



**African Conservation Tillage Network**

*"Turning Conservation Agriculture Knowledge into Action"*

## **2016 AN ASSESSMENT OF CONSERVATION AGRICULTURE IN ZAMBIA**

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## **Executive Summary**

### **1. Background of evaluation**

Conservation Agriculture (CA) has been promoted in Zambia since the mid-1980s by government, private sector, cooperating partners, and a number of non-governmental organisations to varying degrees in terms of coverage area, operational approach, time span and technical content. Until recently, targeted areas of implementation were mostly in agro-ecological regions IIa and I (*see map attached*). Different project methodologies were employed to implement CA by the different institutions. In 1999 the government of Zambia decided to support the introduction and spread of CA countrywide as a matter of policy, with a target to engage 50% of farmers into the CA uptake process by 2015.

By 2013, global trends record 155 million hectares under CA and 50% of which is in developing countries. A number of studies have been conducted to investigate the economics and adoption of CA practices in Zambia. While some report of between 200,000 to 300,000 farmers practising forms of Conservation Agriculture, many scholars observe that CA adoption still remains low not just in Zambia but in most developing countries as well. Others document high levels of dis-adoption of CA practices particularly when supporting programmes withdraw. Various reasons for low adoption and dis-adoption are challenges that researchers, technologists, extensionists and scholars need to positively tackle in the CA promotion agenda as a desirable practical intervention for responding to climate change. A shift from labour-intensive manual land preparation (planting basins) and weeding (women and children) systems to less labour-demanding ADP and motorised systems suggest increasing CA hectareage and uptake.

### **2. Methodology of evaluation**

An ex-post evaluation methodology was applied because of different objectives and implementation strategies by different implementing agencies at different times. Guided by 3 key questions, a number of steps to facilitate the study were employed. These steps included selection of study districts (Mumbwa and Mpongwe), literature review, key informant interviews, household surveys, and data compilation in readiness for analyses. Details are given in section 2 below.

### **3. Major results and discussions**

#### *(a) The Impact of the different CA interventions in Zambia*

While CA practices among smallholder farmers have been promoted mostly in agro-ecological regions IIa and I, these interventions are also being adopted in the agro-ecological region III (a higher rainfall area).

Extension support to the households, cattle ownership and asset holding were regarded significant in determining adoption of CA practices. Physical constraints, farming practices and climatic factors influenced participation of farming households in CA activities, and thus significant in the adoption process. It was also observed that smallholder farmers positively implemented CA because of financial incentives, reduced production costs, and access to support services.

Results of the survey in Mumbwa and Mpongwe districts show increasing engagement with CA related practices among households trained by promoting agencies, but also through self-adoption processes, and continued farmer-driven learning and training through farmer-to-farmer interactions. A discussion on decision making about whether to participate on CA interventions

or not follows from different perspectives.

From the key informant interviews conducted, knowledge and skill of herbicide use has increased steadily in the targeted areas, not just among CA farmers but also among non-adopters, recording a rise from 5% to as much as 30% of effective herbicide use within a 5-year period (2010-2015). In addition, many farmers have extended their CA to include planting of trees such as *Faidherbia albida* which has caused increased of maize yield of as much as 4.1 t/ha without use of inorganic artificial fertilizer.

While it is generally felt among sections of the scholars that some initial efforts did not achieve widespread adoption of CA, recent developments point to increased participation for a number of reasons:

- the weather changes show that crop yields under CA practices perform better because of embedded in-situ rainfall water capture techniques, supported by precision input placement, than under conventional practices particularly in drought seasons or when rains are erratic and unreliable;
- improvements in addressing labour-demanding operations that can sometime act as a hindrance to adoption, in terms of land preparation (involvement of CA ripper and seeding hire services, which must also lead to herbicide weeding hire services), and weeding demands (affordable and effective use of herbicides);
- increased availability of CA equipment among farmers (not necessarily individually owned only but also through hire services); and
- development of confidence and experience, and improved and shared knowledge and skills among field staff on CA systems and on CA introduction and adoption process.

*(b) How CA has affected gender dynamics in the different communities and its effect on labour*  
Resource-poor smallholder farmers in Zambia, like elsewhere in Africa face shortages of labour, farm power and inadequate financial support which can limit their access to improved technologies. However, CA interventions when correctly implemented offer opportunities to introduce commercialisation of farming that can generate surpluses at lower input costs and thereby increase crop income significantly. A mixture of participation by female and male farmers by household lead-persons characterised the CA adoption and uptake agenda.

*(c) Institutional factors affecting CA adoption and uptake.*

In 1999, the Government of the Republic of Zambia, through the Ministry of Agriculture, Food and Fisheries (MAFF), declared Conservation Farming (CF) and related technologies a priority for promotion by both MAFF and the various partner Institutions. It supported an intensive training programme of all its Camp Extension Officers in Central, Eastern, Lusaka and Southern provinces with a 'fast-track' approach for promoting to demonstrate its commitment. MAFF set a target of 50% of farmers to be engaged in the CA adoption and uptake process by 2015.

#### **4. Key lessons learned**

- (1) Absence of a CA 'clearance' or repository centre has led to institutional memory loss over the years from many agencies who once-led CA introduction and adoption promoting projects and programmes, to an extent of creating lapses in records, spread of adoption and performance of CA among farmers;
- (2) The studies that suggest that the promotion and uptake of CA in Zambia has not 'skyrocketed', and that adopting farmers only use some of the principles on a portion of their land, is leading to deterring potential development investment and research on CA that would have attempted to address new positive developments.
- (3) Information sharing is limited among development agencies promoting CA making it difficult to understand and appreciate the real status of agricultural transformation towards

CA in Zambia. Partners tend not to fully share some information with others.

- (4) CA adoption and development requires competent promoters with a longer-term commitment that can keep pace with target groups, responding and building their confidence, with or without development 'incentives'.
- (5) From the study, it is evident that widespread CA adoption is a time related process, just as any other agriculture system including conventional tillage agriculture. The process of adoption and spread as well as in establishing and improving CA system quality, soil health and farmer knowledge base and experience of his or her specific CA system takes time for smallholder farmers who are familiar and experienced in using traditional methods. Similarly, realisation of different types of productivity, economic, environmental and social benefits come through over time as CA management, social conditions and cropping systems improves.
- (6) Farmers adopting CA practices tend to establish a basin-making plot of about 0.25 ha for guaranteed food security, even when they may have other reduced or zero tillage systems on the farm such as micro-pits in manual systems or direct no-till seeding with tine (or shallow ripper furrow) seeders in animal traction or mechanised systems where in-situ water harvesting is not critical.
- (7) Input and output markets and supply chain services are essential for the sustainable adoption and spread of CA like is true with any farming technology.
- (8) The study points out that affordable access to private-sector/farmer-led animal draught power (ADP) or motorised hire services for no-till ripper seeding services and " herbicides application services hold high potential for CA adoption and widespread uptake. Alongside, there is a need to promote the development of soil mulch cover with residues and cover crops, and for diversifying cropping systems. These practices take longer to establish in drier areas than in moist areas but they would add resilience and sustainability to existing and new CA systems and their adopters.
- (9) There is a need to redress effectively communal land use systems especially those that involve unsustainable crop-livestock relationships under customary tenure that lead to land degradation and loss of productivity.

## **5. Recommendations for future programming**

- (1) Although the uptake of manual CA systems in many customary areas has increased, the area under CA still remains relatively low due to high initial labour demand for land preparation and weeding. Greater adoption and spread may be achieved when CA its policy framework, field operations and private-sector participation are enhanced, and supported by experienced land preparation and weed-control hire schemes.
- (2) There is need to promote low labour demanding CA systems that involve use of no-till seeding in micro pits or direct seeding in no-till soils with tine or ripping seeders powered by animal traction or a tractor, where in-situ water harvesting is not challenging.
- (3) Establishment of data/report/forum/repository where all stakeholders can participate is essential to maintain the CA adoption and uptake promoting process towards consolidating and building the CA development momentum, supported with appropriate evidence of achievements, developments and lessons learned from actions taken. An initial solid adoption study is required as a basis of evidence and future record of CA development on an annual basis.
- (4) CA development in Zambia had benefitted from commendable support the Conservation Farming Unit (CFU). Further advances in CA development in Zambia in the coming years requires the support of a national mechanism with a long-term commitment and dedication to spearhead and continue the promotion and synthesis of various CA approaches and experiences in Zambia and in the region as well as internationally. This diversified approach to CA development in Zambia in the future as well as improving the quality of existing entry-

level CA practices should take cognisance of various opportunities that may be availed to the existing and future target groups under the general systems concept and principles of CA.

- (5) Zambia-based research and development must spearhead relevant CA development of practices, tools, and a critique that supports the mainstreaming of the CA adoption and uptake process suitable for Zambian smallholder farmers.
- (6) Revision in customary land use tenure management that can address the need to improve crop-residue/livestock relationship on a win-win basis should be undertaken for CA land use development across Zambia. This should include the avoidance of burning of crop residues and a positive communal grazing management for improved large-scale livestock integration with farming systems in the different agro-ecological zones. A political and developmental will to integrate customary tenure matters that will regulate burning and crop/livestock conflicts especially of crop residue management versus communal grazing is necessary
- (7) A need for assessment of non-prescriptive 'best-fit' CA technologies for different types of smallholder farmer environments.
- (8) Better CA coordination, implementation, monitoring and recording.
- (9) Identify appropriate permanent soil cover options suitable for Zambia's agro-pastoral semi-arid land use systems supported by desirable measuring tools for determining cover. longer term support to entrench relevant CA support systems addressing issues of CA tools and machinery, relevant support research (soil cover, weeding), land tenure development and farmer organisation and technology confidence building.

