national level and the community shop level. For example, The CFU promotes the use of hoe, ox and tractor mechanisation and tillage service. CFU realised about a decade ago that providing different tillage entry points to CF minimum tillage was key. By restricting it to a hoe technology the programme effectively dissuaded those who already had access to oxen or tractors from taking it up. Recognising also that most of the people did not own these assets, the CFU has since worked hard to foster a layer of farmers and businessmen who provide tillage services, even to those with very small landholdings.

In the last eight years, CFU has directly channelled $3.9m of trade through community level agro dealer shops. The CFU's relationships with the private sector are also increasingly extending to link the technical and market opportunities available to the successful CF farmers to become trainers and agro-dealers.

1.3 Aim

The aim of the social learning activity was to explore the contribution that the CFU programme makes to SAI through a participatory assessment of socio-ecological trade-offs and synergies of CA practices

1.4 Objectives

The objectives of the social learning activity were:

i. To gather perspectives from various stakeholder groups on the influence of CA on social, ecological and economic domains.

ii. To explore trade-offs and synergies of the SAI practices

iii. To identify key investments needed to minimise negative influences.

2. Methodology

The overarching method was situated in participatory assessment and interdisciplinary approaches. A social learning lab approach adapted from urban studies on climate change (Arrighi et al., 2016) was used as a means or guide for operationalising the participatory assessment of trade-offs in CA. The major tenets of a social learning lab include; co-exploration of the problem, co-production of knowledge and solutions, and transdisciplinary epistemology to include experiences and knowledge from non-academic stakeholders such as smallholder farmers.

The following stages were undertaken in the process of social learning.

2.1 Planning phase

The preparations for the social learning visit to the CFU Eastern Region was highly consultative. The team engaged with the CFU headquarters and regional programme staff, and with the Ministry of Agriculture Provincial and District Coordinator's Offices, the Chipata District Commissioner and other relevant government ministries and departments.

A concept note was developed and circulated among the NLA trade-offs thematic group members for review. The Sustainable Intensification Assessment Framework proposed to be used was subjected to peer revision and later discussed by the interdisciplinary thematic group. The selection of stakeholders to take part in the exercise was guided by members of the NLA and expert assessment of state and non-state actors that are directly involved with farmers. Categories of stakeholders that participated were the public sector; the private sector; civil societies and non-governmental organisations; and the farmers. Invitation was through both phone and written letters. The number of stakeholders involved are shown in Table 1. (See Appendix 1 for a full list of participants organised by stakeholder group).

Table 1. Number of stakeholders participating in the three sets of activities

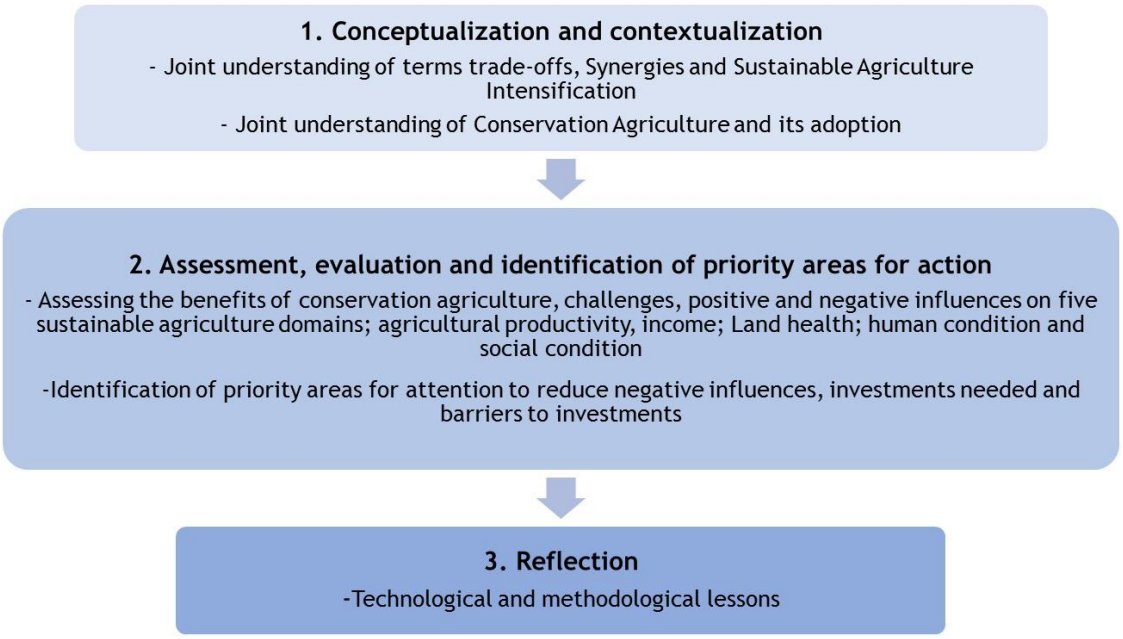
	NGOs		Public sector		Private sector		Farmers	
	Male	Female	Male	Female	Male	Female	Male	Female
Village social learning lab	1	1	0	0	0	0	14	18
District social learning lab	4	3	3	4	3	3	9	13
Individual consultations (CFU, DACO, DC, FIELD OFFICER)	2	2	3	2	1	1	4	3

During the planning phase the purpose of the social learning lab was explained to the CFU. This included explaining that the process was primarily for learning through a participatory assessment of socio-ecological trade-offs and synergies of CA practices. Roles, responsibilities and expectations were communicated to appropriate stakeholders during this phase. For example, CFU was tasked to mobilise farmers (both those that practice CA and those that do not) in a village of their choice for a village social learning lab.

The social learning visit included individual consultations, community learning and a district level workshop. It should be noted that, although the workshop was conducted at district level, the social learning on the CFU programme covered the Eastern Region. The participants took part in scoring CA on the five domains in the assessment tool (productivity, economic, environment, human condition and social) and in the discussions that were facilitated to follow. See below for detailed methodology of the social learning lab phase and the assessment and analysis phase.

