

Lessons learned

Designing and implementing conservation agriculture in sub-Saharan Africa

Environment and climate change



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These notes are “living” documents and will be updated periodically based on your comments and feedback.

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List of acronyms

BANDERA	Balimi Network for Developing Enterprises in Rural Agriculture
CA	conservation agriculture
CFU	Conservation Farming Unit
COMACO	Community Markets for Conservation
FAO	Food and Agriculture Organization of the United Nations
GM	genetically modified
LUSLM	Lower Usuthu Sustainable Land Management Project (Swaziland)
NGO	non-governmental organization
SCI-SLM	Stimulating Community Initiatives in Sustainable Land Management (Zambia)

Introduction

This “Lessons Learned” document of the conservation agriculture (CA) in sub-Saharan Africa toolkit reviews experiences over the last two decades. First, the context and challenges of CA in sub-Saharan Africa are addressed. Then the main issues follow – those previously raised in the Teaser as being crucial to the successful design and implementation of CA programmes, or CA components within development programmes. These issues are all key to initiating and sustaining CA, but simultaneously constitute elements that have perplexed those involved in promoting and implementing CA projects. The issues are approached from the available literature and enriched with experience from various countries in Southern, East and West Africa. Third, a series of country case studies are presented to review experience on a national basis, but also to highlight particular points. The document ends with a summary of key lessons and strategic recommendations that lead into the How To Do Note.

Context and challenges

Conservation agriculture is a combination of minimum soil disturbance, continuous soil cover and crop rotation (Box 1). When these three “principles” are implemented together, and they are associated with supportive agronomic measures, CA has the potential to reduce losses in soil organic matter associated with traditional tillage, raise fertility levels, improve rainfall infiltration and water use efficiency, reduce erosion, and improve biodiversity in the soil. It can also reduce costs (by saving fuel and labour) and assist in timely planting because fields can be prepared more quickly and in advance of the first rains. CA – at its best – can help to counter land degradation, reduce greenhouse gas emissions, sequester carbon in the land (under certain circumstances), confer climate resilience to a landscape within a healthier ecosystem, and lead to higher and more stable crop yields. It can thus make a vital contribution to sustainable intensification of food production, and people’s food security and livelihoods

Box 1. The three principles of conservation agriculture

- Continuous minimum mechanical soil disturbance
- Permanent organic soil cover
- Diversification of crop species grown in sequences and/or association

Source: Food and Agriculture Organization of the United Nations.¹

Traditionally, in sub-Saharan Africa, smallholder farmers wait for the first rains of the forthcoming wet season before they begin land preparations. The first step is overall tillage of land using either the hand hoe or an animal-drawn plough. In many areas where animal traction is practised this first ploughing includes planting by dropping seed into the furrow to be covered by the next pass of the plough. Some four to six weeks after planting, weeding takes place, predominantly by women and children using hand hoes. Conservation agriculture offers an alternative to this traditional method of farming and brings with it various benefits.

Conservation agriculture’s evolution and spread over the past 25 years has been little less than a global phenomenon: currently, almost 10 per cent of all arable land is farmed under some aspects of this system. In the Americas, in particular, specially designed mechanized equipment, together with herbicides (often in combination with genetically modified seeds resistant to the herbicides), medium- to large-scale farms, rainfall supportive of green cover crops and farmers keen to cut costs, has led to very high levels of CA adoption (see Figure 1). However, Africa appears not to be joining in this widespread adoption of CA. Why is this after considerable development investment over the last 20 years? The answers to this question are explored in this second document of the three-part toolkit. Nevertheless, there have also been emerging success stories, and while these have been almost exclusively limited to Southern Africa, there is real reason for optimism. Smallholder farmers in Zambia and Zimbabwe have widely taken up various forms of CA, and larger-scale mechanized farms have also begun to use CA in these two countries as well as in South Africa.

Africa accounts for only 0.8% of the world's Total CA area, of which 98.5% is practiced in Southern Africa

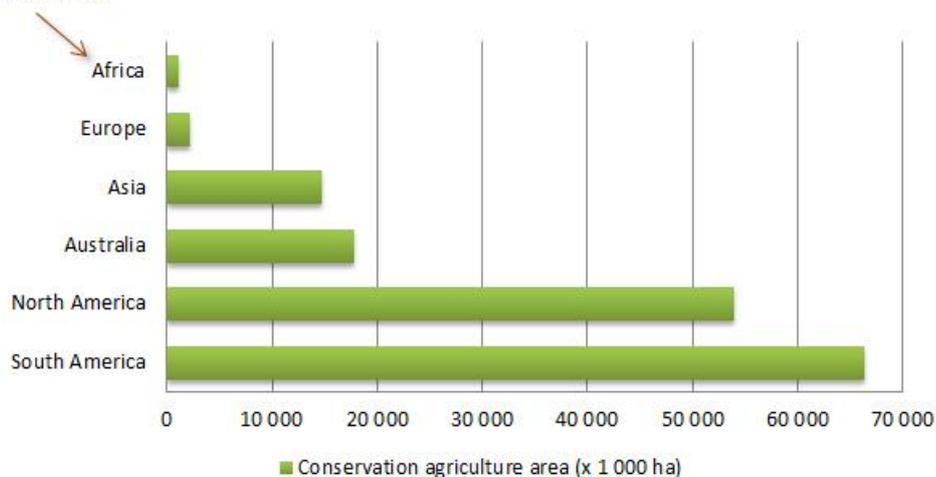


Figure 1. Global area under conservation agriculture

(Source: Aquastat, accessed 14 October 2015)

Lessons learned

Issues

The following issues are based on the analysis conducted in developing this toolkit. These were summarized in the first document – the Teaser. In this section, answers are provided to these identified issues. While the country case studies that follow provide support to most of the analysis, relevant literature has also been extensively used to underpin the analysis.

1. Purism or pragmatism?

Those familiar with CA in Africa will remember the impact made in 2009 by Giller and colleagues through their article *CA and smallholder farming in Africa: the heretic's view*.² The title was deliberately provocative, the implication being that the CA agenda in Africa was in danger of being taken over by proponents of the “three non-negotiable principles”. They argued for a more pragmatic stance that was based on an appreciation of African reality. In sub-Saharan Africa, there are widely heterogeneous agroecological zones with multiple and varied farming systems, generally very small farms, poor marketing infrastructure, and only basic levels of extension support. All of this is very different from South America, where CA is flourishing on farms of commonly 20 hectares or more, where herbicides are available, mechanization is the norm, and economies in the use of fuel are a clear trigger. There are further important points raised in the article regarding semi-arid areas and supply of residues (see below). This debate still continues and stances have “remained polarized”,³ though the paper acted as a timely reality check to all sides and has undoubtedly led to keener analysis of the situation in sub-Saharan Africa.

Reality and experience demonstrate an apparently growing consensus that “one size” simply does not “fit all” in sub-Saharan Africa and that a flexible approach is required.^{4,5} Above all, a transfer-of-technology approach from outside Africa has a long history of failure – and will continue to be counterproductive. A follow-up article by Giller and colleagues, published in 2015, suggests that a “Systems agronomy approach to the identification of appropriate agronomic practices...[will]...place the beneficiaries at the centre of activity where they belong.”⁶ A basic conclusion is that CA works better in some situations than others. It needs to be tailored to specific situations and “partial CA” can deliver at least some of the benefits.

2. Residues: for mulch or other uses?

One example of how sub-Saharan Africa presents a difficult basis for adoption of CA is the use of crop residues to support the principle of continuous soil cover. In much of Africa, particularly in semi-arid zones, not using residues as fodder for livestock, and even for fuel, comes with a high opportunity cost. The option of interplanting a cereal crop with a green manure/fodder may be valid in Latin America, but most of sub-Saharan Africa is simply too dry, with insufficient residual moisture in the soil for the legume/green manure crop to mature. How then is it possible to break into the virtuous cycle of CA, where many of the benefits, and the incremental sustainability of the system, depend on residues remaining on the ground? The multiple benefits of maintaining soil cover between growing crops, and after the cropping season, are listed in various publications^{7,8,9} – and that list is impressive, being at the heart of CA. These reported benefits include:

- reduction in evaporative loss from soil surface
- increase in rainfall infiltration and water use efficiency
- minimizing oxidization of soil organic material
- reduction of compaction by machinery
- maintaining a supply of organic matter for soil organisms
- suppression of weeds (under a heavy mulch).