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## Acronyms

ACT	African Conservation Tillage Network
ADRA	Adventist Development and Relief Agency
ADP	Animal Draught Power
ASP	Agricultural Support Programme
CA	Conservation Agriculture
CAP	Conservation Agriculture Programme
CARE	Cooperative for Assistance and Relief Everywhere
CASPP	Conservation Agriculture Scaling up for Increased Productivity and Production
CCZ	Council of Churches in Zambia
CEO	Camp Extension Officer
CFU	Conservation Farming Unit
CASU	Conservation Agriculture S Up-scaling Programme
CLUSA	Cooperative League of the USA
COMACO	Community Markets for Conservation
CRS	Catholic Relief Services
CV	Conventional Farming (hoeing, ploughing, soil inversion)
DANIDA	Danish International Development Agency
EEOA	Economic Expansion in Outlying Areas
EU	European Union
FAO	Food and Agricultural Organisation of the United Nations
FISRI	Farmer Input Support Response Initiative
GART	Golden Valley Agricultural Research Trust
GTZ	German Federal Ministry for Economic Cooperation and Development
HBC	Home Based Care
KATC	Kasisi Agricultural Training Centre
KII	Key Informant Interview
ICRAF	World Agroforestry Centre
LM and CF	Land Management and Conservation Farming
LWF	Lutheran World Federation
MACO	Ministry of Agriculture and Cooperatives
MAFF	Ministry of Agriculture, Food and Fisheries
MoA	Ministry of Agriculture
NORAD	Norwegian Agency for Development Cooperation
PAM	Programme Against Malnutrition
PELUM	Participatory Ecological Land Use Management
PROFIT	Production, Finance, and Improved Technology
PUSH	Programme Urban Self Help
SCAFE	Soil Conservation and Agroforestry Extension
Sida	Swedish International Development Cooperation Agency
TSB	Technical Services Branch
UNDP	United Nations Development Programme
WVZ	World Vision Zambia
ZARI	Zambia Agricultural Research Institute
ZNFU	Zambia National Farmers Union



**(2) Agro-Ecological Region IIa:** Region IIa is a sub-region of the medium rainfall degradation plateau, which includes the main farming areas on the plateaux of most of Central, Eastern and Southern provinces. Rainfall averages from 800 mm to 1 000 mm. Altitude ranges from 900 m to 1 300 m above sea level. The length of the growing season is from about 120 to 150 days. This region comprises agro-ecological zones/sub-zones 2-ce, 2-n, 4-e, 5, eastern half of 8-c, 8-e, 9, 10, 11, 12, 14, 15, 16, 17, 19, 20, and 27-w.

**(3) Agro-Ecological Region IIb:** Region IIb is a sub-region of the medium rainfall aggradation plateau. Rainfall averages from 800 mm to 1 000 mm, and altitude ranging from 900 m to 1 200 m above sea level. The length of the growing season ranges from about 120 to 150 days. It covers Western and part of North western provinces, and is characterised by deep Kalahari sands. Region IIb comprises agro-ecological zones/sub-zones 8-c, 8-w, 13, 21, and 22.

**(4) Agro-Ecological Region I:** Agro-ecological region I receives the lowest rainfall, of less than 800 mm per year, and is characterised by low altitude of between 400 m to 900 m above sea level. This relatively hot region covers the dry areas along the Luangwa, Luano and Zambezi rift valleys. The growing season ranges between 80 to 120 days. It comprises agro-ecological zones/sub-zones 1, 2-s, 2-cv, 3, 4-w, 6, and 7.

Different project methodologies were employed to implement CA by the different institutions to meet the set objectives of improving household food and nutrition security/requirement, increasing productivity, addressing land degradation challenges, or mitigating climate change effects. CA practices in Zambia are based on retention (no burning) of at least 30% of crop residues in-field, land tillage of only 10-15% of the surface area without soil inversion, land preparation during the dry season, precise and permanent grid of planting stations (CFU), furrows, pits, trenches or ridges on the contour, and rotation with nitrogen-fixing legumes of at least 30% of the cropped area.

By 2013, global trends record 155 million hectares under CA and 50% of which is in developing countries (Kassam et al., 2014). A number of studies have been conducted to investigate the economics and adoption of CA practices in Zambia (e.g. Haggblade and Tembo, 2003; Chomba, 2004; Kabwe and Donovan, 2005; Nyanga et al., 2011; Nyanga, 2012, Ng'ombe, 2014). The survey found that of the approximately 850,000 farming households in Zambia, between 200,000 and 300,000 farmers practise different variants of Conservation Agriculture (Table 1).

Many scholars observe that CA adoption still remains low (Milder et al., 2011; Ng'ombe et al., 2014), not just in Zambia but in most developing countries (Derpsch, 2013). Others document high levels of dis-adoption of CA practices particularly when supporting programmes withdraw (Arslan et al., 2013; Ng'ombe et al., 2014; Hichaambwa et al., 2016). Researchers, technologists, extensionists and scholars need to positively contribute in the CA promotion agenda as a desirable practical intervention for responding to low adoption and dis-adoption, climate change, increasing productivity, reducing soil erosion and preserving agricultural land resources.

Table 1. *Forms of Conservation Agriculture among Small-scale Farmers*

S No	Type of Conservation Farming	Numbers of Farmers
1.	Reduced Tillage Only (RT= Minimum or Zero T tillage)	13%
2.	RT + Soil Cover (SC) + Crop Rotation (CR)	25%
3.	RT + Cover Crop (CC) + CR	7%
4.	RT + Herbicide (H) + CR	21%
5.	RT + SC+H + CR	31%
6.	RT + SC+H+CC + CR	< 5%

Source: Key Informant Interview Survey

Various reasons have been alluded to for the low adoption and dis-adoption: (i) high labour demand for land preparation and weeding; (ii) inadequate farm machinery (rippers, direct seeders, weed control); (iii) insufficient access to use of herbicides; (iv) challenge of meeting soil cover demand; and (v) inadequate time for confidence building of projects.

However, it can also be argued that where farmers have had more participation and exposure time with CA promoters, the learning has motivated them attain confidence levels that make them become emerging and self-sustaining (Mwanza, 2011). The dawn of rudimentary CA land preparation hire schemes and increased use of chemical weed control methods suggest increased levels of CA adoption, resulting in increased hectarage and production (Haggblade S. et al., March 2011).

## 2. Methodology of evaluation

An ex-post evaluation methodology was employed in the assignment in the absence of a coherent programme theory, baseline survey or a randomisation process. This is because different objectives and implementation tools were used by the different implementing agencies at different times to implement CA activities in Mumbwa (agro-ecological region IIa) and Mpongwe (agro-ecological region III) districts of Central and Copper belt provinces of Zambia respectively. A number of steps were employed:

- (1) After due consultation with key stakeholders, and responding to set requirements, the districts in Table 2 were selected.

Table 2. *Basis of Selection of Districts*

	Criteria	Districts	
		Mumbwa	Mpongwe
1	Agro-ecological region	IIa	III
2	Involvement of CA Implementers	CFU, CASPP, FISRI, CASU	GART, FISRI, ZNFU, CASU
3	Province	Central	Copper belt

- (2) Literature review of current debate on CA adoption was also done, characterised by series of recent scholarly models<sup>1</sup> to derive adoption conclusions. The study also sadly noted the poor institutional memory decay among the different CA players particularly when projects or programmes phase out, unless where publications have been made.
- (3) At field-level, an electronic-based household questionnaire was administered to capture a minimum of 100 sample households in each of the 2 districts. The 100 households were randomly selected (of whom 50% were female-led) through the field-based government agricultural Camp Extension Officers (an entry point and custodian of all interventions in specific given geographical area), of which 60 were CA farmers (treatment group), and 40 non-CA farmers (counterfactual group).
- (4) Two enumerators recommended by the Department of Agriculture were engaged and oriented into the assignment to conduct the questionnaire survey, and on how to use the electronic iPads. A first half-day's training was to acquaint the officers into the questionnaire on one day; and a second half-day two days later was to orient them on use of the iPads, a training conducted by Skype from ACT's Nairobi office.
- (5) Enumerators were then set to collect household data after prior approval of DACOs, and involvement of CEOs to identify targeted households in their areas of operation. This activity took some 14 working days to reach out to the 100 households per district.
- (6) Field visits were made to backstop enumerators both in Mumbwa and Mpongwe districts. The consultant witnessed some of the household data capturing sessions in the field. Necessary adjustments to the data collection were suggested, when necessary. After screening, enumerators remitted the survey data electronically to the server in Nairobi.
- (7) Key Informant Interviews were also held at National and District levels with some CA implementing institutions, field staff, and Lead farmers. Interactions were made with CFU, World Vision, CRS, Ministry of Agriculture, Concern World Wide, ZNFU, KATC, and FAO. Some case studies were also captured as part of the analysis in the Mumbwa area.

### **3. Evaluation questions/points for investigation**

Three evaluation questions guided the approach to the study, as outlined:

- i). What has been the impact of the different CA interventions in Zambia?
- ii). How has CA affected Gender dynamics in the different communities and its effect on labour, and
- iii). Which institutional factors have affected CA including the Policy environment?

Major results from both literature review and outcome of field investigations are given in the section below.