2.2 Social learning lab

Figure 1. Framework for joint participatory assessment of trade-off in Conservation Agriculture



2.2.1 Conceptualisation and contextualisation

Before beginning the trade-off assessment exercise at district level, visits were made to the offices of the District Agricultural Coordinator and District Administrator. During these visits introductions were made, the objectives of the visits were articulated and discussions on sustainable agriculture projects within the Eastern Province and their impact in terms of production were held. These visits were followed by community level meetings with farmers from Chief Kapatamoyo and Madzimoyo in Mnoro Agricultural Camp where sustainable practices being implemented by different organisations were discussed. At the district level workshop, participants were divided into groups based on the various stakeholder categories present in the workshop. The groups were: government, NGOs, private sector and farmers. The farmer group was further sub-divided by gender.

To develop a common understanding of concepts for the participatory trade-off activity, participants were led through the following exercises:

Exercise one. Participants were asked;

When you came to the workshop today, (1) What did you hope to gain? (2) What did you give up?

A few participants were asked to report back to the whole group on what they hoped to gain and/or what they gave up attending the workshop.

Exercise two. In their respective groups, participants were asked to discuss with colleagues the following two questions:

(1) What is your definition of a synergy?
(2) What is your definition of a trade-off?

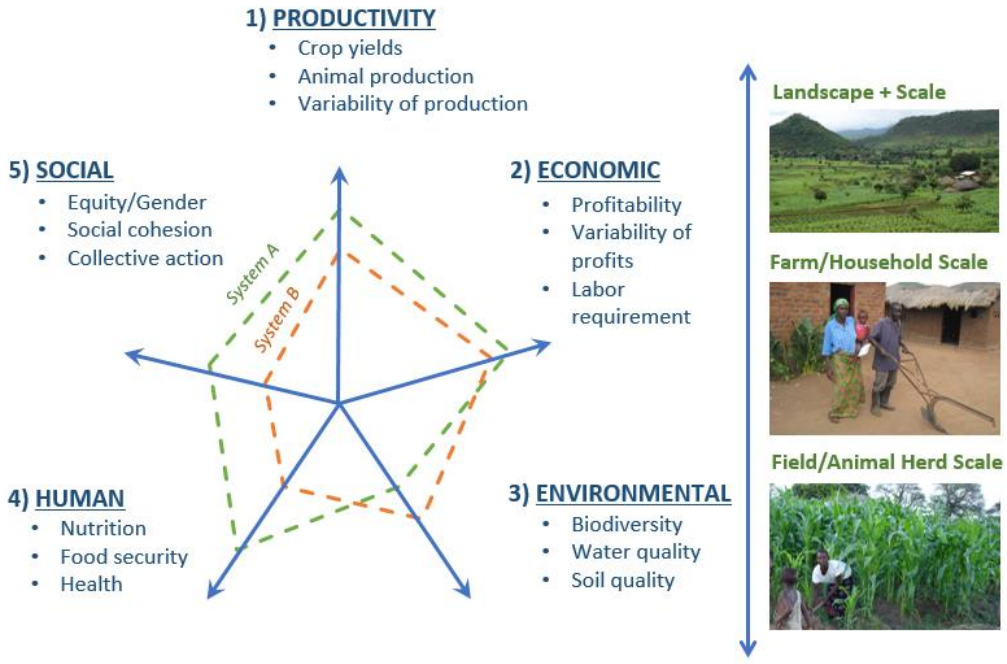
Each group was asked to report back in plenary on the definition of a synergy and, the definition of a trade-off.

2.2.2 Assessment and evaluation

Trade-off analysis has become an increasingly important approach for evaluating system level outcomes of agricultural production and for prioritising and targeting management interventions in multifunctional agricultural landscapes. For participatory trade-off analysis we used the Sustainable Intensification Assessment Framework, which presents five domains namely productivity, economic, environment, human condition and social (Masumba et al., 2017). Within these five domains are indicators which are quantitative or qualitative factors or variables that provide a simple and reliable basis for assessing achievement, change or performance (Masumba et al., 2017). A participatory trade-off activity was developed to gather perspectives from stakeholders on the synergies and trade-offs of CF as being promoted by CFU in the Eastern Region. Trade-off analysis was done at district level (however it is important to note that CFU promote CF/CA across the Eastern Region) with different stakeholders including farmers and extension agents. Participants were requested to i) gather perspectives on the trade-offs and synergies of Sustainable Agricultural Intensification (SAI) practices, ii) identify key areas for action to minimise trade-offs, and iii) identify key data needs to assess the trade-offs and synergies. The exercise produced comparative analyses by gender, by sector and for various SAI practices. In this case trade-off analysis was done on CF across gender and sectors.

The process has seven stages, which included scoring of indicators under the five different domains (Figure 2). The whole process was guided by the facilitators using the assessment guide. As described previously, stakeholders were purposefully divided into groups based on the various stakeholder categories present in the workshop. These were: government, NGOs, private sector and farmers. Each group had about 6 participants, they were asked to do the following exercise as a group and to note down any comments deemed important for discussion.

Figure 2. The SAI framework showing interlinkages across the five domains of sustainable intensification and cross spatial scales with examples of indicators for each domain



Step 1 – Identify how the SAI practice influences the indicators by scoring the level of impact. Score -5 to -1 for negative impact, 0 for no influence and 1 to 5 for positive influence. Write down the score next to each indicator in each trade-off theme.

Step 2 - Within each theme, add the negative values separately from the positive values so you will now have one negative score and one positive score for each theme. Divide the negative score by the number of indicators rated negatively within each theme to get an average. Then divide the positive score within each theme by the number of indicators rated positively. Do not include the zero scores in the averages.

Step 3 - Using the provided graph, plot the average of the positive and negative values (convert to positive for graphing) under each theme. Use different colour marker pens to plot the averages of the positive and negative values. Averages will be plotted on the line for each theme and then connect those dots with the appropriate colour to make a web.

Step 4 - Discuss the results of the exercise and identify which one of the five themes will need the most attention to reduce the negative impact of the SAI practice.

Step 5 - Within that theme, identify the indicator(s) where you may need to make a change to reduce the negative impact. Write those indicators down on the green card provided.

Step 6 - Now think about the kind of investment you will need to make to reduce the negative impact on the identified theme and/or indicator. Write down the investment you would make and what outcomes you would expect to get.

Step 7 - On the back of the card write down the factors stopping you from making the investment to address the trade-off

2.2.3 Reflection

At the end a discussion was initiated with the participants on general feedback on the results of the trade-off activity, including identifying sources of any data identified as necessary to collect.