It is inevitable that semi-arid areas will lack adequate mulch more than humid areas because yields tend to be lower, residue decomposition rates greater, and the demand on residues for animal feed higher. This competition is implicit in most of the country case studies discussed in the next section, and explicit in Mozambique. Contrastingly, Malawi does not, apparently, have a mulch/fodder problem. This is due to lower livestock numbers, though (as in Ghana) some farmers burn residues to chase out small game for the cooking pot. One possibility in the more humid zones is to “prime” the system through biomass transfer, where organic materials, such as grasses or forest leaf litter, are brought from elsewhere and applied as mulch to the CA land. To avoid degradation of one part of the landscape to improve another, this should only be an initial biomass transfer and strictly for a limited period of time. Naturally, ownership of natural resources comes into the equation also – to take organic material from land used by others in common will often lead to conflict.

3. Fertility management: can yields be rapidly and sustainably improved?

Improved crop yields are one of the primary key factors behind farmer acceptance of new technologies in sub-Saharan Africa. However, the inherently low fertility of Africa’s very old soils and nutrient mining (by export of products without replacement by manures or fertilizers¹⁰), combined with no tillage, which reduces nutrient mineralization processes and the often vigorous weed growth, mean yields in the early years of CA can be lower than those under conventional ploughing systems.^{11,12,13} The imperative to improve soil fertility alongside the introduction of CA in Africa has led to a proposition that soil fertility management and, specifically, fertilizer addition, be taken on as a “fourth principle”.¹⁴ That idea was rejected by opponents¹⁵ – not because fertility was not viewed as being important, but rather because the three principles of CA have been determined in such a way as to distinguish it from other systems of good agricultural practice.¹⁶ Thus, it is not contested that fertility management is crucial to the success of CA programmes; it can, and must, be addressed simultaneously.¹⁷ For example, in southern and western Zambia, the recommendation is to basal-dress maize with 100-200 kg/ha of a compound fertilizer, followed by top-dressing with 100-200 kg/ha of an N-based fertilizer.¹⁸ However, in the more humid Luangwa Valley of eastern Zambia, with its more fertile soils, the Community Markets for Conservation (COMACO) organization discourages fertilizer application and promotes compost application and an agroforestry system of “alley cropping”, which includes mulching with the leaves of *Gliricidia sepium*.¹⁹

Strategies to improve the nutrient use efficiency of fertilizer, for example, microdosing as well as complementary liming and use of organic manures together with the introduction of leguminous

agroforestry tree species into the system, need to be considered.^{20,21} In this respect, there is a close parallel with the traditional *zai* and *tassa* systems of Burkina Faso and Niger, respectively, where widely spaced planting holes are foci for concentration of manure as well as harvested rainwater. It should also be recognized that, over time, fertility of the soil builds up under CA as a combined function of non-disturbance, precision application of available soil fertility amendments to permanent planting positions, rotations with legumes, and the application of residues. Eventually, this leads to sustainably improved yields and the generation of increased crop residues for mulching and for feeding to livestock. Most of the country case studies do report improved yields over time, though there is not enough consistent data to draw any firm conclusions about average periods required. While Uganda's recent experience (see case study) reports impressive first year improvements, most countries have to wait a few years before this occurs. Invariably, greater application levels of fertilizers and manures have accompanied CA where higher yields have been recorded.

4. Weed control: weeds – a manageable menace?

The large-scale adoption of CA in South America has been driven by the use of a (relatively) rapidly decomposing and safe herbicide – glyphosate (often employed on that continent in combination with genetically modified (GM) seeds which permit post-emergence spraying). The dedicated website of the Food and Agriculture Organization of the United Nations (FAO) specifies that the use of herbicides is “inevitable” in the first few years under CA systems.²² After a number of years, however, the weed burden is reported to decline under CA, as the weed-seed pool in the soil diminishes and, correspondingly, less herbicide is required; others suggest, though, that some more “pugnacious” weeds persist. Nevertheless, in parts of Africa, the logistics of spraying, let alone affording and acquiring herbicides (or insecticides to control stalk borer that can be carried over in maize stover), are beyond many small-scale farmers²³ without specific assistance from programmes and projects. Furthermore, in most African countries (South Africa and Kenya being exceptions), GM seeds are not permitted. Traditionally, ploughing was used to bury the first flush of weeds; no-till places an extra weeding burden on farmers unless herbicides can be supplied and farmers supported in their use.

Early weeds pose a particular problem for farmers using hand-based systems: the frequent hoeing required can exacerbate labour constraints²⁴ and increase the labour burden on women and children. The recommendation from the International Maize and Wheat Improvement Center (CIMMYT)²⁵ (for non-GM crops) is to use the non-selective systemic herbicide glyphosate pre-emergence, followed by a contact herbicide, e.g. gramoxone, post-emergence. Without herbicides, early yields are almost inevitably reduced and the field simultaneously looks messy and poorly managed; hence, farmers are discouraged. Other methods can help in the short term, such as animal-drawn roller blades, superficial hoeing and hand pulling. But apart from small plots (less than 0.2 hectares, close to home), herbicides will be a necessity even though amounts required will lessen over time. Weed management remains a real issue under CA in sub-Saharan Africa, and a genuine concern to farmers and programme managers alike. It is considered by some to be the main constraint to widespread uptake of CA in Africa.²⁶ This is something that must be carefully handled by those promoting and supporting the introduction of CA. While almost all countries reported in the case studies have introduced herbicides as part of their CA package, Zambia's campaign led by the Zambia National Farmers' Union offers the clearest experience of how herbicides can be introduced, their use demonstrated and subsidized, and how small-scale farmers can relatively quickly remove weeds from the negative side of the CA equation.

5. Crop rotation: what to do where the market for legumes does not exist?

Rotation is one of the three principles of CA: without some form of rotation the system ceases, according to the official definition, to be considered as true CA.²⁷ One reason is that weed problems can become much more severe.²⁸ In sub-Saharan Africa, all manner of crop associations (intercropping, relay cropping, as well as inclusion of leguminous woody species) are used to fulfil this criterion and reap at least some of the benefits of rotation. To the CA purist, these systems may verge on the borderline between CA and non-CA; to the pragmatist, this is a question of achieving what is possible and what farmers will accept. Crop

rotations conventionally include a legume crop in the cycle. Legumes have the benefits of being nitrogen-fixing (but only on fertile soils) as well as being a nutritious food. But if a pure stand is grown, then a market may not exist for its sale; indeed there is also, commonly, no market to supply good quality seed. One interesting exception is under COMACO in eastern Zambia where branding of CA-produced groundnuts, and then their transformation into groundnut butter under the “It’s Wild!” label, currently guarantees farmers a premium price.²⁹ There are other alternatives for the African situation – for example, intercropping with legumes (even at low density) for home consumption or sale. The pigeon pea (*Cajanus cajan*) is an excellent example. Another related “supplement” comprises agroforestry systems based on leguminous tree species; this is reported from Zambia and Kenya (see case studies). Legumes grown for “green manure” or simply as “cover crops”, which are very popular in South America, are only a feasible option in the more humid zones of sub-Saharan Africa. However, Kenya is reported to have used them and they would possibly fit the Ugandan situation also (dependent on the particular agroecological zone). Rotation with legumes is an area where the stimulation of value chains and market-led approaches can help to act as “pull” elements that entice the farmers towards CA rather than “push” factors that oblige them to take a specific course of action.