## **4. Major results and discussions**

### **4.1. What has been the impact of the different CA interventions in Zambia?**

#### **4.1.1. Level of adoption of CA in 'hot spot districts'**

Studies by different scholars show different reasons why CA adoption takes place, and these being attributed both to quantitative and qualitative factors (Nyanga, 2012; Ng'ombe, 2014).

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<sup>1</sup> It was interesting to see so much interest being generated on the matter, comparing this to the mid-1990s when our researchers described CA as a 'backward-leading' practice.

Results from these studies and from this survey indicate, for example, that a quantitative analysis of CA trainings and exposures; previous experience in reduced tillage, cover crops, crop rotations; membership in farmer organisations; ownership of CA tillage equipment; and use of herbicides significantly increase the likelihood of CA adoption.

A qualitative analysis shows that good responsive relationship development with farmers (of confidence-building, extension strategy, household approach, monitoring and performance evaluations, engagement of traditional leadership, quality and extent of technical knowledge and artificial incentives) positively influence adoption of CA (Haggblade and Tembo, 2003; Mwanza, 2011; Nyanga, 2012; Ng'ombe, 2014). Government, donor support, and collaboration with a keen private sector enhances increased adoption of CA among smallholder farmers. Incoherent short-term project implementation lack institutional memory as has been observed with many interventions previously implemented in Zambia.

Among the 200 households sampled in Mumbwa and Mpongwe districts, CA households tend to have both a permanent basin field (hand-hoe dug) of between 0.25 ha to 0.5 ha; and ripped land usually larger than that under basins. With the evolvement of tractor CA land preparation hire schemes and relatively affordable herbicides, more hectares are being put under CA. While the main extension message has been streamlined to respond to pertinent Zambian challenges (e.g. in situ water harvesting, reduced tillage, no burning, crop rotation, planting of *musangu* (*Faidherbia albida*) trees), room should still be given for incorporation of other CA techniques. While crop residues are still a major impediment to soil cover, necessary actions need to be taken towards changing grazing rights, incorporating green manures, intercropping systems, and more agro-forestry integration. Permanent soil cover is a matter still to be tackled particularly among livestock-keeping communities. Firstly, supportive land use by-laws at communal level need to be instituted to address apparent crop/livestock conflicts regarding use/management of field crop residues. Secondly, research needs to invest in determining other interventions possible besides crop residue/dry mulch soil cover options. Establishment of managed *Faidherbia albida* trees in the cropping fields create a more permanent soil cover on many of the fields, but over a time span. Results also show that the dawn of herbicide use has drastically reduced intercropping and cover crops in many places. Many farmers practice single crop fields and very few of them do intercropping.

Table 3 shows that a total of approximately 350,000 (41% of farmer households) small-scale farmer households practice forms of CA in Zambia (*see Table 1*), over an area of almost 175,000 ha or equivalent to 0.5 ha/farmer as at 2015. This has been the average hectareage by CA farmers since 2010 when participation increased by 100,000 farmers and hectareage by 50,000 ha during the period. Between 2000 and 2015, the number of participating farmers and area in CA grew almost 12 times.

Table 4 shows that by 2015, smallholder CA adopters put approximately 25 - 30% of their prepared land under reduced tillage, a significant increase in the last 5 years from 13%. Similarly, use of herbicides increased to between 13% and 25% by 2015, an increase from 5% in 2010.

Table 3. *Extent of adoption of CA in Zambia in the past 10 years*

Attribute	Units	Small-scale (< 2 hectares)				Large Scale (> 2 hectares)				Totals (2015)
		2000	2005	2010	2015	2000	2005	2010	2015	
Estimated number of smallholders practising CA	Number	30,000	78,000	250,000	350,000		15	150	200	<b>350,200</b>
Estimated area under CA	Hectares	7,500	19,500	125,000	175,000		150	1,500	2,000	<b>177,000</b>
Estimated percent of farmers adopting CA	%			16%	16-25				17	<b>35</b>

Source: Results from KIIs conducted

While CA adopters leave their residues in the fields, the materials either get grazed upon under communal land tenure systems as was the case in the Mumbwa agro-pastoral system or usually burnt by outsiders in search of other materials (mice, left-over crop materials) as was the case in the Mpongwe area. From the survey, it appears that little residue retention or mulching satisfies the permanent soil cover requirement. CA adopters using cover crops are about 10%, a low rate partly due to increasing use of herbicides. However, for those not using herbicides, cover crop use has risen to 10% by 2015 from 5% in 2010.

Table 4. *Breakdown of CA attributes being adopted*

Attribute	Period		
	2000	2010	2015
Estimated percent of farmers practising reduced tillage	10	13	<b>25-35</b>
Estimated percent of farmers using herbicides for weed control		5	<b>12.5 - 30</b>
Estimated percent of farmers practising residue retention/ mulching		10	<b>20 - 30.5</b>
Estimated percent of farmers using cover crops		5	<b>10</b>
Estimated percent of farmers practising crop rotation		20	25-30

Source: Results from KIIs conducted

#### 4.1.2. The impact of the different CA interventions in Zambia

While CA practices among smallholder farmers have been promoted mostly in agro-ecological regions IIa and I best-suited for the permanent basin making and ripping tillage systems, extension support to the households, cattle ownership and asset holding were also significant in determining adoption of CA practices (Haggblade and Tembo, 2003; Nyanga et al., 2011; Grabowski et al., 2014). These results are consistent with other studies on CA in Zambia (e.g. Keyser and Mwanza, 1996; Chomba, 2004; Kabwe and Donovan, 2005). With less conducive changing climate conditions in the southern part of the country, CA interventions are being adopted in the north as well, in agro-ecological region III.

Physical constraints, farming practices and climatic factors such as geographical location,

extent of land degradation, prevalence of drought conditions, and types of farming practices tend to influence participation of farming households in CA activities and therefore significant in the adoption process (Chomba, 2004; Baudron et al., 2007). It was also being observed that smallholder farmers were being positively influenced to implement CA because of available financial incentives, reduced production costs and accessibility to support services.

Results of the survey in Mumbwa and Mpongwe districts show increasing engagement into CA related practices among households trained by promoting agencies, but also through spill-over effects, and continued training through farmer-to-farmer interactions (exposure visits, demonstrations, micro-trainings) especially through Lead farmers (practising farmers trained to train others). Main reasons for increasing uptake of CA was attributed to reduced labour demand, for example, for land preparation from 14 hours/ha under ADP ploughing plus 7 hrs/ha under ridging to 4 hours/ha under ADP ripping; 30-35 standard person days/ha or more under hoe tillage, to 25-35 standard person days/ha under Reduced tillage CA systems per hectare. (CFU, 2011). With frequent erratic/reduced rainfall, CA permanent basins and ripping practices assure better moisture/in-situ rainwater harvesting CA practices are themselves a disciplining set of action planning for timely field operations, and comparative better returns.

Some literature on agriculture technology adoption considers that the decision to adopt technologies including CA is affected by the characteristics of the farm household head and the household at large (Haggblade and Tembo, 2003; Chomba, 2004; Kabwe and Donovan, 2005; Nyanga et al., 2011; Nyanga, 2012). However, increasing gender awareness/trainings among smallholder farmers exhibit increasing evidence of the household approach where decision-making is no longer vested in one person but shared at household level (Farnworth and Munachonga, 2010). These different forms of decision-making processes were witnessed during the field surveys.

Farming households that have not attained self-confidence levels (especially those still dependent on input support) tend to fall off when input support is withdrawn. Lessons from ASP stress the importance of household performance confidence building in technology grasp and skills building (Mwanza, 2011). From the KIIs conducted during the study, knowledge and skill of herbicide use is increasing steadily, not just among CA farmers but also among non-adopters. A rise from 5% to as much as 30% of effective herbicide use within a 5-year period (2010-2015) is tremendous achievement, from a time when herbicide use was considered a threat to the soil (von Essen and Nolin, 2005).<sup>2</sup>

As at 2012, more than 160,000 farmers had extended their Conservation Agriculture practices to include the planting of crops within agroforests of *Faidherbia* and related trees over an area of 300,000 hectares. The Conservation Farming Unit (CFU) observed that unfertilized maize yields in the vicinity of *Faidherbia* trees averaged 2.8 t/ha, compared to 2.2 t/ha nearby but beyond the tree (GART; 2008, 2009).

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<sup>2</sup> Without CA, the uptake nor availability particularly of herbicides would not have developed as fast as it has, remembering that it was the weeding pressure under CA that has led to this reality, and with it freedom for women and children previously 'yoked' to tackle the weeding heavy-laden.

While Umar (2012) finds no evidence of CA associated improvements in soil fertility after five years of CA practice<sup>3</sup>, most probably because crop residues were removed from the fields, her study also reports no evidence of hoe/plough hard pans either under CA or CV<sup>4</sup>. A similar observation is held by Esser et al. (2016) reported in their CAREP final report. However, *Faidherbia albida*, a leguminous tree promoted as part of the CA package in Zambia, is associated with significantly higher levels of nitrogen, organic carbon and potassium under its canopy. Both in Mumbwa and Mpongwe, there is evidence of *Faidherbia albida* plantings in some fields growing at different stages. Once mature, the trees will enhance effective soil cover requirements beyond other benefits such as soil fertility improvements, shelter and livestock feed.