2.3 Capturing the learning process and lessons

The learning was captured at village and district levels through use of rapporteurs, flip charts, photos, direct observation, debriefing sessions and audio recording.

At village level, rapporteurs took notes of discussions while others took pictures of various stages in the learning process. Direct observations were also made at village level particularly in the fields where either CA or conventional agriculture were being implemented.

Flip charts were used both at village and district levels. These were used both in groups and in plenary sessions. Presentations from various groups provided additional opportunity of capturing lessoning processes through video clips and audio recording. The video and audio recording were done at all levels; individual, village and district. Every evening, the field team held debriefing sessions to share their observations and experiences in order to enhance the capturing of the lessons throughout the various social learning activities of the day.

Participatory analysis was a continuous process starting from data collection through to the write-up process.

2.4 Sharing of the Results

Results dissemination will include: a report, a policy brief and a journal article (the latter two including results from similar social learning and assessment processes conducted with other agricultural programmes). The results were also shared at NLA national meetings in November 2019 and January 2020. The mode of sharing beyond those meetings will largely be electronic based. However, if funds are available it will be important to circulate hard copies among farmers that participated. The social learning is meant to co-generate new evidence and support the development of tools to support farmers, government, donors and the private sector to make good policy and investment decisions. The NLA's approach is intended to strengthen collaboration among the stakeholders to jointly learn and find solutions. The audience for this report is primarily the government and its cooperating partners – CFU, donors and the private sector.

3. Results

3.1 Conceptualisation and contextualisation of trade-offs, synergies and conservation agriculture

3.1.1 Trade-offs and synergies

Trade-offs were defined by stakeholders as what one would give up in order to gain something else. For example, participants listed a number of issues they could have attended to if they would not have been attending the workshop. Another definition was "*to strengthen one part at the expense of the other*".

Synergies were defined as something that gives results when efforts are combined, rather than each working individually (NGO); Benefits resulting from combining two different groups, people or objectives (private sector), Symbiotic relationship (give and take) (government); Interdependence in crop relations in connection with productivity. Also cooperation of different plants for high yields (Farmers).

3.1.2 Conservation agriculture

Conceptualisation and contextualisation of CA (DC Chipata)

Prior to the field trip and workshop in Chipata the team had a meeting with the District Commissioner (DC) who highlighted the importance of SAI, and particularly CA, in the district. According to the DC, CF is the type of farming that has shown positive results in the farming communities. As much as there are farmers practicing CA and getting good yields the DC said that he was disappointed with some farmers who do not want to learn from each other to improve. He cited an example of one farmer who did extremely well along the Lusaka- Chipata road whose maize crop was healthy and promising a good harvest while neighbouring farmers had their crops completely damaged as a result of poor rainfall. As an agronomist, the DC could not clearly see where the neighbouring farmers were going wrong – they were within the same agro-ecological zone that, received the same rainfall and applied the same type of fertiliser but could not emulate their colleague.

In his closing remarks he thanked the CFU for its initiative on CA especially now when the issue of climate change is clearly one to be dealt with now and into the future, and he implored farmers to adopt these (CA) modern farming practices. He was also quick to mention that CA is welcomed by farmers, but bemoaned the low adoption rate. "*Farmers are quick to accept, but to adopt the technology it takes a bit of time*".

Conceptualisation and contextualisation of CA (farmers)

Participants at both the village social learning lab (farmers only) and district multi-stakeholder social learning lab (various stakeholders including farmers) were asked what conservation farming was. During the village social learning lab, farmers gave responses associated with the advantages of CA. This is typical of 'staging behaviour' where respondents tell visitors everything in support of a technology. When the question was rephrased to ask farmers to list things that they were doing when implementing CA, the farmers listed various practices. Some of these practices were listed in both the district and village social learning labs but others were not listed in either social learning lab (Table 2).

Generally, the participants at the district level social learning lab seemed to have a broader conceptualisation of CA than participants at the village level. Within the groups at the district social learning lab, there were no substantial differences among men and women farmers but there were remarkable differences between farmers and the other groups. The farmers' list included practices that were not listed by other groups, such as; liming, tilling against the slope (essential from a practical point of view), and application of manure. The farmers were not so much concerned about the core practices of CA - of crop rotation, crop and precise input application as promoted by CFU. The

farmers either had to be reminded about these practices in order to list them or they did not list them at all.

Table 2. Contextualisation of conservation agriculture in a village and district social learning lab

What is conservation agriculture about?	Village social learning lab (farmers only)	District social learning lab (various stakeholders including farmers)
Minimum tillage-Foundation	√√	√√
Crop rotation with Legumes	√	√√
Keeping plant residues	√	√√
Agroforestry with Musangu	√√	√√
Agroforestry with *Gliricidia*	√√	x
Timeliness e.g. starting land preparation in time	√√	√√
Precise input application-efficiency in input use	X	√√
Concept of tilling a manageable area	X	√√
Safe use of herbicides	X	√√
Liming	√√	x
Tilling against slope	√√	x
Application of manure	√√	x

KEY: √=listed after being reminded about the CA practices being promoted by CFU; √√=Listed without any reminder; X=Not listed

Benefits and challenges of CA vs conventional farming

Farmers highlighted the benefits and challenges of both conservation and conventional farming (Table 3). In Zambia, conventional farming generally consists of ploughing with a mouldboard plough, minimal to no application of fertiliser, herbicides and pesticides, mainly weeding once and practicing mono-cropping. Many farmers were able to make this assessment because they apply both conventional and CA approaches.