6. Labour: does CA ease the burden?

Seventy per cent (or more) of power on sub-Saharan Africa’s farms comes from manual labour (see issue 10). It hardly needs repeating that the majority of this is women’s work. Any progressive development in agriculture therefore requires that labour demands are reduced, and women’s input is lowered (absolutely and relatively). Thus the question is: does CA reduce labour requirements in reality, and rapidly, or may it be that early season weeding burdens (for example, see issue 4) are actually increased? What could be done if so? This question is very closely connected to that of a reduced weeding input, which, as has been noted, is by no means proven in sub-Saharan Africa. Nevertheless, one big advantage of CA is that it is based on permanent planting stations (holes or lines) so the overall seasonal land preparation burden is reduced. The step from hand-based systems to ox-drawn furrow opening is a major cultural change for some groups of African farmers, and involves considerable investment also. There is also the question of feeding the oxen: the field operation of furrow-opening/ripping occurs at the end of the dry season when the animals are at their weakest. Ironically, supplementary feed in the form of crop residues, while helping the animals, acts against the interests of one of the three key principles of CA – maintaining soil cover. What is certain, however, is that shortage of labour is one of the main constraints to smallholders in sub-Saharan Africa, and if CA does not relieve this burden, it will be quickly dismissed by farmers.

7. Water harvesting: can CA play a role?

Throughout the semi-arid zones of Africa, water harvesting – in its true meaning of “the concentration and collection of rainfall runoff for plant production”³⁰ – has, historically, provided food from plants in zones where rainfall alone would be inadequate. Thus, water harvesting depends on bare areas of land to act as a catchment, yet this appears to contradict the principles of CA. The two can indeed be reconciled, but once again the “purist” interpretation of CA needs to be adjusted to this very specific situation. The catchment area between planted lines should not be mulched, whereas the cultivated strip in front of the contour ridge, where the water concentrates, should be mulched. A further advantage of this modification is that where residues are limited (as they almost always are in semi-arid areas) this economizes on their use. In the case of the well-known Sahelian *zai* and *tassa* pitting systems, where wide planting pits are dug specifically to capture runoff and the land between not tilled, the limited available mulch is again best located around the plants rather than in the catchment areas between the planting stations. Zimbabwe’s trials with widely spaced, broad tied furrows in Chiredzi would have offered an excellent opportunity for such “spot mulching”³¹ (though it is understood this system was too labour-intensive to spread beyond the research station). Likewise, catchments between planting strips in Botswana would similarly “qualify”.³² In the case of external catchment systems (used in semi-arid/arid conditions), the outside catchment should certainly not be mulched as it would be a meaningless waste of residues. This is a case of where an African-specific interpretation of CA is called for, and where there can be incremental benefits to existing systems.

8. Soil and water conservation structures: are they still needed under CA?

Strangely, there is no mention in the recent literature about the place of existing soil and water conservation structures within CA systems – nor indeed the requirement for structures such as bunds and contour grass strips on sloping land where CA is introduced. With respect to existing structures, in the absence of specific analysis or comment, there is certainly a case to maintain these structures to prevent water runoff and soil erosion, especially during the period that the CA system takes to become fully effective in protecting the land. Furthermore, grass strips, or earth bunds planted with grass, can help provide an excellent source of mulching materials or, alternatively, fodder for zero-grazed livestock. Such contour structures also act as ideal sites for agroforestry trees. A further possibility is planting with “push-pull” species that help control pests; for example, desmodium produces repellent volatile chemicals, while napier grass acts as a haven for natural enemies of stalk borer.³³ Where CA is introduced on otherwise unprotected, steeply sloping land in sub-Saharan Africa, either uncultivated contour strips with natural vegetation left untouched or conventional soil and water conservation, structural measures will be needed, at least in the first years. Many of these same arguments hold for strips of land around fields, where planting of trees and other vegetation will help with wind and water erosion control as well as providing mulching/fodder materials.

9. Livestock: how can they best be integrated into CA systems?

Few African farming systems are based on crops alone. They are either mixed systems where a small number of livestock graze or browse areas between crop fields, or, where agriculture is more intensive, zero-grazed dairy cows may be part of an integrated system. In semi-arid lands, there may be reciprocal arrangements between crop farmers and livestock herders to yield mutual benefits, such as stubble grazing in exchange for manure deposited. The competition for crop residues – between its use as fodder and its value under CA as a mulch – has already been noted as being a key issue in sub-Saharan Africa, yet surprisingly there does not appear to be much analysis of how this problem can be resolved. Experience from elsewhere would point to better pasture management combined with new land use arrangements – sometimes based on more secure land tenure – that would take pressure off the harvested croplands. Fencing is an issue, though it may be possible to introduce “social fencing” in some areas, especially when a critical mass of CA farmers develop a common interest in such arrangements. In more humid zones, the obvious choice is to move to zero-grazing of dairy cows (and even small stock), thus exercising control over fodder sources and preventing grazing of residues. East Africa has long experience with such systems, especially when water supply issues are resolved. One significant associated benefit of zero-grazing is a source of manure close to the household, or, when combined with biogas units, high-quality slurry. Due recognition of the role of livestock is urgent if CA is to merge into, and add value to, overall farming systems in sub-Saharan Africa.

10. Mechanization: can CA help take the burden out of farm work?

Africa has the lowest level of mechanization of any continent. As noted, 70 per cent of farm power comes from manual labour, predominantly from women; less than 10 per cent is from engines, with animal draught making up the balance.³⁴ In Latin America, with its medium-sized farms and history of mechanization, CA lends itself to machines, and field operations can be efficient and quick, with an appropriate power source and an established CA system. This could potentially address one of the key adoption constraints of African smallholders and reduce the burden on women, too. However, in the short term, the two basic forms of field operations under smallholder systems in sub-Saharan Africa are likely to remain hand hoe pitting (with certain specific planting aids such as “jab planters”) and ox-drawn furrow openers using either the existing mouldboard (as a temporary solution) or a ripper tine attached to the plough beam. Zambia (see case study) has relevant experience with hand- and oxen-based systems.

Four-wheel tractors with appropriate direct drill attachments may be feasible in some situations, especially where large-scale farms neighbour smallholder areas. But they can best be made available to resource-poor farmers through privately operated hire systems – an opportunity for youth perhaps? Such microbusinesses will need to be stimulated and supported by loans in order to be established and become

viable in the long term. The private sector must be brought into the picture here, working alongside government and donors; there will be profits to be made in the years to come if and when CA takes off and sufficient demand is created for mechanization. Two-wheel tractors, however, with suitable attachments are still very much in the design phase.³⁵ While hoes and ox-drawn furrow openers (e.g. the “Magoye ripper”) can be manufactured in most countries, a significant hurdle to mechanization is the non-availability of machinery, even ox-drawn seed drills. Importation is expensive and maintenance skills so far lacking, as are spare parts. Not only does this call for support to the small-scale manufacturing sector, but it also may imply reducing tariffs on imported steel in specific countries and on equipment in others. An alternative route is to reduce import tariffs on machines that are known to work effectively, with the hope that these may stimulate local manufacture of spare parts (at least) in the short term.

11. Incentives: are they starters, bribes, shared costs, rewards or compensations?³⁶

Farmers will need some initial support to help them invest towards sustainable systems of CA. There are set-up costs involved, including new tools and machinery, fertilizers, herbicides with associated sprayers, and improved seeds. Agroforestry will require seedlings, while legume crops will require the supply of quality seeds and a market for the produce. Fields may need to be protected against livestock. Thus, alongside training, farmers will require support in the short to medium term. The balance between using just enough incentives to stimulate, and just too much, which distorts farmers’ activities and ends up being counterproductive, is hard to achieve. There is a fine line between achieving the desired “tipping point”, when farmers can take over without the need for more help, and creating addiction to free inputs. As has been noted, Zimbabwe is a case in point where there has been “dis-adoption” after withdrawal of subsidized inputs, as there were no associated investments made in the input supply side of the market.