While it is generally felt that initial efforts did not achieve widespread adoption of CA among sections of the scholars, recent developments point to increased participation for a number of reasons:

- (1) the weather changes show that crop yields under CA practices perform better because of embedded in-situ water harvesting techniques, supported by precision input placement, than under conventional practices particularly in drought seasons or when rains are erratic and unreliable;
- (2) improvements in addressing labour-demanding operations that acted as a major hindrance to adoption, in terms of land preparation (evolution of CA ripping hire schemes, which must also lead to herbicide weeding hire schemes), and weeding demands (affordable and effective use of herbicides);
- (3) increased availability of CA equipment among farmers (not necessarily individually owned only but also through hire schemes); and
- (4) Development of confident, improved and shared knowledge and skills among field staff on CA.

#### 4.1.3. Assessing the overall impact of CA

##### a. CA capacity/knowledge of the farmers

The challenges of agriculture among small scale farmers include low farm productivity and continuing yield decline as a result of human-induced soil degradation, high costs of external inputs, inadequate farm power, and the vagaries of climate change, that continue to negatively impact on the agriculture landscape. Many households consequently had to re-locate to new areas (Baudron et al., 2007) as a consequence of using inappropriate farming practices and because of unfavourable climate variability (Mwanza et al., 2012).

The traditional techniques of ploughing and hand hoe ridging expose the soil to elements that do not improve soil structure/health, but enhance development of hardpans, and inhibit in situ

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<sup>3</sup> It depends on the assessment methodology/point, noting that precision placement of inputs under Zambian CA practices is restricted to basins and rip-lines.

<sup>4</sup> While one rarely expects to find a hardpan under CA, ripped or re-dug almost every year, rampant J-rooting system of much of cropped land, evidence of seasonal water logging in many fields must be reminiscent of the problem.

rainwater harvesting and moisture retention, making desirable soil/crop development difficult (von Essen and Nolin, 2005).

Farmers in the study area being cognisant of these predicaments have positively responded by adopting CA out of experience of the hardships met in their farming activities. Three case studies from Mumbwa district, of Ms Joyce Shompa of Shoma village, Chief Mulendema; Ms Vainess Tapisha of Kawelele village, Chief Kabulwebulwe; and that of Mr Jackson Lungu of Mukabe village, Chief Moono show how they graduated after training under CFU from conventional farming techniques to CA techniques, a new practice that offered them opportunities to increase area under production, achieve higher yields, diversify their crops, and assured of dependable income to support their family needs.

All these 3 persons define their understanding of CA as a soil conservation practice through ripping, basin-making, not burning crop residues (soil cover), practising a cereal/legume/cash crop rotation system that gives both rewards to the land being used (soil fertility) and money into their 'pockets'. Joyce in the 2015/16 season worked with 5.8 ha, Vainess did 3.65 ha and Jackson 3 ha under CA. All the 3 are also CFU's Field Coordinators (Lead Farmers) extending CA to many others through farmer-to-farmer interactions. Issues of sustainable farming, profit-making, food security, fire-breaks and 'not burning', musangu tree (*Faidherbia albida*), reduced tillage, labour-saving and effective use of herbicide (non-selective and selective) were articulated among them in their approaches to CA.

From these case studies, it can therefore be confidently stated that adequate knowledge and skill has been provided to the farmers to enable them reap the benefits of CA and also built capacity to train others. The evolvment of e-voucher schemes, presence of an active cadre of agro-dealers, and coming up of service hire schemes address past problems that hindered CA effectiveness such as at peak labour demands, of inadequate machinery, or lack of access to inputs. Many of these improvements have come because of the CA agenda, particularly at district level.

*b. Natural resources management, farming system and crop production;*

Climate change models predict low productivity scenarios in the Southern African region if no farm practice changes are made; and hence the reason for the advocacy and promotion of CA - a disciplining farming practice. CA responds not just to climate change challenges, but also those of soil erosion and reduced yield even when appropriate seed and fertilizer ameliorations have been made. Consequences of not adapting to new farming methods have led to reduced yield per unit area due to poorer crop growing conditions such as inadequate soil moisture, reduced infiltration, increasing plough/hoe pan, and rampant soil erosion. CA offers opportunities for a resilient farming environment that provides desired soil-water-plant relationships, reduces soil erosion, and guarantees a steady harvest (Thierfelder and Wall, 2009), thus a reason for its advocacy among Zambian farmers and stakeholders.

Discussions held among CA adopters illustrate that one of the reasons they introduce CA is because of the land degradation that has led to reduced yields in the past, also evidenced by widespread deterioration of the landscape in the study areas, e.g. deforestation, rills and gullies.

At field-level, while reduced tillage attributes offered good soil conservation, permanent soil cover remains a big challenge. Firstly, it would be too costly in terms of labour, to move mulching material to and fro the field; secondly, the challenge for food for livestock that the customary norm has placed on crop residues to be accessed by all livestock in the community, and thirdly the challenge of wanting to collect/gather on other people's lands. Unless appropriate supportive land tenure by-laws are formulated, agreed upon, and implemented, the challenge of having a permanent ground soil cover on smallholder fields will remain daunting until research makes a breakthrough with better options.

*c. Farm labour requirements, disaggregated by gender, in the farmers' life*

Some scholars record that reduced labour and costs among CA adopters are observed compared to those under conventional (those hoeing, ploughing, inverting the soil) practices. To women and children in many households, CA has freed them of the many hours spent toiling, particularly during the hand-based land preparation and labour-intensive weeding windows of the farming season. Well thought of and planned, land preparation spread over the season guarantees earliness in the execution of farm activities of the new season.

Work done by Haggblade S. et al. (2011) in the Mumbwa area among cotton smallholder farmers shows that waiting to rent or borrow animal-draught power ploughing teams at a cost of US\$ 60/ha under conventional farming is less profitable than owner-operated ploughing or hand hoe CA, as the owners have to plough their own fields first before renting or borrowing. This delayed land preparation and planting resulted in a cotton yield fall of 15% and a maize yield fall of 25% compared to owner-operated ploughing. Cotton production with rented ploughing teams reduced returns to land by approximately 50% compared to CA basins.

Similarly, dry season renting of ripping services costs about \$25 per hectare and offers several major benefits: on-time planting, soil organic matter retention, and area expansion made possible through animal traction. Under rented ripping services, as with hand hoe CA, weeding labour limits area planted unless with herbicide use. (Haggblade et al., 2011).

*d. Changes in the supply and demand of input such as seeds, implements, herbicides, etc.;*

Compared to the past, except for cover crop seed that is difficult to transact across the shelf, the number of small-scale agro-dealers has dramatically increased in the last 5 years. In Mumbwa town there are well over 10 agro-dealers, while in Mpongwe there are not less than 3. Mostly these businesses stock seed, fertilizer and herbicides (a new entry on the market). Use of improved seed and fertilizer is much higher than in the past. Available seed supply chain comprises different varieties to meet diverse climatic conditions and timings for most of the field crops. The advent of e-voucher schemes on the market has attracted many players from researchers, seed and fertilizer producers to distributors and retailers.

While the supply of field-based farm implements is rather limited, a variety of CA implements are now available, mostly imported especially those for planting. Many farmers in the study area use hand methods to plant even after ripping either by oxen or tractor. The usual Brazilian planters (Fitarelli and Werner) appear still too expensive. In order to attract local private sector equipment manufacturers, conducive incentives and commercialisation strategies are required

to attract affordable production. There are still not yet locally made planters on the market. Dibble sticks/machete techniques do not exist, neither little-known jab planters nor Li hoes for hand-held implements. These have not been exposed. The smallholder farmers are familiar with the ADP Magoye ripper, Fitarelli and Werner planters, and motorised rippers. For herbicides, one or two-person hand held knapsack sprayers are used. There are not yet ADP sprayers. Large scale farmers, of course, have been using modern CA machinery for a longer period.

The study by Haggblade et al. (2011) shows that CA enables even the smallest, most cash-constrained Zambian farm households to achieve yield gains of about 40% to 50% over conventional tillage when they plant up to 1.5 ha under hand hoe-based CA. These farming techniques offer feasible means of doubling household crop income among resource-poor smallholder cotton farmers in Central Zambia, increasing their crop income by 140%, from \$170 to \$420 by adopting CA hand hoe packages for cotton as well as for low-input maize. Higher returns can be attained for those able to access high-input CA packages along with standard company-financed cotton packs, thus raising their crop income further to \$495-\$880 per season when farmer-financed herbicides, fertilizer, and seeds costing \$130 per season are included.

Currently, massive government fertilizer subsidies dominate agricultural input supply, which have also trickled down to many CA adopters.

Provision of incentives to CA farmers characterised CA promotion in Zambia among almost all key players (Umar, 2012) coming in different forms, for example, under CASPP, FISRI, CAP and CASU which provided redeemable input vouchers of some value (sometimes US\$100 per lead farmer), or direct input support for tree seedlings or cover crop seed (Umar, 2012). However, with attachment of incentives to technology adoption, it may be difficult to evaluate adoption of CA among beneficiaries in the absence of a broad comprehensive assessment. Use of the Lead farmer model have served as CA pull factors by using trained and implementing local farmers to demonstrate the benefits of CA through farmer-to-farmer exchange strategies. The Lead farmers, called different names under the different programmes, are each given a set of electronic vouchers worth so much that are redeemable at selected agro-dealers, while the farmers under the Lead farmer also receive one voucher each. Of course the process may have its challenges along the value chain like the ones Umar (2012) raises in her study.