Table 3. Farmers' assessment of benefits and challenges associated with CA and conventional framing

Benefits of conservation agriculture	Challenges of conservation agriculture
• High crop yields from small pieces of land (maize), improved food security and income • Improves water retention, important for drought periods • Enables early planting and early harvest • Improves soil fertility hence use of less inputs such as fertiliser • Not labour intensive (use of ripper and herbicides) • Less soil disturbance hence reduced soil erosion	• If one does not have manure or fertiliser, crops do not do well • Lack of weed killer (herbicides) makes weeding laborious, it actually burdens women • In a good to above normal rain season it can cause water logging and affect crops • Digging planting basins is labour intensive, with basins CA needs a lot of power/strength • Weeding using hands is very difficult • If using hand hoe, area covered is very small • Collection of manure requires transport
• Crops grow fast • Low weed pressure, easy to weed and no need for herbicide • It discourages laziness as one has to prepare bigger areas of land • When there is too much rain no challenges with water logging as crops are on ridges • Ridging reduces weeds pressure • We can produce different types crops in same piece of land • Groundnuts do very well • Crops grow well, fast and there is less competition for nutrients	• It is labour intensive (requires labour over longer period) • Causes soil erosion because of tilling everywhere, cause soil hard pans and promotes loss of soil fertility • Expensive to prepare land • Yields are low (not enough food), plant populations is a challenge • In dry years crops wither • Difficult to apply manure

CA has many components which are applied at different intensities and levels by different farmers. Of these components ripping (minimum tillage) emerged as one of the most practiced and preferred. Farmers highlighted the following about ripping:

- A bigger piece of land is worked on in a very short period
- Ripping improves soil air circulation
- A ripped field does not require a lot of seeds as one would only plant once and no need to replant
- Nutrient application concentrates where plants are
- It is a way of weeding before planting

Both CA and conventional farming approaches have their challenges and benefits, although it is clear that, in both cases, farmers definitely need inputs (both external and local) to enable them to produce enough. CA is good only when one has implements such as the ripper and can afford other inputs such as fertilisers and herbicides. Having these inputs can substantially reduce labour required from the farmers - this seems to be a challenge as farmers highlight that CA can potentially cause laziness. It is therefore important for technology implementers/promoters to have a holistic assessment of benefits and challenges of different technologies. This will enable implementers to give guidance on, for example, what other activities farmers can engage in to make use of the time freed up. Lack of inputs such as herbicides can increase weeding time required by farmers, hence it is imperative to design and target different practices to suit different farmer types.

Individual farmer and extension officer experiences of CA

Farmers who were participating in CA were interviewed so they could share their experiences. Extension officers were also interviewed to understand challenges and benefits of CA across the district.

David Mwale, farmer from Chief Kapatamoyo (Chipata)

- Started CA in 2009
- Happy with CA even though friends been laughing at him as to why he cultivates early
- Healthier crops – maize, sunflower and groundnuts
- Good water retention with early planting
- Able to feed his children and able to pay for their school
- Manages crop residues and doesn't burn his fields after harvesting
- Livestock feeds from the field and improves animal nutrition
- Planted Musangu tree for fertiliser and home energy needs

Challenge:

- Does not know when to apply manure and how much and would like CFU to train him on that

Rodrick Ngoma, farmer from Madzimoyo chief Chinyaku

- Before CA had challenges with his farming and had very poor yields most of the years and not able to meet the needs of his family for survival
- In 2008 CFU visited and engaged him through training
- Hired oxen to increase hectarage
- Benefits – Bought oxen, taken children to school and completed secondary school education, bought a motor bike, built agro shop supplying inputs to the farmers in his community
- Planted Musangu trees and he's found it beneficial as he doesn't need to use D compound
- Trained by Profit Plus on the different technologies.
- Great benefit of CA for him
- He has more time to do other things – Provides services to his fellow farmers – increased his incomes, Manages to rip 1ha per day and able to plant the same day and apply manure and urea since he doesn't need D compound
- Use of chemicals has also freed up more time for him
- Doesn't need to hire labour for weeding and his wife does not do laborious work anymore

Abraham Banda, Extension officer for Chipata, Mambwe and Vubwi districts CFU Eastern Region

What he does and is promoting

- Promoting CA with the sets of practices to increase productivity
- Farmers use land sustainably
- Minimum Tillage – basins using chaka hoes and ripping using oxen or tractors to improve water harvesting
- Farmers should maintain a layer of residue to reduce soil erosion and allow the decomposed residues to be used as manure
- In view of climate change crops require a lot of water - last 4 years poor rainfall in the region
- Encourage farmers to have permanent planting stations – harvesting manure from the residues and also particular about how the farmers manage the nutrients
- Crop rotation – Legumes and other crops also beneficial for pest management
- Diversification in case one crop is not doing fine
- Promoting the planting of more trees besides the Musangu as it is government policy to integrate trees in farming
- Increase in population requires more hectarage to increase production
- Musangu has characteristics – dropping leaves and the leaves provides nutrients

Challenges

- Residue management challenges – people in the region burn residues for mice hunting hence managing residues is a challenge. The fields which are closer to villages are more at risk.
- Worked for CFU for 9 years and the programme only allows 2 years for operating in each area
- In the first-year adoption is extremely poor with farmers waiting to see the results from early adopters
- Adoption standing at 30-40%
- Field days conducted and farmers have an opportunity to see what CA can do and they adopt after making comparisons on the technologies
- Promoting two technologies – basins and ripping
- Women mostly adopt basins because they have time to do that. Most men have too many other things to do
- Investing in the option for ox ripping – now farmers are increasing the number of oxen they have. Programme is encouraging farmers to buy oxen for business and working towards having a farmer in each area to provide ripping services
- One of the farmers has been able to make money cultivate 50 acres of land at ZMW120 per acre
- Land ownership in eastern region – farmers have little access to good land and do crop rotation
- In areas where the project is no longer active the farmers have continued practising
- Human nature – people tend to wait a longer time before they adopt

3.2 Joint Assessment of socio-ecological trade-offs of conservation agriculture

As described in the previous section, Joint participatory trade-off analysis of CA was done in groups (private sector; public sector; civil society organisations and non-governmental organisations, female and male farmers). The results generally show more positive than negative influences of CA among the five domains (Table 4 and Figure 3). For complete results see appendix 2.

In section 3.1 above, farmers highlighted both benefits and challenges of CA. their scores in the joint assessment exercise, however, show otherwise: all farmers, both male and female, ranked CA highly on all five domains. See table 4 and figure 3 below for the scoring and table 5 for participants' comments on the trade-offs identified.

Table 4. Average score across sustainable intensification assessment domains by different stakeholders.