The length of support needs to be determined (a few seasons, until the CA system “warms up” and begins to yield economic and production benefits) and the form and quantity of inputs (in kind rather than cash, or e-vouchers with a reducing value over several seasons that can only be spent on specific inputs). A further, essential precondition of an effective incentive system is that programmes and projects harmonize their positions on incentives at a national level. This relates not just to amounts, but also to duration. An effective incentive system is one that is phased out strategically under a carefully planned exit strategy – at a point that it has helped to stimulate a self-sustaining process.

12. Outscaling and upscaling: how to break out of the project enclave to reach the majority?

Many reports testify to the “promise” of CA under project support. But experience dictates that this is little guarantee of progressive upscaling (institutionalization) and sustained outscaling (adoption) to a significant number of farmers post-project. Outscaling is crucial in the early stages, as CA thrives best where it picks up a critical mass of participating farmers, and this is not just for the ecosystem benefits that a large area under CA can deliver. Some technologies are scale independent, and in specific cases farmers thrive best when they are the only ones embracing an innovative system in the area. Take, for example, a private nursery that produces budded citrus or grafted mangoes – others taking up enterprises present competition.

Conversely, CA thrives on whole communities embracing the system. Many interconnected factors benefit from the demands that are generated. Suppliers have a firm market for improved seeds and increased amounts of fertilizers and herbicides, the small-scale manufacturing sector has a solid base to invest in producing machinery and spare parts, and there are less obvious impacts such as local pressures on better livestock control and land use management, addressing national land degradation concerns and reducing greenhouse gas emissions.

13. Triggers: what fires the starting gun?

In most cases of technology adoption, it is possible to identify a “trigger” or driver that propels the process. With CA these can be very different. For example, it was air pollution from straw burning in China; in much of Latin America, it was high costs of land preparation. On large-scale farms in Zimbabwe, the trigger was

soil degradation, but also the fuel shortages during the days of international sanctions. As also noted, in Malawi, labour reduction is key, and with “spare” labour comes the capacity to prepare land and to plant early. Triggers are often the reciprocal of problems, so do we know enough about farmers’ primary constraints in different farming systems of sub-Saharan Africa? This can guide us towards the potential initial entry point for action and advocacy.

Figure 2 presents a generic problem tree for sub-Saharan Africa, where the fundamental causes of low and erratic yields are traced back to a series of constraints. The three basic problems are identified as: (i) lack of inputs (caused primarily by cash shortage and market failure); (ii) land degradation (with multiple causes including soil fertility decline); and (iii) shortage of labour and farm power (migration of labour away from farming and lack of appropriate mechanization). These constraints are often highlighted more brightly in the literature³⁷ than in project design. This is a generic problem tree, and each situation needs to be analysed individually. The essential next step is to ask the question: can CA help overcome that problem, and how? Then, assuming the will to move towards self-sufficiency, surplus and, eventually, to commercialization, that problem provides the initial trigger. That is where a programme should focus its attention.

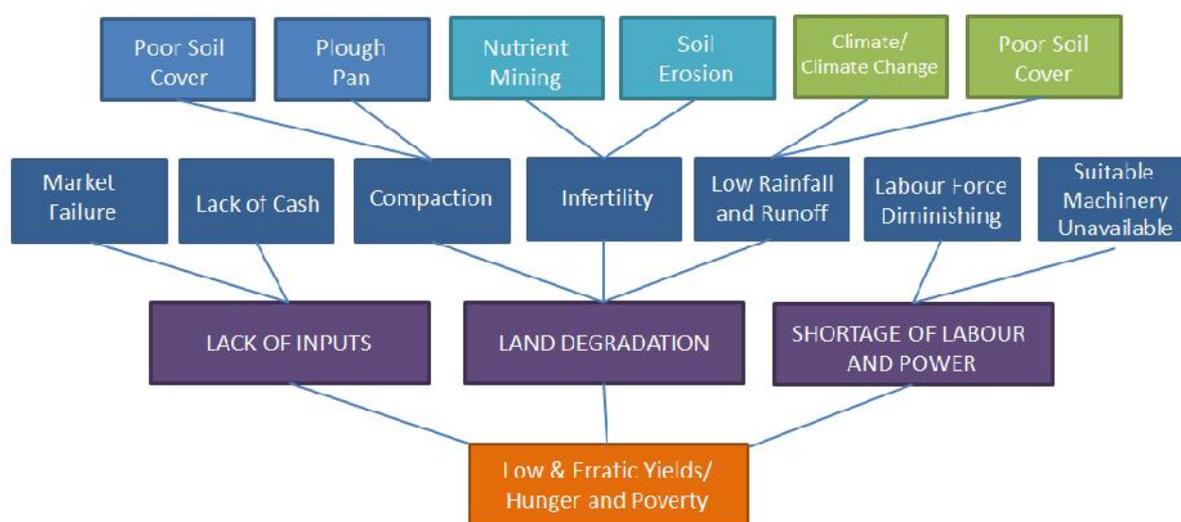


Figure 2. Generic problem path of small-scale farmers in Africa

14. Socio-economic issues: do we focus too much on technology?

To argue that by adopting CA's principles “soil health” will benefit is fine as far as it goes, but an African farmer may need a more compelling and practical reason to change a centuries-old system. Having identified key constraints and entry points (see previous section), there may be further, less evident issues that prevent adoption. Already it has been noted that there can be competition for residues between the needs of livestock herders and crop farmers. It may be that burning of residues and dry weeds is valued for driving small game towards waiting hunters (note the Ghana and Malawi cases). Local communities are often reluctant to change their diets, and bringing legumes into a rotation might make perfect agronomic sense but can be rejected in the kitchen. Perhaps as important as anything else is something that has already been noted – breaking with the age-old tradition of ploughing. Unploughed land and crops struggling to compete with an early weed burden are more generally associated with poor farming than a radical and progressive system. Neighbours notice such things.

To support design and implementation of projects, it is key to understand the socio-economic constraints that prevent households from investing in agricultural production and CA. Many biophysical considerations are considered in this section, but other aspects are important too – like a household's access to rural finance to buy inputs, hire labour or to access mechanization services. Another is the shift in the labour burden within the season where, for example, there is increased weeding needed as more land is opened through animal-traction CA. All these need activities designed to support them. Are such factors taken adequately into consideration when promoting CA? It seems not: sensitivity is required.

15. Extension and advocacy: in what ways can change agents become more relevant?

Extension services are vital and extensionists, or “change agents”, as they actually are in the case of CA, need to be adequately trained and to thoroughly understand the systems themselves. There must not be a reversion to a transfer-of-technology system, which can be a temptation with a new approach that (in many ways) is counterintuitive. Farmer field schools are an excellent way of joint learning where extension agents can participate initially and then withdraw when farmers take more control over the process. There are many examples of where exchange visits, both within and between countries, have had a powerful impact. CA presents an excellent opportunity to bring South-to-South learning to the fore: if a community embraces CA and benefits from it, the members will not only have a sense of pride, but will also want to share what they have achieved.³⁸ There is even an argument for internships, where one or two farmers from a pilot area are placed for a full season within a vibrant CA community area, learning the skills hands-on.

16. Research: can the scientific community add value?

The research community has a role to play in developing CA systems, and nowhere is this truer than in sub-Saharan Africa, where the systems need adaptation and fine-tuning. An extremely important starting point is helping gather information – in other words, supporting monitoring and evaluation systems. There is simply not enough data about even the basic parameters regarding CA in sub-Saharan Africa (inputs, labour, adoption, yields, weeds, etc.). An added incentive for researchers is that CA, being such a heralded new system of ecologically based sustainable intensification, has generated global interest and provides rich opportunities for publication of research papers. It is also the role of research to help produce, or at least lend technical support to, the production of technical guidelines and handbooks to support country programmes.