*e. Policy and institutional factors*

Creating an enabling environment is important in accelerating participation and subsequent adoption of new technologies. Shula (2012) advances a number of tactics employed to positively influence adoptions, as illustrated below in Table 5.

Despite being an early CA promoting country in the Southern African sub-region, and Africa a large, Zambia did not have a CA task force like many other countries in the sub-region. It was only in the last 2-3 years that this body was established.

The CA Task Force chaired by CFU, with an alternating Secretariat between MoA and FAO is currently tasked to:

- i). Develop a database on CA (and thus get rid of institutional memory loss, access fuller CA records);
- ii). Develop a training curriculum for CA for tertiary institutions, and later for lower levels of education; and
- iii). Develop a joint CA manual for Zambia.

Small sub-committees have been set up to pursue these matters.

Table 5. Adoption approaches for enhancing CA uptake

Category	Approach	Promoter
Financial incentives	Free inputs	PAM, CLUSA, CARE, CRS
	Input subsidy	FISP, FRA
	Revolving fund	FAO
Voluntary compliance	Training and extension services	Department of Agriculture, LM and CF – SCAFE, ASP, CFU
		Zambia Agricultural Research Institute, Golden Valley Agriculture Research Trust.
Cross-compliance	Support for CA intervention in exchange for undertaking related projects/ programmes	Mainly NGOs e.g. PAM, CLUSA, CARE, CRS

Source: Shula, 2012

At district level, in the two selected districts, local CA coordinating committees do exist that regularly meet to deliberate on CA matters.

*f. Gender. How has gender accelerated or hindered adoption of CA? Are different gender groups benefiting equally to adoption of CA?*

The gender dynamics in many facets of society come with accelerated developments that are enhancing household livelihoods. Evidence in Mumbwa shows active women participation in CA activities enabling them to achieve set objectives. However, Zambia being a multi-cultural country does have many conflicting views on gender issues, contributing to various challenges when it comes to effective service delivery. At village and household levels, perceptions on gender can be vast due to the different traditions and beliefs. Some studies consistently show that women, compared to men, have much poorer access to extension services such as demonstrations, meetings, training and research activities. The choice for married women to participate in the extension programme activities has been shown to depend on their spouses, suggesting that participation in extension activities is a major family decision and the extension staff should treat it as such. Further, the choice of technologies promoted affects the level of participation between men and women. There is need to provide evidence for CA and the gender divide, based on its knowledge, intensiveness, and practices of reduced tillage complemented by herbicide application (knowledge of chemicals, safety, application); permanent soil cover, competition for crop residue for mulching from maize stalks versus livestock stover, and possible rotation crops (Mwanza et al., 2012).

*g. Community social cohesion/conflict management and overall resilience to natural shocks e.g. community-NRM strategies to avoid soil erosion, bush fires, etc.?*

Is it indeed ‘toothlessness’ or ‘adamancy’ among society leaders that inhibit a sense of discipline in regulating use of available land resources? In both Mumbwa and Mpongwe for

instance, rampant set bush fires even when sufficient firebreaks have been put in place were mentioned as challenges to maintaining sufficient soil cover where livestock grazing is not an issue. The 'harvesting of undomesticated edible fauna' was another menace resulting into burnt fields was another situation. Even when communities in such scenarios have agreed to put appropriate measures, no actions appear taken to discipline the culprits.

Neither are there actions taken against the charcoal burners that have increased due to accelerated demand as a consequence of electricity power load shedding and effects of increased electricity tariffs. Appropriate local land use regulatory rules do not appear to exist. Evidence of moderate soil erosion in the watershed appear not to be addressed even when important local infrastructure gets disrupted.

In general, there appears to be a challenge at the local level that needs to be resolved and that may contribute to despondency of the matter. An appropriate enabling environment is required whilst supporting CA development and adoption.

#### **4.2. How CA has affected gender dynamics in different communities and its effect on labour**

Resource-poor smallholder farmers in Zambia, like elsewhere in Africa face shortages of labour, farm power, while inadequate finances limit access to improved technologies. However, CA interventions offer opportunities to increase crop income significantly when judiciously implemented (Haggblade S. et al., March 2011).

At some households visited during the surveys, wives were more conversant, and ably presented their positive experiences with CA while their husbands confirmed the developments. Yet at other households, it was the husband that took the lead in CA activities with their wives only being told what to do next. Increased gender exposures through training have resulted in evolvement of household approaches to enhance planning and activity implementation, and did not specify particular gender roles in the household. Rather, new gender dynamics including under CA are about becoming entrepreneurial/cash economy-oriented through a rational, careful planned approach to farming to meet food and nutrition needs, generate income, and plan expenditure (Farnworth and Munachonga, 2010).

While many households cannot afford hire of labour, labour availability at farm household level is significant in determining adoption of CA. Inadequate labour has deterred many households from adopting CA, particularly with regard to high labour demands at land preparation and weeding times. Studies carried out in Zambia indicate that smallholder farm households that have more labour available for agricultural use tend to easily adopt CA. This result is consistent with other studies on CA whose findings show that because CA is labour intensive it requires that adopters have enough labour (Haggblade and Tembo, 2003; Wall, 2007; Nyanga et al., 2011; Ng'ombe et al., 2014).

However, it is also argued that under CA the amount of labour demand is reduced, at land preparation and also at weeding. Labour gains under CA regimes have opened new money-making opportunities unlike in the past. In the study area, households opened new, usually non-traditional enterprises – e.g. building of houses for rent in towns, retail trading.

Increased access to herbicides for weed control has freed women and children from the traditional weeding burden. Smallholder households in the study area apply a heavier herbicide regime of two rounds of herbicide use, a first round usually of a non-selective pre-emergent application, followed later by a second round of a selective post-emergence application to get rid of late – emerging weeds. Haggblade et al. (2011) show that under this heavy herbicide regime, returns to land exceed conventional weeding practice by a wide margin, for both cotton and maize.

### **4.3. Institutional factors affecting CA including the policy environment.**

#### **4.3.1. Policy pronouncement**

In 1999, the Government of the Republic of Zambia, through the Ministry of Agriculture and Food and Fisheries (MAFF), declared Conservation Farming (CF) and related technologies a priority for promotion by both MAFF and the various partner institutions, such as the Conservation Farming Unit (CFU), Golden Valley Agricultural Research Trust (GART), Land Management and Conservation Farming Programme (LM and CF) and its successor programme the Agriculture Support Programme (ASP), and the World Agroforestry Centre (ICRAF) in order to address the issue of low farm productivity and sustainable production (Mwanza et al., 2012; Shula, 2012). Government supported an intensive training programme of all its CEOs in Central, Eastern, Lusaka and Southern provinces with a ‘fast-track’ approach for promoting CA (MAFF, 1999). Supporting research by national and international institutions has been conducted on a variety of CA attributes over a period of time (Thierfelder C and Wall PC, 2009; Umar, 2012) arising from Government pronouncement.

In order to produce economically, small scale farmers need to increase productivity and entrepreneurship to afford accessing required inputs at optimal cost, and also to access markets for their products. Because markets are thin and poorly integrated and offer farmers very low prices, several organizations (e.g. PROFIT, ZNFU and MUSIKA) have stepped in to develop more efficient and competitive markets for inputs and produce. This has been achieved through establishing market information systems for collecting and publicising information about prices and quantities of inputs and produce at various locations in the country. This information is conveyed to the public through radio programmes, printed media and SMS services. The development of a network of agro-dealers in the country who have been provided with training in input and products marketing provides for important market intermediaries (Mwanza et al., 2012).

#### **4.3.2. Level of interest and involvement of development actors and farmers**

While development of CA among extension and development players had inadequate supportive research locally, dissemination and training of the new technologies were initiated and generated some interest among targeted beneficiaries, with the Ministry of Agriculture taking a leading role in promoting ADP techniques related to the newly designed Magoye ripper, and CFU building on the Oldrieve-styled hand-hoe techniques. Later, the coming up of GART and other researchers enhanced developments. Support from development partners (FAO, NORAD, IMAG, Sida, EU, and UNDP, among others) boosted implementation.

It can be stated that well over 300,000 farmers must have participated in some kind of CA implementation activity in Zambia since the mid-1980s. Over these years the partners continued to support the CA initiatives that have resulted into positive change among confident households, and commitment among actors. Agricultural research, extension and technology development programmes have continued to inform farmers about these new technologies and opportunities in the value chain to help them attain better returns from their agricultural activities as well as sustaining use of their environment (Mwanza et al., 2012).<sup>5</sup>

Table 6. *A progressive summary of CA promoters in Zambia*

Period	Promoters by Agro-Ecological Region			
	I	IIa	IIb	III
1985-1990	MoA (SCAFE),	MoA (SCAFE),		
1991-1995	ADRA, Global 2000, MoA (SCAFE), CFU, ICRAF	CLUSA, EEOA, LWF, Every Home for Christ, ADRA, ICRAF, MoA (SCAFE)	Home Based Care (HBC)	
1996-2000	ADRA, ,Global 2000, MoA (SCAFE, LM and CF), ICRAF	MoA (LM and CF), CFU, CLUSA, EEOA, LWF, Every Home for Christ, ADRA, UNDP, ICRAF	Home Based Care (HBC)	MoA (LM and CF), UNDP
2000-2005	ADRA, ASP, PUSH, MoA (LM and CF), GART	GTZ, DANIDA, CLUSA, CARE, CFU, WVZ, MoA (LM and CF), ASP, GART	CFU	MoA (LM and CF), UNDP GART
2006-2010	FISRI, CCZ, DAPP, ASP, CRS, PUSH, MoA	CFU, CASPP, FISRI, ASP, COMACO, MoA, UNZA, KATC, C-FAARM, PAM, Diocese of Monze	CFU, CASPP, FISRI, MoA	
2011-2015	MoA, FISRI, CASU, DAPP, COMACO, WVZ, ZRCS, Zambezi River Initiative, ZNFU Land O Lakes, Action Aid,	MoA, COMACO, CFU, CASU	MoA, CFU, CASU, Concern Worldwide	CASU, MoA