Domain	Direction of influence	Private sector	Farmers (male)	Farmers (female)	NGO/ CSO	Government (District)	Average scores
1.Agricultural Productivity	Positive	2.4	5.0	5.0	2.7	2.3	3.5
	Negative	-1.0					-1.0
2.Income	Positive	3.4	4.7	4.3	3.0	2.8	3.6
	Negative	-3.0	-5.0	-3.0		-3.0	-3.5
3.Land Health	Positive	3.0	4.9	5.0	3.1	2.9	3.8
	Negative	-2.0		-3.0			-2.5
4.Human Condition	Positive	4.25	5	5	3.5	3.8	4.3
	Negative						
5.Social	Positive	2.8	3.8	5.0	3.4	4.3	3.9
	Negative						

Key: Positive influence meaning farmers are benefiting, negative shows losses or barriers

Domain 1: Agricultural productivity

Under the agricultural productivity domain, both male and female farmers gave a score of 5 while the NGO/CSO group - the main promoters of the technology - gave a score of 2.7, and government and private sector gave scores of 2.3 and 2.4, respectively. This raises a question about why farmers rank CA so high while at the same time they highlight challenges.

Farmers suggest that CA provides consistently good crop yields irrespective of seasonal variations but are concerned about livestock feed, especially during the dry season, and see increased crop residue as provision for livestock feed. Correspondingly, the NGO/CSO group see livestock as a challenge to achieving residue retention. The private sector stakeholders agree that in the long-term CA will assist with increased yields and soil fertility, however they suggest that yields will reduce in the short-term as farmers will not be using fertilisers. The Government stakeholders also give a low score for productivity because of the exclusion of livestock from the CA approach. They are of the view that CA must integrate livestock to reduce competition between crop and livestock for mulch and feed, respectively.

Domain 2: Income

CA can be labour intensive if implements such as the ripper and or herbicides are not used to control weeds. This was highlighted by farmers at community level and seconded by different stakeholders at district level. Most stakeholders scored the labour requirement indicator with a negative three, however the private sector suggested that use of CA equipment and principles can reduce labour requirements.

The fact that CA requires different inputs and implements limits its profitability, hence the low scores under the income domain. Farmers and NGOs are of the view that income can be increased through increased production using CA but access to markets emerges as a serious challenge to realising that potential increased income. This issue is reflected in the negative ranking from male farmers. Even if markets are available, farmers are not involved in deciding on prices and have poor access to market information. The Government representatives emphasised that it is important for organisations promoting CA to provide market information and incentives for farmers.

Domain 3: Land Health

There were mixed views on CA's impacts on land health. Land health generally improves with CA, however there is need for training on proper use of herbicides and pesticide. If herbicides are used (which reduces labour required for weeding) there are negative effects on biodiversity and water quality (potential ground water contamination especially if farmers use shallow wells). The NGOs highlighted that there is a shortage of wood for fuel as few farmers are planting trees. However, the Government group reported that those who plant fast growing species like Gliricidia can have both wood and leaf biomass for soil fertility.

Domain 4: Human condition

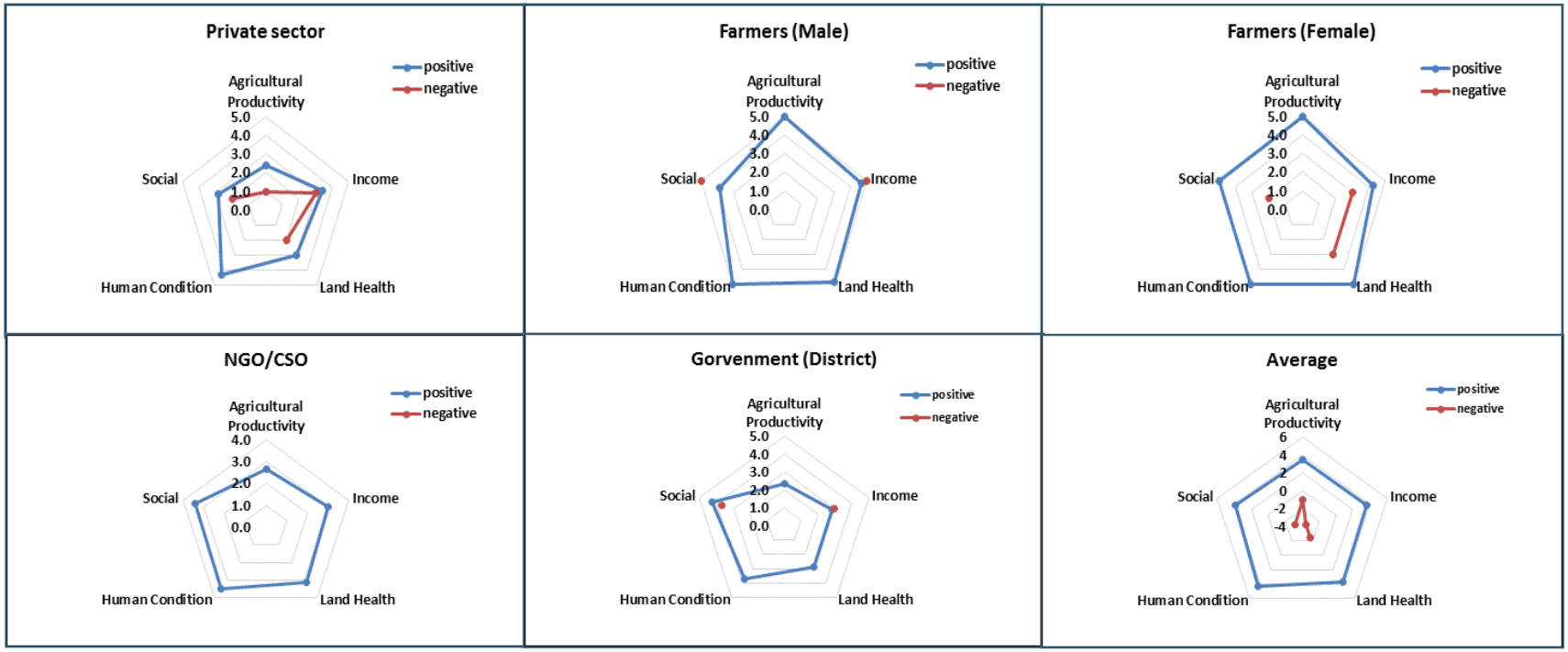
Under the human condition domain, the CA technology was highly ranked by all stakeholders. This may be due to the possibility of including legumes and increases in maize production. All stakeholders agreed that increased crop productivity and crop diversity as promoted by crop rotations improves nutrition. Income gained can assist in sending children to school and general wellbeing of the household.