Zambia's Golden Valley Agricultural Research Trust has been instrumental in guiding that nation's CA programme through applied research and related publications. While research still conjures up images of white-coated scientists carrying out on-station trials, it is essential that the role of farmers and community research and innovation is not lost. CA must not revert to the outmoded top-down transfer-of-technology paradigm. CA in sub-Saharan Africa can only spread and be sustained if ideas are generated by practitioners; formal researchers can then join in and support local innovation. Research and communities working on CA together can generate hybrid knowledge.

17. National campaigns: pulling together to bring about change, the only way to create real impact?

In order to succeed at a national level, CA requires multiple actors to become involved and work together in a joint, coordinated manner. Too many efforts in sub-Saharan Africa have been scattered and disjointed. There has to be support at the policy level, naturally from the ministry of agriculture to provide guidance and to state a position, and even from the ministry of finance, for example, with respect to import duties on steel and incentives for rural financial institutions to support the smallholder. The ministry of environment can also help promote a system that reduces greenhouse gas emissions from the agricultural sector, with CA constituting a part of a climate change policy. Various ministries may need to be involved in developing market chains to help “pull” production rather than “pushing” farmers. The ministry of agriculture will be crucial in organizing extension and supporting research.

The private sector has an important role in mechanization, marketing (where sustainable, climate-change-friendly branding can play a role) and providing microfinance. Farmers' associations can be crucial in organizing farmers. Non-governmental organizations (NGOs) can help extend the nationally agreed messages of changed practices more broadly than government alone. International agencies can be instrumental as catalysts and instigators, and strategically used donor funding may make a vital contribution in the start-up phase. In short, a campaign is required to make a significant difference, and it needs to be backed by all sectors, working in partnership, talking with one voice. As Figure 3 demonstrates, the three principles of CA need to be surrounded not just by associated technical practices, but also to be encased in an enabling environment of political will. That is the only way a campaign can thrive and make a significant impact.

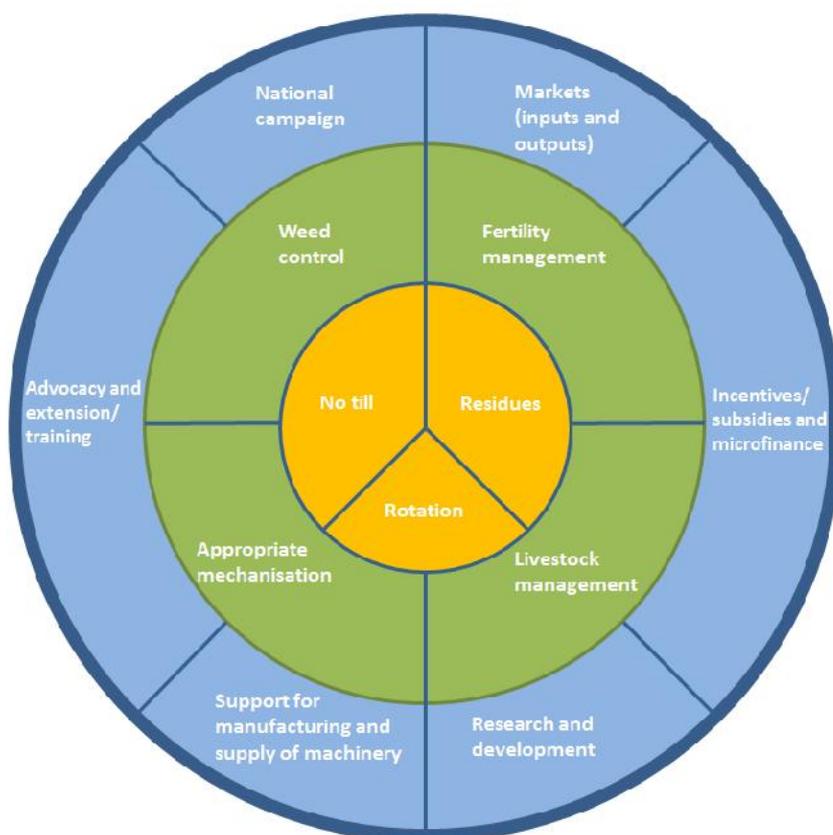


Figure 3. Conservation agriculture: principles surrounded by practices within an enabling environment (developed from a CA principles graphic: African Conservation Tillage Network³⁹)

Country experiences

Zambia: a strategic campaign

Zambia's recent and continuing rapid progress with CA among smallholder farmers is unrivalled in Africa. While Zimbabwe may have more practitioners (according to the official FAO AQUASTAT statistics⁴⁰), in Zambia, from a baseline of almost none in the mid-1990s, there were 250,000 farmers involved in CA by 2012 and the number was still increasing rapidly.⁴¹ Income from crops can increase by 140 per cent among the poorest farmers, and much more among those who can afford the full suite of inputs.⁴² As a result of a visit by a delegation from Zimbabwe in the mid-1990s, accompanied by a technical manual⁴³ (see Zimbabwe case study), CA was taken up with enthusiasm in Zambia. This was the catalyst for the establishment of the Conservation Farming Unit (CFU) in 1996 by the Zambia National Farmers' Union, supported by the private sector, the Norwegian Government and other donors, including World Vision. Since that time, the CFU has spearheaded a national campaign. Working closely with the Ministry of Agriculture and cooperatives, the CFU has coordinated action to bring CA to as many smallholder farmers as possible. CA was seen as the answer to diminishing maize yields on increasingly impoverished soils, and Zambia consequently embraced the concept of CA under a national campaign.^{44,45}

The campaign has been based on the promotion of mainly the hand hoe – but also oxen-draught – systems, underpinned by coordinated training and extension. Hand hoes have been the main focus since promotion coincided with livestock deaths in the early 1990s, which limited the availability of oxen. Private cotton companies supported this as a means of keeping the production going using CA methodology, based on a rotation of cotton, maize and soya bean. Hand hoes are used to make planting pits/basins, while the locally made, animal-drawn “Magoye ripper” (or “Magoye furrow opener”, a standard African ox-drawn plough with the mouldboard replaced by a shallow tine and wings) opens planting lines without disturbing most of the soil. Both methods are combined with permanent planting lines/stations, precision hand-planting, liming and fertilization. A herbicide (glyphosate) is used to control weeds. It is applied using a backpack sprayer to weeds pre-emergence between the planting stations. Lead farmers are selected as pioneers and supported with inputs and training. They then establish CA demonstrations on their own fields and are encouraged to spread the word to others in their group, community and beyond. Thus, they act as frontline extension workers, speaking from first-hand experience of increased yields and income: they are ambassadors for CA.

A key feature of the Zambian campaign has been research support from the Golden Valley Agricultural Research Trust (GART). One very promising development, pioneered by GART, is the introduction of agroforestry trees. *Faidherbia albida*, an indigenous “fertilizer tree”, drops its leaves in the dry season, enriching the soil and allowing crops to grow vigorously underneath the bare canopy. Zambia, in fact, only uses the term “conservation agriculture” to describe a complete system that includes agroforestry; otherwise, it is known as “conservation farming”. Zambia has the best documented CA programme in Africa, both in terms of extension materials and promotional articles and documentary films. The CFU has published a CA handbook to cover not only Zambia but also East and Southern Africa, too.⁴⁶ This handbook compares and contrasts CA with conventional farming (see introductory section). There are also a series of leaflets that focus on specific topics within CA.⁴⁷ While Zambia has much to teach the rest of Africa in terms of a concerted, targeted campaign with popular success, there remains several challenges. In relation to mechanization, there are no locally mass-produced ox-drawn direct drills even though a prototype seeder that can be linked to the Magoye ripper was developed in Zimbabwe. The marketing of legumes is another challenge. And there remains the crucial question of at what point can CA be truly considered to have taken off, and thus when can support be gradually withdrawn in a strategically planned exit strategy?