Source: Adapted from Mwanza and Mashingaidze, 2010; Hichaambwa et al., 2016

## 5. Strengths and weaknesses of CA

CA techniques offer a good recipe for CSA in addressing climate change challenges, in terms of responding to the negative effects of climate variability, manifested by floods and droughts, likely to be experienced for decades to come. By practising the 3 CA principles, soil and water

<sup>5</sup> Various studies that are now being undertaken must pursue and address pertinent CA research areas on a long-term basis, looking at tillage, beneficial /monetary-value of cover crops and crop rotations, liming in response to acidified soils, varying fertilizer rate effects, and science/practice in CA systems of weeds, pests and diseases. It is also important to tackle problems peculiar to particular AERs such as moisture deficits in AER I, soil acidity and leaching in AER III, or mono-cropping/plough pans in AER II. Results achieved need to be packaged and appropriately disseminated to make CAWT interventions attractive.

conservation preserves and also improves soil/water/plant conditions necessary for increased productivity when supported with judicious use of production inputs such as improved seed, adequate fertilizer, and relatively safe herbicides and pesticides.

Major weaknesses were high labour demand and effective weed control mechanisms. The debate in Europe on use of glyphosate is also of concern. Access to appropriate farm tools/machinery is still beyond reach of many farmers, especially that these equipment have to be mostly imported.

## **6. Key lessons learned**

- (1) Absence of a CA ‘clearance’ or repository centre has led to institutional memory loss over the years from many agencies who once-led CA introduction and adoption promoting projects and programmes, to an extent of creating lapses in records, spread of adoption and performance of CA among farmers;
- (2) The studies that suggest that the promotion and uptake of CA in Zambia has not ‘skyrocketed’, and that adopting farmers only use some of the principles on a portion of their land, is leading to deterring potential development investment and research on CA that would have attempted to address new positive developments.
- (3) Information sharing is limited among development agencies promoting CA making it difficult to understand and appreciate the real status of agricultural transformation towards CA in Zambia. Partners tend not to fully share some information with others.
- (4) CA adoption and development requires competent promoters with a longer-term commitment that can keep pace with target groups, responding and building their confidence, with or without development ‘incentives’.
- (5) From the study, it is evident that widespread CA adoption is a time related process, just as any other agriculture system including conventional tillage agriculture. The process of adoption and spread as well as in establishing and improving CA system quality, soil health and farmer knowledge base and experience of his or her specific CA system takes time for smallholder farmers who are familiar and experienced in using traditional methods. Similarly, realisation of different types of productivity, economic, environmental and social benefits come through over time as CA management, social conditions and cropping systems improves.
- (6) Farmers adopting CA practices tend to establish a basin-making plot of about 0.25 ha for guaranteed food security, even when they may have other reduced or zero tillage systems on the farm such as micro-pits in manual systems or direct no-till seeding with tine (or shallow ripper furrow) seeders in animal traction or mechanised systems where in-situ water harvesting is not critical.
- (7) Input and output markets and supply chain services are essential for the sustainable adoption and spread of CA like is true with any farming technology.
- (8) The study points out that affordable access to private-sector/farmer-led animal draught power (ADP) or motorised hire services for no-till ripper seeding services and ‘herbicides application services hold high potential for CA adoption and widespread uptake. Alongside, there is a need to promote the development of soil mulch cover with residues and cover crops, and for diversifying cropping systems. These practices take longer to

establish in drier areas than in moist areas but they would add resilience and sustainability to existing and new CA systems and their adopters.

- (9) There is a need to redress effectively communal land use systems especially those that involve unsustainable crop-livestock relationships under customary tenure that lead to land degradation and loss of productivity.

## **7. Recommendations for future programming**

- (1) Although the uptake of manual CA systems in many customary areas has increased, the area under CA still remains relatively low due to high initial labour demand for land preparation and weeding. Greater adoption and spread may be achieved when CA its policy framework, field operations and private-sector participation are enhanced, and supported by experienced land preparation and weed-control hire schemes.
- (2) There is need to promote low labour demanding CA systems that involve use of no-till seeding in micro pits or direct seeding in no-till soils with tine or ripping seeders powered by animal traction or a tractor, where in-situ water harvesting is not challenging.
- (3) Establishment of data/report/forum/repository where all stakeholders can participate is essential to maintain the CA adoption and uptake promoting process towards consolidating and building the CA development momentum, supported with appropriate evidence of achievements, developments and lessons learned from actions taken. An initial solid adoption study is required as a basis of evidence and future record of CA development on an annual basis.
- (4) CA development in Zambia had benefitted from commendable support the Conservation Farming Unit (CFU). Further advances in CA development in Zambia in the coming years requires the support of a national mechanism with a long-term commitment and dedication to spearhead and continue the promotion and synthesis of various CA approaches and experiences in Zambia and in the region as well as internationally. This diversified approach to CA development in Zambia in the future as well as improving the quality of existing entry-level CA practices should take cognisance of various opportunities that may be availed to the existing and future target groups under the general systems concept and principles of CA.
- (5) Zambia-based research and development must spearhead relevant CA development of practices, tools, and a critique that supports the mainstreaming of the CA adoption and uptake process suitable for Zambian smallholder farmers.
- (6) Revision in customary land use tenure management that can address the need to improve crop-residue/livestock relationship on a win-win basis should be undertaken for CA land use development across Zambia. This should include the avoidance of burning of crop residues and a positive communal grazing management for improved large-scale livestock integration with farming systems in the different agro-ecological zones. A political and developmental will to integrate customary tenure matters that will regulate burning and crop/livestock conflicts especially of crop residue management versus communal grazing is necessary
- (7) A need for assessment of non-prescriptive 'best-fit' CA technologies for different types of smallholder farmer environments.
- (8) Better CA coordination, implementation, monitoring and recording.
- (9) Identify appropriate permanent soil cover options suitable for Zambia's agro-pastoral semi-arid land use systems supported by desirable measuring tools for determining cover. longer term support to entrench relevant CA support systems addressing issues of CA tools and

machinery, relevant support research (soil cover, weeding), land tenure development and farmer organisation and technology confidence building.

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## Appendices

### Appendix 1: Itinerary of Field Visits

	Date of Visit	Purpose of Visit	Organisation	People Met	Contact
1	16/5/16	Follow up of CA Survey ipads	DHL, Lusaka	Reception	
2	16/5/16	CA Stakeholders identification;	MoA	Andrew Muma	0977 429928
3	19/5/16	Registration of CA ipads with Airtel		Airtel	
4	24/5/16	KIIs - Lusaka	WVZ	Makabiso Ndhlovu	0977 785649 thulanilimied@yahoo.com
5	24/5/16	KIIs - Lusaka	Concern World Wide	Zenebe	0978 777364
6	24/5/16	KIIs - Lusaka	CRS	Douglas Mwasi	0971 237055 douglas.mwasi@crs.org
7	24/5/16	KIIs	Musika	Charles Musonda	<a href="mailto:Charles@musika.org.zm">Charles@musika.org.zm</a>
8	24/5/16	KIIs	NWK Ltd	Joseph Mwanza	<a href="mailto:Joseph.mwanza@nwkzambia.com">Joseph.mwanza@nwkzambia.com</a>
	27-29/5/16	Field Visit to Mumbwa			
9	27/5/16	Courtesy Call	Dept. of Agriculture	Kanyanta Musonda	0977 538190 <a href="mailto:kanyantamusonda@gmail.com">kanyantamusonda@gmail.com</a>
10	27/5/16	KIIs	WVZ	Benson Chimbwe	0979 932328 <a href="mailto:benson_chimbwe@wvi.org">benson_chimbwe@wvi.org</a>
11	27/5/16	KIIs	CFU	Enyster Womba	0966 238002
12	27/5/16	KIIs	Concern WW	Kasongo	0978 008051 kelvin.kasongo@concern.net
13	27/5/16	Household surveys, Moono camp	Farmers	Maurice Mapani, Enumerator	0962 844732
14	28/5/16	KIIs	CFU, Kabulwebulwe Field Facilitator	Timothy Mpandala	0965 238051
15	28/5/16	Case Study, Mulendema Area	Farmer	Joyce Shompa,	0964 645128
16	28/5/16	Case Study, Kabulwebulwe area	Farmer	Vainess Tapisha	
17	28/5/16	Case Study	Farmer	Jackson Lungu	
18	30/5/16	KIIs	MoA	Andrew Muma	0977 429928
19	30/5/16	KIIs	FAO	Ronald Msoni	Ronald.Msoni@fao.org

20	30/5/16	KIIs	KATC	Bridget Connor	O	Bridget.oconnor8@gmail.com
21	30/5/16	KIIs	CFU	Collins Nkatiko		0965 238058
	30/5-3/6/16	Field Visit to Mpongwe				
22	31/5/16	KIIs	ZNFU	Margaret Chabala		
23	31/5/16	KIIs	ZNFU	Camos Mukonka		0976 550947 cmukonka2@gmail.com
24	01/6/16	KIIs	MoA	Melvin Tembo		0963 800295 Melvin.tembo80@gmail.com
25	01/6/16	KIIs	MoA, CEO, Kanyenda East	Beatrice Kalimbwe		0965 059011
26		Household visits	Kanyenda East	3 Farmers		

## Appendix 2: Case Studies

### CASE STUDY I. Joyce Shompa

1. Name: Joyce Shompa, Female, Cell: +260 964 645129
2. Age: 39
3. Location: Shompa Village, Chief Mulendema, Mumbwa District, Central Province, Zambia.
4. Family:

		No.	Age	Gender	Primary School	Secondary School	Tertiary School	Other information
1	Spouse	1	44	M				Tyson Lubungu +260961 169708
2	Children	6	20,18,15,1 2,7,2	F=4, M=2	2	3	0	
3	Dependants	4	25,21,16,1 3	F=3, M=1	1	3	0	
4	Totals*	12		F=8, M=4	4	6	0	

\* = Inclusive of everybody in family

This female-blessed household has enough human resources to tackle any labour demanding tasks. She says however, that when they practised CV, more time was spent for land preparation and weeding. Under CA, there is less demand, and the workload is fairly stretched over a longer period of time.