Domain 5: Social

A larger number of negative scores were highlighted by most stakeholders under the social domain. A key reason was the negative score given to the "access to credit" indicator. Access to credit is a challenge affecting all farmers whether one practices CA or not. One of the reasons is that, in many cases, farmers do not have collateral. Access to credit is conditional while access to market information is a challenge.

In addition, stakeholders reported that youth participation in agricultural activities, particularly males, is very low. Reasons for this include the difficulty of practicing CA if one does not have the required implements and the fact that benefits take longer to realise while the youths tend to prefer faster returns (government). Women participate more, however there is a need to tailor technologies so as to increase the ability of physically challenged people to practice CA.

Figure 3. Assessment of socio-ecological trade-off by different stakeholders showing positive and negative influences of conservation agriculture across the five sustainable intensification domains



3.3 Farmers' and other stakeholders' perspectives on trade-offs of SAI approaches and technologies

As noted earlier, trade-offs were defined by farmers and other stakeholders as "what one would give up in order to gain something else" In practicing CA, participants identified a number of trade-offs (tables 5 and 6 below).

The use of herbicides for economic saving of labour vs diversification in terms of being able to grow different crops in one field is one trade-off identified. Traditionally farmers practice intercropping for diversification, and pest management among other reasons. However, due to their selective nature, the use of herbicides does not support intercropping while increasing the potential for mono-cropping. Hence diversity is lost. While, without the herbicides, labour is a challenge especially for women and children.

Livestock production is an important source of livelihood in Eastern Province, however one of the CA principles is that of keeping residues in the field as mulch. The trade-off here is that of cost to soil health (improved by the use of organic fertilisers) vs benefits from livestock products and services and or cost of livestock feed. The keeping of residue for mulch is difficult to reconcile with communal grazing practices in smallholder farming systems. Generally, very little crop residue remains on the fields at the end of the dry season as most farms are not fenced.

Crop rotations are also important for CA benefits to be realised, however legume markets are not well established in the country. Farmers battle with the cost of soil health (organic fertiliser) vs production of other cash crops (e.g cotton, tobacco etc). Areas under maize are generally larger than those under legumes, reducing the practice of rotation.

Farmers do battle with the above trade-offs when making decisions on which practices to use on-farm. As much as CA has potential to improve crop productivity, income and land health the above trade-offs need to be understood and addressed to help farmers' decision making in terms of take-up of the CA approach.

Table 5. Comments from different participants on socio-ecological trade-off assessment on conservation agriculture across the five SAI domains

Domain	Male farmers	Female farmers	NGOs	Private sector	Government
Agricultural productivity	• Domestic animals increase in number due to availability of feed (crop residues) • CA keeps moisture	• Productivity is very high even this year when there is excess rains. For CA farmer it is 100%	• Plant residue retention is quite tricky because of uncontrolled burning plus grazing.	• Productivity has reduced because of non-application of chemical fertiliser • Residues will reduce costs for the farmer i.e. by not using chemical fertiliser • Improves the quality of livestock through feeding of residues	• Plant residue productivity adoption is low • No CA targeted towards livestock productivity
Income	• CA harvest a lot of food and money • CA brings good soil as the farm products increases	• Capacity to sell agricultural products is a problem. • Labour intensive • Poor access to market information as a result briefcase buyer take control	• Marketing is terrible therefore low profitability • Capacity is there but market is where the problem lies. Farmers are not involved in the pricing of their products	• Will increase because of less use of chemicals • Unpredictable because of the weather pattern • Will generate more income from various crops • There is maximum use of inputs • Proper use of CA equipment and principles will reduce labour requirements	• Institutions promoting CA provide market information and incentives for CA farmers
Land health	• Because of good soil, the germination increases • Because of increased manure, even crop yields are also increased	• Insect biodiversity is a challenge because of not knowing the right pesticides to use and the safety to our lives • some farmers don't have safe drinking water	• Fuel wood security is a challenge as very few are planting musangu (Fidherbia Albida) and a lot of fields are cleared of any shrubs to prepare for planting	• If trees are planted properly, they reduce deforestation • There is need for proper use of insecticides and herbicides (IPPM) • Help to conserve and improve the water quality • Increases soil health	• In areas where there are agroforestry species like Gliricidia Sepium there is production of fuel wood; biomass transfer increases soil health and so will retention of crop residue and application of animal manure
Human nutrition and food security	• There is no HIV/AIDS because we have plenty of food for all the groups • Food is plenty because we harvest a lot of farm produce • We manage to take children to school	• When you have plenty of food nutrition, human health, access to education becomes easy	•	• There is food security because of a variety of crops • A variety of food is readily available hence supporting nutrition	• Human health is improved as result of additive effects of improved crop productivity, profitability and nutrition.
Social	• Young men do not take part as they see it to be very difficult • A lot of woman are the ones who take part • A lot of groups do not want to take part because they want to do it on their own	• As farmers, we don't have access to credit from banks • The Government does not take part in promoting CA because it is not budgeted for. Instead they leave to donors, Private Sector, Village Bank	• Female youth are more involved than their male counterparts who indulge in alcohol. • Cotton and tobacco get notable access to credit, the rest exist solely as out grower schemes • Access to information is high but application is low.	• Participation of youths is not much at the moment and need to be encouraged.	• Youths have no patience for CA (live a life of urgency) • Physically challenged people do not have tailored technologies

Table 6. Examples of Farmers' and other stakeholders' perspectives on trade-offs of SAI approaches and technologies

Technology	Benefits	Negative	Trade offs
Use of herbicides v hand weeding	Reduce labour burden especially for women, also time gained can be used for other activities for increasing household income	Farmers say that most of them do not have anything to do especially during the rainy season, hence too much time and this leads to laziness. Herbicides if not properly used can also affect the environment No crop diversification	Diversification in terms of being able to grow many crops in field v economic saving of reducing labour Environment cost of water pollution, loss of biodiversity v economic saving of reducing labour
Use of ripper v conventional plough	More land can be cultivated (e.g. convert more land under conventional practice to CA), crop yields (grain and residues increased), income also can be increased	Too many weeds when using ripper hence need for herbicides Soil disturbance is high with conventional plough leading to land degradation	Environment cost of water pollution, loss of biodiversity v environment cost of land degradation
Crop residues and livestock	Dry season feed, improved livestock production	Needed for soil cover (mulch)	Cost of soil health (organic fertiliser) v benefits from livestock services and products Cost of soil health (organic fertiliser) v cost of livestock feed
Rotations	Soil health improved, as well as household nutrition and income	Not able to plant legumes on larger areas due to market challenges	Cost of soil health (organic fertiliser) v income loss due to lack of markets or production of cash crops instead of legumes

3.4 Identification of priority areas for action

Participants were asked to discuss the results of the previous exercise and identify which one of the five domains (and which specific indicators within that selected domain) will need the most attention to reduce the negative impact of the SAI practices. Although there was agreement in some case, in the main different stakeholders highlighted negatives in different domains (table 7 below).