Contrastingly, in the east of Zambia, where rainfall is considerably higher, COMACO, which is a limited company, has established a programme under which farmers comply with CA practices and receive premiums through branded products under the “It’s Wild!” label.⁴⁸ Peanut butter from groundnuts is an example. This is a unique, market-based approach to CA, tapping into a premium market that values “naturally grown” products. COMACO’s ethos is to rely on compost and agroforestry, with species such as *Gliricidia sepium* as mulch rather than using fertilizer and herbicides. All operations are by hand. Around 96,000 farmers have been reached in the Luangwa Valley through this model.⁴⁹

Sources and further information: CFU website;⁵⁰ World Bank documentary;⁵¹ Haggblade and Tembo (2003);⁵² and the www.itswild.org website.

Zimbabwe: learning by doing

According to historical notes, Zimbabwe’s CA roots can be traced back to the 1980s when trials on large-scale farms provoked dismay at the state of the soil and triggered the process.⁵³ After successful results, the technology was modified for promotion among smallholders and a “farm management handbook” on CA was produced in 1993.⁵⁴ Progress was steady, but received a boost with programmes championed and supported by the United Kingdom’s Department for International Development and the European Commission’s Humanitarian Aid Office, among others.⁵⁵ The promotion of CA in Zimbabwe has been paired with intensive training and subsidized inputs to stimulate small-scale farmers to apply the system. The Zimbabwean Conservation Agriculture Task Force, supported by donors and government, developed common messages – and both NGOs and the Department of Agricultural Technical and Extension Services play important roles in supporting farmers in adopting CA. A key feature of promoting CA in Zimbabwe is the focus on “learning by doing” and the underlying notion that successful extension is only achieved through committed institutions and individuals who believe in the message. Today, approximately 300,000 farmers (close to 30 per cent of rural households), on some 332,000 hectares (2013 figures), are apparently practising CA and have nearly tripled their production.⁵⁶ However, these numbers may be overoptimistic; it has been suggested that a “large share” of farmers who first adopted CA later abandoned the practice as direct support was withdrawn.⁵⁷

Three methodologies shape how organizations promote CA in Zimbabwe: (i) trained governmental or non-governmental extension agents directly support local farmers in the implementation of CA; (ii) extension agents work with lead farmers, who, after successfully practising CA, in turn work with farmer groups in communities; and (iii) combined extension agents and lead-farmer systems, where organizations begin working with groups of farmers and from these they select lead farmers who will guide groups in the future. CA in Zimbabwe is characterized by the promotion of planting basins – small basins dug by hand hoes, which capture rainwater before seeds are sown into them. This method of “precision conservation agriculture” is defined by the application of crop residues, manure, “microdosing” with a basal fertilizer, and topdressing, as well as timely weeding and crop rotation.⁵⁸ The planting-basin concept was developed in Zimbabwe in the late 1980s and subsequently promoted in Zambia. It has been estimated that a modest sized plot (0.6 hectare) close to the homestead can produce 900 kg of maize using this method.⁵⁹ Change is not without pitfalls, and there is a continued risk of farmers abandoning CA in Zimbabwe (and elsewhere, too) if external support is withdrawn too soon. In the case of Zimbabwe, the input supply market has not been adequately developed, so leading to a degree of “dis-adoption”. Thus, a key issue is when, and how, farmers can best be weaned off subsidized inputs. Stimulating input supply markets, creating farmer support networks, and providing support, advice and training from extension agents for *at least* five years are all important ingredients of successfully promoting CA.

Sources and further information: Pedzisa (2015);⁶⁰ FAO (2015);⁶¹ Zimbabwe CA Task Force (2009);⁶² Zimbabwe CA Task Force (2008),⁶³ Oldrieve, B. (2004),⁶⁴ Oldrieve, B. (1993)⁶⁵

South Africa: transitioning through policy change

Agricultural policy developments in South Africa are showing signs of transitioning towards a sustainable paradigm in which CA plays an important role. South Africa is atypical in sub-Saharan Africa, with the majority of farmland still in large-scale mechanized “commercial” units – which is where CA took off through farmer clubs and societies. A strong incentive has been savings on fuel costs. Unsurprisingly, because of adoption on large units and because of the size of the country, South Africa leads the way in sub-Saharan Africa, with some 368,000 hectares under CA (though the latest data from FAO relates to 2008,⁶⁶ so this is likely to be a significant underestimate). The smallholder sector has been slower to adopt CA. Efforts have largely concentrated on importing equipment, such as tractor-mounted planters from South America, not uncommonly (or unsurprisingly) without English-language manuals. South Africa clearly illustrates the significance of policy and institutions in transitioning to CA and placing emphasis on information and training. While South Africa has one of the largest areas under CA in Africa, this holds fewer lessons for the rest of sub-Saharan Africa because of where the CA is located – on large-scale, mechanized commercial farms, where GM crops are permitted and the use of agrochemicals is normal practice. Certainly, national policy will play a role in promoting the spread of CA, but farmers will continue to respond to savings in production costs.

Source and further information: FAO (2010),⁶⁷ Midgley et al. (2015),⁶⁸ Wall et al. (2013)⁶⁹

Malawi: conservation agriculture for staple crop production

In Malawi, CA was first introduced in 1998, supported by the government and funded by various donors. Since its introduction, farmers are increasingly embracing CA technologies, which is attested to by an upward trend in the average area under CA per adopting farmer. In Malawi, where most farming systems are based on manual systems (there is very little animal traction), farmers apparently appreciate the reduction in labour associated with CA. Direct seeding on the flat, or on the top of old ridges, with a dibble stick that opens a planting hole in the otherwise undisturbed soil, greatly reduces labour-intensive agricultural practices. In addition, weed control with herbicides reduces soil disturbance and contributes to greater yields. Trials with CA in Malawi have shown higher maize yields. However, the trials also illustrated the importance of training and continued technical support, as clear benefits from CA are only achieved after several cropping seasons. It is interesting to note, compared with other sub-Saharan countries, that Malawi’s relatively low cattle population possesses less of a problem in terms of competing for crop residues as fodder. Malawi demonstrates that CA, where it has the capacity to reduce household labour demands and increase yields of major crops (especially maize), has potential as an alternative to the very labour-intensive ridging system currently practised. This could be the specific trigger that starts the process of widespread adoption in Malawi, where the area under CA has already reached 65,000 hectares.⁷⁰

Sources and further information: Thierfelder et al. (2015),⁷¹ Ngwira et al. (2014)⁷²

Swaziland: conservation agriculture for climate-resilient households

Swaziland does not feature in FAO’s list of national CA coverage data because it is a country where CA is currently being pioneered. In the early 2000s, FAO trained around 800 land users and created “a demand for expansion of CA” among farmers in Shewula. More recently, IFAD has introduced CA under its Lower Usuthu Sustainable Land Management Project (LUSLM), and at the time of the terminal evaluation in 2015, a total of 1,220 households were reported to have adopted CA principles against a target of less than half of that number. The systems introduced comprised hand-dug planting holes close to homesteads on small plots and mechanized CA (using tractors and direct drills) for farmers who aim for commercial production. Intercropping has been used rather than sole-crop legume rotations, and the legumes intercropped in the maize are said to have increased income. The follow-up Smallholder Market-Led Project/Climate-Smart Agriculture for Resilient Livelihoods initiative, currently in preparation by IFAD, aims to encourage 12,000 families to create homestead CA plots of 0.1 hectares each as one constituent of “climate-resilient households” (the other constituents being rainwater harvesting, roof tanks and home gardens). The entry point here is the urgent need to assist families to meet basic food requirements at the household level with

a climate-resilient package. Simultaneously, mechanized CA will be promoted for income generation on larger plots – though experience under LUSLM has led to an insistence that any machinery needed should be serviceable and spare parts available. Commercially oriented CA production will be helped by the dedicated, designed “pull” of the Smallholder Market-Led Project.

Sources and further information: FAO (2008);⁷³ IFAD (2015) LUSLM internal memo; and IFAD (2015) Smallholder Market-Led Project/Climate-Smart Agriculture for Resilient Livelihoods (SMLP/CSARL) project design report draft.