#### 5. Reasons for CA Uptake:

Joyce and her husband Tyson have lived on their piece of land for the last 17 years, witnessing during that period of frequent late/erratic rainfall, effects of late planting and increasing weeding challenges having a negative effect on people's livelihoods.

Prior to converting to CA in 2008, Mama Shompa used to plough 0.8 ha using ox-drawn plough and 0.4 ha using hoes for growing their maize, cotton and groundnuts. After attending CA training under CFU, she put 0.4 ha under CA and 0.8ha under CV. Upon realising a bigger harvest on the CA field compared to what she got under the bigger CV field, Joyce and her husband decided to abandon the CV practice opting to go CA throughout. From the 2009/10 season, Mama Shompa together with her husband grow their crops using CA principles. She has also graduated from just being an ordinary CA farmer into being one of the 30 CFU Field Coordinators in her area.

#### 6. Farmer Practices:

Mama Shompa regard CA as a soil conservation practice of ripping, basin-making; soil fertility improvement through cereal/legume crop rotation; and crop residue management by not burning the residues in the fields. However, communal pressure to let animals graze between August and November reduces the amount of residue cover on the land. Asked what the importance of crop residue were, Joyce remembers her lessons – that crop residues in the cropping field increase soil fertility, keep moisture, and are termite food when the crop is growing, and release residual fertilizer to the new crop. She relents that she is no getting fuller benefits accruing from crop residue management, but hopes that one day appropriate customary by-laws will be put in place to protect one's crop residues in situ.

Joyce and her family uses a 2-herbicide application system using a knap-sack sprayer, beginning with a non-selective herbicide (glyphosate) application soon after planting, following a selective herbicide application after germination. She says sometimes they apply herbicides only once during the growing season. Joyce says that while herbicide prices vary, they have become relatively cheaper than before. In her area she reports that approximately 50% of farmers use herbicides for weed control, and the demand for herbicide is increasing.

During the 2015/16 farming season, Mama Shompa using a hired tractor/ripper (at approximately US\$35/ha) planted 2.5 ha under maize, 1.5 ha under soya beans, 1.3 ha under cotton, 0.25 ha under groundnuts and 0.25 ha under common beans, all under CA totalling to 5.8 ha. Sowing of seed and fertilizer application was by hand, using family labour to quickly cover the fields after a pair of own oxen with ripper open planting lines. With a light spread over the seed, the planted lines are thereafter covered.

In terms of crop yield, the following comparison was given:

	Crop	Yield before CA	Expected Yield under CA
1	Maize	2.3 tonnes/ha	5-6 tonnes/ha
2	Cotton	22-25 bales/ha	

#### 7. Challenges:

- i). Communal livestock grazing being allowed during the dry season reduces soil cover depriving the household potential soil fertility improvement material and reduced soil moisture retention mechanism.
- ii). Maintaining a bigger family required venturing into new innovative livelihood approaches.

#### 8. Benefits:

- The decision made since 2009 to go CA in their farming has allowed them to send their children (6) and dependants (4) to school, into primary and secondary school.
- They were also able to build a modest iron-roofed house (indicating to me the old grass-thatched house they occupied before), and do have a set of solar panels for energy in the home.
- Joyce and her family have also managed to purchase 2 residential plots in Mumbwa town where they plan to build houses for renting out.
- The family have a recently bought a pair of oxen; and they run a business stand in Mumbwa where they sell clothes.

They attribute all these developments to the decision to go CA that triggered increased production and productivity. CA has guaranteed them better returns even when others (non-CA adopters) miserably fail.

#### 9. Way Forward:

Joyce and her husband hope to meet their set visions in the businesses that they have established.

Joyce wishes to see more of her neighbours become CA farmers through her farmer-to-farmer training effort.

## CASE STUDY II. Vainess Tapisha

1. Name: Vainess Tapisha
2. Age: 44
3. Location: Kawelele Village, Chief Kabulwebulwe
4. Family:

	No	Age	Gender	Primary School	Secondary School	Tertiary School	Remarks	
1	Spouse	1	48	M			Watson Kawelele	
2	Children	9	29, 26, 23, 21, 19, 16, 9, 9, 5	F=3 M=6	2	2	1	3 stopped school in G9/10
3	Dependants	0						
4	Totals*	11		F=4, M=7	2	2	1	0

\* = Inclusive of everybody in family

This is a male-blessed household but challenged by school drop-outs at mid-school level. It is also relatively a large family that avails its labour to waning CA activities.

### 5. Reasons for CA Uptake:

Low harvests being experienced under CV at their previous home led Vainess' family to find a new home. Whilst here, awareness meetings made Mama Vainess to attend a CFU training programme to become a CA farmer from 1997, and eventually a Farmer Coordinator.

### 6. Farmer Practices:

Mama Vainess considers CA as sustainable farming, which she practises and no longer to let her abandon her land again, because the land she uses gives her profit both in monetary terms but also food security. It is a farming system characterised by no burning, reduced tillage, use of herbicides for weed control. Land preparation is by use of a ripper and not by ploughing. Vainess ripped 1 ha by tractor hire and 2.65 ha by an ADP Magoye ripper using the 8 cattle (1 bull, 7 cows) they own. Planting is by hand while weeding is done using herbicides (which has greatly reduced the labour burden) with knap-sack spraying of glyphosate (non-selective) at planting and a selective herbicide after germination.

Only cotton crop residues are left in the field because all the others are grazed by livestock, except the hardy materials.

Vainess compares yields under CV before and those under CA in the 2015/16 season.

	Crop	Size, in ha	Yield/ha	
			Under CV	Under CA
1	maize	1	0.25 t/ha	4.2 t/ha
2	soya beans (new crop)	0.8	-	1600kg
3	cotton	1.2	10 bales	17 bales
4	ground nuts	0.4	125kg	1500kg
5	cassava	0.25	nd	nd
Total		3.65		

### 7. Challenges:

- Erratic rainfall but answered by CA, farmer has planted musangu trees.
- She appears expectant of handouts – loans, fertilizer, planter and sprayers.

### 8. Benefits:

Family has managed to buy oxen, able to watch TV, sends children to schools, food security.

### 9. Way Forward:

Farmer continues with CA, and no longer sees another o vacate her land again. On it she has invested long-term virtues such as musangu and jatropha trees. She has offered to host a group poultry business.

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## CASE STUDY III. Jackson Lungu

1. Name: Jackson Lungu

2. Age: 74

3. Location: Mukabe Village, Chief Moono

4. Family:

		No.	Age	Gender	Primary School	Secondary School	Tertiary School	
1	Spouse	1	69	F				Essy J. Lungu
2	Children	8	32, 29, 26,	M=1 F=7				Lives with only 3 of them; Age range elder 36-45
3	Dependants							
4	Totals*			F=8, M=4		4	6	0

\* = Inclusive of everybody in family

Before CA, weeding took much time, but with use of herbicides, it takes less time and the crop grows uniformly on clean fields. Jackson says he has continued with basins because making these keeps him fit. He also observes that groundnuts and Bambara nuts do well in basins.

### 5. Reasons for CA Uptake:

Change in weather patterns that led to erratic rainfall, reduced yields (of harvesting 1-2 scotch carts of 5-10 x 50kg bags per lima (0.25ha) ) during CV practices made Mr Lungu abandon hoeing and ploughing activities in 2008.

### 6. Farmer Practices:

From the issue of low harvests and hunger-threatening erratic rainfall, Jackson started to implement CA activities from 2009, initially with basins on 1 lima (0.25 ha). Jackson, who already was making his basins for the 2016/17 season, has musangu and jatropha trees established on his land. He used to grow cotton but stopped in the last 2 years because of age.

CA to him means soil conservation (reduced tillage – basins and ripping, no burning, making firebreaks ), tree planting – musangus for fertility improvement, crop rotation, soil cover with crop residues- for moisture preservation, cooling the soil, termite protection when the crop is growing, money!

At an age of over 70, current production is as follows:

	Crop	Size, in ha	Yield/ha	
			Under CV	Under CA
1	maize	2	2 t/ha	4.5 t/ha
2	sugar beans	0.2		0.9 /ha
3	ground nuts	0.4		2.1 t/ha
	Total	2.6		

Jackson does 0.4 ha under basins, and the rest (2.2 ha) using a hired tractor and ripper (at US\$35/ha). He uses lime to amend his soil; and 2 herbicides for weed control (non-selective and selective at planting and post-germination respectively).