Farmers and government agreed on the need to address some indicators under the social and income domains. These were; access to credit, capacity to sell agricultural products and participation of youth. Investments needed include provision of soft loans, capacity building through on-farm demonstrations, creation of youth groups, and use of approaches such as social activities to promote agriculture. Government representatives suggested support should also include provision of implements and inputs, which currently are difficult to get as youths do not have capital and generally cannot get loans. Lack of implements and inputs deters the youth from participating in CA. The private sector agreed that access to loans is a challenge for farmers, however were also of the view that there is a need to train farmers on loan management: this would include disseminating information about loans to farmers. The government actors suggested that lack of political will, lack of farmers' will to adopt technologies and heavy reliance on input subsidies are some of the factors that hinder developments towards farmers' access to credit.

The private sector and NGOs highlighted indicators under the crop productivity domain, where areas of attention needed are plant residue and crop productivity. Private sector representatives said that contract

farming is an approach that can be used to increase productivity as markets will be assured. They also were of the view that it is important not to only focus on NPK rich fertilisers, but to also consider liming as most soils are acidic.

On the issue of crop residues the NGOs identified retention of these as tricky due to communal grazing and uncontrolled burning. They also said that factors causing low adoption of also CA include the generally limited scope of CA projects: they are mostly activity based and limit innovation/useful integration. Due to the nature of the projects there is generally a low sense of ownership on the farmers' side and a lack of coordination amongst promoters.

The government and private sector actors identified the participation of marginalised groups under the social domain as a challenge. They said that there is need for designing user-friendly technologies and developing programmes that enable easy participation in CA.

Table 7. Investments needed to effect change and the stumbling blocks that are hindering stakeholders from addressing the trade-offs

Group	Domain that needs most attention	Indicator that needs most attention	Actions needed	Barriers to investments
Farmers-Women	Income	Capacity to sell agricultural products	To provide soft loans for machines for processing	No access to loans from the banks Poor markets (low prices)
Farmers-Men	Social	Access to credit		
		Participation of the youth	Inviting youths to participate in lessons of farming Creation of groups Use socially attractive approaches e.g. football games Calling all people to be taking part during field days	
Private sector	Agricultural productivity	Crop productivity	Selling of agricultural lime and organic manure Contract farming	
Public sector	Social	Participation of the youth	Introducing or intensifying CA interest groups Continue capacity building through demonstration by both state and non-state actors.	Lack of political will Insufficient operational funds Lack of will to adopt among farmers Heavy dependence on free inputs from programmes
		Participation of marginalised group	Designing user friendly technologies Support CA programmes by all stakeholders to enable marginalised groups to easily participate	
		Access to credit	Capacity building on credit/loan management Improvement of information flow on loans to farmers by all stakeholders	
NGOs	Agricultural productivity	Plant residue Productivity	Sensitisation Budget flexibility	Limited scope of the CA projects Activity based funding limits innovation/useful Integrations Low sense of ownership by famers Poor adoption of CA Lack of coordination among CA promoters

4. General discussion

A CA or CF approach is generally defined as a management system based on three principles that should be applied in unison in a mutually reinforcing manner; minimum physical soil disturbance, permanent soil cover with live or dead plant material (e.g. crop residues), and crop diversification, (e.g. crop rotation, cover crops or intercrops with legumes).

Our results show that currently farmers are largely practicing only one of the three main principles of CA at most, minimum tillage. Rotations are not possible due to small areas under legumes, and residue retention is difficult to achieve due to free/communal livestock grazing and uncontrolled fires. It is therefore important to address the challenges highlighted by farmers in relation to the trade-offs they have identified if CA is to be fully practiced.

All stakeholders, with the exception of the private sector, held a common narrative on the potential for CA to achieve higher yields or productivity. However, there was little emphasis from participants (apart from the private sector) on the need to expand the area under CA in order to realise these benefits although it was generally agreed that the areas under CA are still small such that the total volume of produce realised is too low to attract private sector investments, such as in provision of markets. This suggests that extension messages are only emphasising productivity whilst providing insufficient information on the need to expand the area under CA to a level that allows households to substantially increase their food security and income. Thus CA does not only have a problem of low adoption rates in terms of the number of farmers using the technology (Zulu-Mbata et al., 2016) but it also lacks of the ability to expand the area under conservation substantially (on current farms).

Crop residues as mulch are barely mentioned by farmers and even by some of the promoters of CA. Challenges associated with the use of residues in CA include livestock, due to communal grazing, and uncontrolled burning largely caused by mice hunting. This raises questions; when farmers say CA improves soils, is this from experience or from what promoters are telling them? There is no soil testing that is done or other means by which farmers could know whether or to what level soils have improved and to know which nutrients are still required.

Rotation is also one of the important ingredients in the CA recipe, however few farmers manage it as most legumes are grown on small areas for household consumption only due to lack of markets. Farmers struggle when making decisions on whether to improve soil health at the cost of losing income due to lack of legume markets or grow other cash crops such as cotton and tobacco instead.