Uganda: inspired by Zambia

There are various initiatives regarding CA in Uganda, though none has yet reached a significant number of adopting farmers, and FAO has no data on total uptake. The following outlines an example of one of the initiatives and is especially interesting because it was triggered by two events: (i) a skill-sharpening workshop where CA was introduced as a topic under the “Stimulating Community Initiatives in Sustainable Land Management” (SCI-SLM) project; and (ii) a visit to Zambia by the national coordinator for Sustainable Land Management in Uganda. Pioneering CA on a community basis is the Balimi Network for Developing Enterprises in Rural Agriculture (BANDERA), an initiative driven by the belief that access to secure markets is a precondition to sustainable land management. In 2011, with the assistance of the Ministry of Agriculture, Animal Industry and Fisheries and the SCI-SLM project, the community set up a small CA experimental plot (0.25 hectares), where conventional planting of maize and beans was compared with CA using planting basins. According to BANDERA’s records, in the season April-July 2012, the average yield for maize under the conventional system was 1.25 tons/ha compared with 4.6 tons/ha under CA, while the average yield for beans during the same season was 0.32 tons/ha under the conventional system and 0.93 tons/ha under CA. Under CA, weeds were controlled with glyphosate. Farmers attributed the increase in yields to: (i) early planting; (ii) increased storage of moisture in the permanent planting basins; (iii) higher plant population under the precise basin spacing; and (iv) addition of soil fertility-enhancing inputs (fertilizers, manure and mulch). Not only was the original stimulus for CA the result of cross-learning from experience elsewhere in Africa, but the BANDERA community itself has undertaken extension work among neighbouring communities. Learning directly from practitioners is a powerful tool.

Source and further information: Muwaya et al. (forthcoming).⁷⁴

Kenya: shallow ripping to increase infiltration

Kenya has seen various recent CA interventions, in particular in the central and western regions. By 2011, the total area under CA had reached 33,100 hectares. CA initiatives have predominately addressed problems around water shortages, soil compaction and the loss of topsoil through erosion. Using modified ox-drawn ploughs, shallow ripping is performed after harvest. Supportive practices, including growing cover crops and agroforestry, can help reduce weeds during the dry season. In addition, as the soil moisture is improved, crops can be planted earlier in the season and hence mature sooner. This means potential access to markets when prices are still high. This form of conservation tillage can increase yields by up to 60 per cent. CA in Kenya shows that the financial benefits of farming can be higher under CA than under conventional farming methods. This is predominately related, apparently, to smaller amounts of fertilizer required, reduced workloads, and (where tractors are used) reduced fuel costs for tillage.

Sources and further information: FAO/TerrAfrica (2011),⁷⁵ and Kaumbutho et al. (2007).⁷⁶

Ghana: experiments and early promise

Ghana starting experimenting with CA practices in the late 1980s and early 1990s. Research institutes began trials with minimum tillage, mulching and using cover crops. Subsequently, multi-agency projects were launched to promote minimum tillage and direct-planting techniques to address the low soil fertility and increasing weed problems. The latest data from FAO (2008) suggest Ghana has 30,000 hectares under CA. Using these techniques, land is prepared by allowing existing vegetation to grow up to 30 cm in height before spraying it with a herbicide, causing the vegetation to die back. The residue is left on the soil surface, serving as mulch. As high amounts of soil cover can impede germination of crops, partial burning is at times carried out to reduce the mulch – though this goes against good agricultural practices (and, needless to say, the ethos of CA). Several days later, direct planting in rows using planting sticks is carried out. Herbicides are not always used, as adequate knowledge is required. Another option is to plant cover crops to control weeds, improve soil fertility and enhance yields while diversifying crop production. Applying these CA methods has decreased labour inputs for land preparation and weeding, especially benefiting women, as they generally carry out these tasks. Ghana's example draws attention to the ways CA can reduce workloads of socially and economically disadvantaged groups, in particular women and children, which can present a possible trigger for its wider adoption. However, certain tasks, for example, planting through mulch, may mean heavier work for men: jab planters may serve as a solution. It also illustrates that knowledge of herbicides, as well as access to herbicides and the equipment needed to apply them, can be a constraint.

Sources and further information: Boahen et al. (2007),⁷⁷ FAO/TerrAfrica (2011),⁷⁸ Kaumbutho et al. (2007)⁷⁹

Other IFAD national plans, investments and experience⁸⁰

Other IFAD investments are under way, though the majority are recent, and overall there is little experience as yet from which to draw firm conclusions. In Zambia, IFAD's Smallholder Productivity Promotion Programme has an intended output of 30,000 farmers adopting CA (or associated practices), but the programme is two years behind schedule and at October 2014 (latest supervision report available), there was zero achievement on the ground. In Malawi, the Sustainable Agricultural Production Programme reports 59 CA trials under way, but many practices are apparently "inconsistent with no-till and residue practices of CA". In Uganda, the Project for the Restoration of Livelihoods in the Northern Region intends to test a two-wheel tractor model and to incorporate CA into crop production systems, but there are no reports of progress so far. The newly designed Kenya Cereal Enhancement Programme/Climate-Resilient Agricultural Livelihoods Window plans for large-scale adoption of CA, but once again it is only in its inception phase and thus has no progress on the ground to report. However, in Eritrea, in support of the National Action Plan (of the United Nations Convention to Combat Desertification), 450 farmers have benefited directly from CA on a total of 34 hectares.

Summary of key lessons

- CA has had a poor record of adoption in sub-Saharan Africa overall; there are multiple reasons for this and it is simplistic to think there is an easy solution. Nevertheless, in Southern Africa, there have been notable successes due to strategic campaigns based on location-specific approaches.
- Many of the reasons for failure (e.g. mixed messages, inappropriate incentive levels), and a number of the factors behind success (e.g. concerted campaigns, common platforms) are not peculiar to CA. They echo past experience with the introduction of technological innovation in sub-Saharan Africa. Nevertheless, there are some new lessons specific to CA, such as increased weed burdens, soil fertility management, and the need for specialized machinery and equipment.

- CA has often been enthusiastically introduced as a complete technological package on the basis of its technical merits in improving, inter alia, soil health, without considering farmers' primary problems and constraints. These are seldom addressed by CA alone, yet offer the entry point for a promotion campaign.
- Sub-Saharan Africa is extremely heterogeneous in climate, farming systems and traditions. A "one-size-fits-all" approach in sub-Saharan Africa has never had a good record in terms of technology adoption and CA is no exception. Where CA has worked best, it has been tailored to the local context. In other cases, "partial CA" has yielded partial benefits.
- Small-scale farmers have often run into secondary problems after starting CA, for example, access and affordability of suitable machinery, equipment, fertilizers and herbicides. Programmes that have not addressed these constraints have made limited progress.
- Residues for mulch pose a particular challenge because of their alternative value as animal fodder, especially in semi-arid areas. This issue has seldom been adequately confronted and remains problematic.
- Crop rotation/association is central to CA, being one of its three principles. It can be achieved in a variety of ways, but without market development, for legumes in particular, standard whole-plot rotation options are not economically attractive to farmers.
- Weeds have proved a major issue under CA: herbicides – with associated equipment and skills – are a prerequisite for all but the smallest plots; otherwise, the weed burden increases labour demands rather than reducing them.
- Soil fertility improvement must go hand in hand with CA. This is the only way yields can be improved in the short term, and without this, farmers will become discouraged. Inorganic fertilizers and manures are indispensable to effective CA and its adoption in sub-Saharan Africa.
- Incentives are invariably provided to give farmers a lift into the progressive incremental benefits delivered by CA. But it is clear that incautious use can mean that handouts are sometimes the sole reason for farmer uptake and "dis-adoption" can occur on withdrawal. Do not dismiss contract farming, as this provided the pinnacle from which CA has been promoted in Zambia.
- IFAD's target group of smallholder farmers in sub-Saharan Africa is not the easiest constituency to reach with CA. Experience over the last two decades indicates that success is only likely with careful and sensitive design.