Mr Njovu says that CA responds to different scenarios, recognises the need to certify those trained and are training others.

#### 7. Challenges:

Crop residue management, as neighbours' livestock feed on the materials during the off-season communal grazing, even though they themselves do not own that type of livestock.

#### 8. Benefits:

Many people around have seen the change and benefit of participating in CA:

- Reduced time, increased yield;
- Timely land preparation;
- Able to send children to school;
- Better food security;
- Others have built better houses.

#### 9. Way Forward:

He trains and assists others with CA that attracts many passers-by (since his fields are by the main road). Jackson says mostly people enquire about the ripping aspects.

## **Appendix 3: Key Informant Interview Notes**

### **1. Preamble**

CA has been promoted by different partners and for different motives since the mid-1980s. Some coordination in one way or another over the years (with the Ministry of Agriculture, FAO, GART and CFU taking leading roles at different times) until it was finally agreed to form a CA Task force in 2014.

The task force has been given certain immediate assignments deal with, and are outlined in the main evaluation report.

In the assignment, MoA and the consultant listed many CA key players in Lusaka that could be visited for key informant interviews. The outcome of the field visits were very striking and some of those outcomes requiring very quick actions.

### **2. CA development as at it stands today**

Whilst many institutions through different ‘recipes’ of CA promotion have participated in the different parts of the country, there does not exist a coherent source of the status of CA development. These remain piecemeal with regard to existing promoting institutions, and ‘buried’ for those institutions, projects or programmes that exist no more. The institutional memory loss must be retrieved and well documented, because the CA story is a good story that must not disappear into thin air.

At the same time, there has arisen a scholarly fraternity gaining interest to collect, analyse and share about the CA ‘story’ on Zambia. Because the ingredients to the story do not seem to be complete, and are not in place, we hear sometimes of ‘erroneous’ interpretations of the story.

Zambia needs to adequately present its story – the genesis, experiences, achievements, constraints and lessons learned along the way since 1985 to be precise.

### **3. KIIs Conducted**

A total of 17 institutions in Lusaka were identified from a record of 30 organisations registering as CA promoters in the past. Of these, the consultant visited 9 of them, and interacted with only 5 of them for a number of reasons, for example:

- (1) Lack of records/memory of past activities/projects/programmes;
- (2) Change of focus of the institution;
- (3) Inadequate follow up to the CA development process;
- (4) Fear of information sharing with others;
- (5) The KII could not generate the data at a single sitting/appointment because some of the data required some researching and referring,

A summary of the outcome of the KIIs is partly presented in the main text in table form but generally discussed in the text.

The main institutional memory on CA development in Zambia is the Department of Agriculture (Technical Services Branch) of the Ministry of Agriculture, the Conservation Farming Unit of ZNFU, and to some extent the Indaba Agricultural Policy Research Institute through its various

studies. There are no specific CA lines under the Central Statistics Office that provide information on CA.

#### **4. Specific KII Results**

- (1) The Ministry of Agriculture records well over 300,000 CA adopters linked or previously linked to different existing and previous programmes and projects. Details in a separate data entry. The figures are not accurate for lack of an effective monitoring system to capture CA activities in the farming community among all farmer categories. FAO partially participated in the compilation of the data.
- (2) Conservation Farming Unit keeps records and monitors farmer performances through their existing network. Details of this group of CA adopters are given in a separate data entry.
- (3) Kasisi Agricultural Training Centre follows up its organic CA or Sustainable Agriculture farming community. They reported a participation of 637 adopters. Details in separate KII data entry.
- (4) Some information was also received from CRS, Concern Worldwide, and WVZ at district level (Mumbwa). These are presented in separate KII data sets.
- (5) No results were received from NWK Limited (formerly Dunavant Ltd), MUSIKA (formerly CLUSA and Profit-related), and CARE.

#### **5. KII - ZNFU, Mpongwe District**

ZNFU in the district offers 2 loan facilities, the Bunjimi loan scheme and the Lima Credit scheme.

The Bunjimi loan is a joint programme with Natsave Bank that provides a 20% cost of equipment security to the borrower and the rest plus interest being paid by the borrower in 1-3 years. The loan package is a selection of:

- i). A 4WD tractor, maize sheller, planter, boom sprayer; or
- ii). An irrigation system; or
- iii). Hammer mill.

The second loan scheme, pays 50% for agricultural inputs, herbicides. The other 50% plus interest is paid after harvest.

During the 2013/14 season, 1250 farmers participated in this loan scheme to cover a total of 2500 to 3000 ha.

The Officer said that the increased demand for herbicides was 'labour-saving' among the many farmers buying herbicides. She indicated, however, occasional challenge of mixing. ZNFU does hold training sessions to facilitate on the matter.

ZNFU also conducts training on agroforestry (of fruits, pine/eucalyptus), and link farmers to markets; supports study circles for vegetables, forest, pig and poultry in the area; and promotes information centres.

## **Appendix 4: CFU 2015 Food Security Survey – Climate Smart Attributes of Min-till**

### **1. 2014/15 Rainfall Season**

The rainfall pattern during the 2014/15 rainy season in Zambia followed a highly unusual profile and proved extremely difficult for all farmers. In light of this, the CFU undertook a survey to ascertain how adoption of Min-Till affected farmer's comparative ability to feed their families for the coming year. The table below which to a lesser or greater extent reflects the general pattern across Zambia's Maize belt shows inadequate rainfall in November, excessive rainfall in December commencing from the 12<sup>th</sup> of the month resulting in a late start to the planting season and severe weed pressure, inadequate rainfall in February and March with extended dry spells, and precipitation in April that exceeded February and March combined.

#### **2014/15 Rainfall Pattern CFU Lusaka**

	<b>Oct</b>	<b>Nov</b>	<b>Dec</b>	<b>Jan</b>	<b>Feb</b>	<b>Mar</b>	<b>Apr</b>	<b>Total</b>
Mean	22	79	177	212	163	142	40	835
2014/15	0	12	286	196	87	48	178	807

### **2. The Survey – Summary of Results**

A total of 3,630 farmers were canvassed, representing equal numbers of small scale Min-Till Adopters, and small scale conventional farmers (non-adopters).

The Survey indicated that 73% of Min-Till Adopters believed they could keep their families food secure until April 2016, based on their projected Maize harvest. Only 30% of Non-Adopters were prepared to make the same statement. This trend was stable across all areas polled.

### **3. Methodology**

61 CFU Field Officers (FO's) in the main Eastern, Central, Southern and Western Regions of CFU activity were each required to canvas farmers at two separately scheduled CFU Field Day events in March and April. In 2014 for example over 4,700 Field Days were held, attracting over 200,000 attendees. 2015 attendance levels will be similar on completion in early May.

Each sample consisted of 15 small scale Min-Till Adopters, and 15 small scale Non-adopters (or conventional farmers), farming between 1-3ha. Adoption of Min-Till was sufficient criteria, be it Min-till Basins, ADP ripping or Mechanised ripping. Non-Adopters had to be complete non-adopters, and the conventional tillage method applied by them whether by hoe, oxen or tractor was not considered.

Intentionally, the respondents were selected randomly without the intervention of the local CFU Lead Farmer (farmer trainer). At the close of Field Day activities, farmers were asked by the Field Officer to raise their hands if they were an adopter and 15 of these were then asked by the FO who was not familiar with the participants to come forward. The same principal was applied to the Non-adopters. These two groups were then taken aside and interviewed separately and individually to

eliminate influence from their peers. They were asked a single question: “After this difficult season, will you have enough Maize to feed your family until the next harvest, i.e. April 2016?” They were to answer a simple Yes or No. If the respondents were to exhibit any bias it was to be expected that in the case of both groups, they would answer negatively, to influence the delivery of Government food relief after a difficult season.

In total, 3,630 farmers were canvased. 1,815 of these were Adopters, and 1,815 of these were non-adopters.

**Table 1: Results by Region**

Region	Secure Adopters by %	Non-secure Adopters, by %	Secure Non-adopters, by %	Non-secure Non-adopters, by %	Total farmers polled
Eastern	66.9	33.1	26	74	900
Southern	72.6	27.4	31.8	68.2	780
Western	74.5	25.5	29.8	70.2	840
Central	72.6	27.4	36.3	63.7	810
Lundazi	84	16	24	76	300
<b>Total</b>	<b>72.6</b>	<b>27.6</b>	<b>30.2</b>	<b>69.8</b>	<b>3,630</b>

#### 4. Conclusions:

The results from the Survey show a consistent trend across all the regions that the CFU works in; Min-till adopters considered they had a better chance of surviving an adverse cropping season with highly erratic precipitation than conventional farmers.

These findings complement those found by Dr Anne Marie Mayer in her recent study for Concern (funded by independently by USAID) and related to the impact of Min-till adoption on nutrition and the wellbeing of households in general. Asking the same question as part of Focus Group Discussions of 124 CF farmers in Mumbwa and Kaoma, the farmer’s opinions reflect this same judgement; that most MT adopters would be food secure until the April 2016 whereas most conventional practitioners would not.

To conclude the results confirm an attribute that has been known by the CFU and evidenced by thousands of adopters from their experiences over many seasons with highly variable rainfall patterns; - that applied properly Min-till is *Climate Smart*.