Projects are short lived, but benefits of CA are generally seen in the longer term. This creates a key challenge for promoters of CA and others in assessing the benefits to farmers of adopting the practices. In the short term, fertiliser may be the reason for increasing yields. To assess the benefits of CA or other SAI practices there is need to work with farmers who have been practicing "religiously" and to assess in terms of soil quality, yields, labour etc. On the legumes issue, stakeholders highlighted that they can create value addition. For example, they can grow crops such as soya beans which are currently being imported for feed production. This will create markets for their produce and can incentivise farmers to grow legumes as they will have a ready market. Currently the middle men play a big role in agricultural markets and not many farmers are benefiting, hence there is little incentive to produce more of the legumes. The lack of markets and conducive government policies directly or indirectly promotes mono-cropping leading to soil fertility decline, low yields and poverty.

5. Conclusions

Conservation Agriculture has potential to increase agricultural productivity, income, land health, human condition (nutrition, food security) and improve certain social aspects of peoples' lives. However, there are a number of

challenges that need to be addressed in order to fully realise these benefits and these can be identified by understanding the trade-offs faced by farmers as they make their decisions on what to grow and how.

The main challenges are failure to practice all principles of CA, in particular residue retention for mulching and crop rotation. Residues are a good source of dry season feed hence there is need to consider livestock issues when promoting CA – livestock currently does not receive very much consideration. Crop rotation brings in crop diversity and can improve nutrition and income at household level, however access to markets and market information are limited leading farmers to grow legumes on small areas only, leaving large areas for maize production, for which markets are understood and available. Developing markets and other options such as value addition could potentially boost legume production and move farmers away from a mono-cropping culture.

There is also an issue around labour. If farmers do not have implements such as the ripper, the alternative is the hand hoe which is labour intensive and can only be used on small areas hence limiting areas farmed under CA principles. If implements such as the ripper are available, but there is no income to buy herbicides, farming is still labour intensive. For this reason most farmers resort to using the mould board plough. Using herbicides has also been highlighted as a potential hazard; there is not much information provided to farmers on their benefits and possible negative effects. In addition, labour issues seem to limit participation of the youth who have the potential to drive the agriculture production agenda.

Other challenges to full take up of CA identified include some related to the design of CA projects and in particular;

- Their limited scope
- The activity based nature of the projects that tends to limit innovation
- A low sense of ownership on the part of farmers
- A lack of coordination among promoters of CA

It is therefore important for CA promoters to understand these challenges and trade-offs and address them, for full benefits to be realised. Currently full benefits of CA are not being attained by farmers. Unless these challenges and trade-offs are understood and addressed, farmers will continue to devote larger pieces of land to conventional farming (low input agriculture practice), which leads to land degradation and reduced yields. Sustainable agriculture intensification, in this case CA, has potential to increase production on current farm sizes and can potentially reduce opening of new fields particularly in search of more fertile land elsewhere.

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Appendix 1.

Attendance List for District Workshop

S/N	Name	Sex	Organisation
01	Virgil Malambo	M	Chipata District Farmers Association
02	Yusuf Patel	M	Businessman
03	Chichonya Geofrey	M	Modern Bazaar
04	Sungwe Nshafuti	M	Export Trading Group (ETG)
05	Kampamba Kelvin	M	Ministry of Fisheries and Livestock
06	Philimon Lungu	M	Ministry of Agriculture
07	Moonga Ndulo	M	Ministry of Agriculture
08	Emma Sichala	F	Forestry Department
09	Mwewa Libweshya	M	Chipata City Council
10	Pascalinah Muntanga	F	CFU
11	Abraham Banda	M	CFU
12	Mwape Chibale	M	COMACO
13	Kenny Silwimba	M	CFU
14	Joyce Nkoma	F	Mafuta Cooperative
15	Florence Lungu	F	Mnoro Cooperative
16	Christabel Phiri	F	Charampa Cooperative
17	Yotam Nyirenda	M	Chiparamba Cooperative
18	Grace Phiri	F	Chinjara Cooperative
19	Bornface Phiri	M	Feni Cooperative
20	Lovemore Bakili	M	Mnoro Cooperative
21	Rodrick Ngoma	M	Chisitu Cooperative

Appendix 2.

Scores across sustainable intensification assessment domains by different stakeholders. (Positive influence meaning farmers are benefiting and negative showing losses or barriers)

Domains and Indicators	Private Sector	Farmers (male)	Farmers (female)	NGO/ CSO	Government (District)	Average
Agricultural Productivity						
crop productivity	-1	5	5	3	3	
plant residue productivity	2	5	5	1	1	
livestock productivity	2	5	5	2	1	
consistent production over time	3	5	5	3	3	
crop diversity	4	5	5	3	3	
capacity to produce surplus for the market	1	5	5	4	3	
average positive	2.4	5.0	5.0	2.7	2.3	3.48
average negative	-1.0					-1.0
Income						
profitabilty	4	5	2	2	3	
consistent profit from each cropping season	0	3	5	2	2	
income diversification	3	5	5	3	3	
input use intersity	4	5	5	2	2	
labour requirement	-3	5	-3	3	-3	
capacity to sell agriculture products	3	5	-3	4	3	
access to market information	3	-5	-3	5	4	
average positive	3.4	4.7	4.3	3.0	2.8	3.6
average negative	-3.0	-5.0	-3.0		-3.0	-3.5
Land Health						
vegetative cover	4	5	5	3	3	
plant biodiversisty	-2	5	5	3	4	
fue security	1	5	5	2	2	
insect biodiversity	2	4	-3	3	1	
water availabity	3	5	5	4	4	
water quality	4	5	-3	3	1	
soil health	4	5	5	4	5	
average positive	3.0	4.9	5.0	3.1	2.9	3.8
average negative	-2.0		-3.0			-2.5
Human Condition						
nutrition	4	5	5	4	3	
food security	4	5	5	4	4	
human health	5	5	5	3	5	
access to education	4	5	5	3	3	
average positive	4.25	5	5	3.5	3.75	4.3
average negative						
Social						
participation of the youth	1	3	5	3	-2	
participation of woman	4	5	5	4	3	
participation of marginalised groups	1	2	5	2	-4	

Domains and Indicators	Private Sector	Farmers (male)	Farmers (female)	NGO/ CSO	Government (District)	Average
participation in farmer groups/womans groups/youths groups	3	3	5	4	4	
access to credit	-2	-5	-2	2	-5	
access to government institutions	4	5	-2	4	5	
access to information	4	5	-2	5	5	
average positive	2.8	3.8	5.0	3.4	4.3	3.9
average negative	-2.0	-5.0	-2.0		-3.7	-3.2