Strategic recommendations

General/programme

- In sub-Saharan Africa, CA is viable and can potentially be a path to sustainable intensification, but it needs a responsive and flexible attitude and approach. There is no simple blueprint: “systems thinking” is the best way forward.
- “Partial CA” (which may not be the technician’s ideal solution) can still yield benefits and help pave the way to fuller CA systems over time. For example: (i) small household plots based on basins dug by hoes can be a productive and instructive start; and (ii) in terms of ox-draught systems, it is possible as an interim measure to use existing ploughs as furrow openers.
- Incentives are required to give farmers a hand-up to begin CA, but caution must be exercised that handouts do not become addictive. Incentives must be pitched at a level that stimulates uptake – rather than constituting the main reason for “adoption”. A key element of an exit strategy is reducing and eventually stopping free inputs. Microfinance from the private sector should be sought to help take over from public-project incentives. Contracting farming may be an alternative option, where a private sector company is able to support production inputs.
- Extension is particularly important as CA involves a suite of new farm operations: there is a role for farmer field schools and for cross-exchange (national and international) – and even farmer internships in areas where CA has been adopted. As a foundation for extension, “change agents” must be fully trained, informed and convinced.
- Applied research can add value to a national programme, especially where there are a variety of different circumstances and location-specific challenges. As well as investigating technological developments, research should look into reasons for adoption and rejection, focusing on both socio-economic and cultural factors. Farmers’ own trials should be stimulated and “hybrid” research between practitioners and scientists encouraged.
- A coordinated campaign is required to make significant progress at the national level. This requires a partnership of government, the private sector, non-governmental organizations, farmers’ associations and international agencies. Common messages should be agreed from a joint platform to avoid confusing both farmers and frontline extension staff.
- International agencies can be instrumental as catalysts and instigators; donor funding, strategically used, may make a vital contribution in the start-up phase.
- IFAD’s target group of vulnerable, smallholder farmers in sub-Saharan Africa is not the easiest sector to reach with CA. Careful, sensitive and informed design is required in order to accommodate their various needs. “Entry points” for CA should be targeted at their main constraints.

Technical

- Residues used for mulch are crucial to many of the benefits delivered by CA, yet their lack of availability poses a particular challenge in the drier zones of sub-Saharan Africa. This is because of low yields (thus less residue) and the opportunity cost of their not being used as animal fodder or fuel, especially in semi-arid areas. This must be addressed by a variety of means, including reducing the amount used through spot mulching and/or by increasing production of mulching materials on existing soil conservation structures or around field boundaries, for example. But the

trade-off question will remain for many farming systems in sub-Saharan Africa: Do I feed my livestock or do I protect my soil?

- Livestock have to be considered as part of an overall CA package in sub-Saharan Africa; they are almost completely ignored in the literature and project reports. A focus on crops alone is misplaced because of interactions, including competition for residues, and potential synergies. CA programmes can act as a trigger for better livestock management through either zero-grazing (with the added benefit of manure close to the fields) or communities agreeing on systems of rotational management of rangeland using “social fencing” systems.
- Crop rotation is one of the three principles or pillars of CA, yet farmers are reluctant to plant non-food or non-cereal crops when they are limited by land area or by markets for sales. Programmes need, therefore, to address issues of input and output marketing – for legumes, especially. Simultaneously, there are alternatives to whole plot forms of crop rotation that can be promoted instead: intercropping with legumes is one, and the introduction/promotion of leguminous agroforestry trees is another.
- The issue of weeds is a major constraint to the adoption of CA. While it is possible to hand weed very small plots close to the house, there is no real alternative to the introduction of herbicides for larger plots. Alongside herbicides appropriate equipment needs to be introduced and new skills learned. Even though herbicide use will diminish over time, as weed burdens decrease a reliable supply of herbicides and equipment must be ensured in the long term.
- Soil fertility improvement may not be counted as an official “principle” of CA, but it must go hand in hand with the three pillars. For various reasons (including weed competition, slower mineralization rates and nitrogen being diverted to bacteria acting on mulch), soil fertility constraints will show up immediately in all but the richest soils. All CA programmes must embrace integrated fertility management: this is the only way yields can be improved in the short term, and without this, farmers will become discouraged.
- Water harvesting in semi-arid regions is a very specific production system that can be improved by aspects of CA, yet this has not yet been well researched. Water harvesting requires runoff, thus catchment strips between planting stations need to be kept mulch-free. Spot mulching around planting stations associated with localized application of fertility amendments makes optimal use of these limited resources. Building on traditional systems (such as the zaï and tassa of West Africa) can add value to water harvesting variations of CA.
- Mechanization is not only the key to successful upscaling, but also the sole route to commercial production. It can also relieve the burden of heavy labour. There has been considerable research on small-scale mechanization and the recommendations should be carefully considered. Attention must be given to small-scale manufacturing of ox-drawn equipment and even small-scale tractor-drawn planters. Hire systems can make equipment available to small-scale farmers and also provide employment opportunities to youth.
- To be effective, CA programmes should be visualized as shown in Figure 3: principles surrounded by practices within an enabling environment.

Glossary of terms and concepts

Agrobiodiversity: the variability among living organisms associated with the cultivation of crops and rearing of animals, and the ecological complexes of which those species are part. This includes diversity between, and within, species and of ecosystems.⁸¹

Agroforestry: land-use systems and technologies where woody perennials are deliberately used on the same land-management units as agricultural crops and/or animals in some form of spatial arrangement or temporal sequence.⁸²

Conservation agriculture: an approach to managing agroecosystems for improved and sustained productivity, increased profits and food security, while preserving and enhancing the resource base and the environment. CA is characterized by three linked principles, namely: (i) continuous minimum mechanical soil disturbance; (ii) permanent organic soil cover; and (iii) diversification of crop species grown in sequences and/or associations.⁸³

Climate resilience: the capacity of a socio-ecological system to cope with a hazardous event or disturbance, responding or reorganizing in ways that maintain its essential function, identity and structure, while also maintaining the capacity for adaptation, learning and transformation.⁸⁴

Climate-smart agriculture: promotes production systems that sustainably increase productivity and resilience (adaptation), reduces/removes greenhouse gases (mitigation), and enhances achievement of national food security and development goals.⁸⁵

Ecosystem approach: strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way.⁸⁶

Good agricultural practices: practices that address environmental, economic and social sustainability for on-farm processes and result in safe and quality food and non-food agricultural products.⁸⁷

Landscape approaches: landscape approaches seek to provide tools and concepts for allocating and managing land to achieve social, economic and environmental objectives in areas where agriculture, mining and other productive land uses compete with environmental and biodiversity goals.⁸⁸

Land degradation: the reduction in the capacity of the land to provide ecosystem goods and services over a period of time for its beneficiaries.⁸⁹

Outscaling: adoption of a practice or systems of production by farmers or households. **(IFAD working definition)**

Public-private partnership: PPP refers to arrangements between the public and private sectors whereby part of the services or works that fall under the responsibilities of the public sector are provided by the private sector, with clear agreement on shared objectives for delivery of public infrastructure and/or public services.⁹⁰

Resilience: the ability of a system, community or society exposed to hazards to resist, absorb, adapt to and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions.⁹¹

Social fencing: a self-enforcing community agreement to protect an area of grazing land/wetland/forest, etc., from use by livestock or harvesting by people without a physical barrier. **(Working definition)**

Sustainable land management: a knowledge-based procedure that helps integrate land, water, biodiversity and environmental management to meet rising food and fibre requirements while sustaining ecosystem services and livelihoods.⁹²

Upscaling: institutionalization of a practice or a methodology within government or other international or subnational agencies ensuring sustainability. **(IFAD working definition)**

Water harvesting: the collection and concentration of rainfall runoff or floodwaters for plant production or other purposes.⁹³

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