Smallholder conservation agriculture

Rationale for IFAD involvement and relevance to the East and Southern Africa region

Enabling poor rural people to overcome poverty

IFAD

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Abbreviations and acronyms

ASSP	Agricultural Services Support Project
CA	conservation agriculture
CF	conservation farming
CFU	Conservation Farming Unit
CIMMYT	International Maize and Wheat Improvement Center
COMESA	Common Market for Eastern and Southern Africa
FAO	Food and Agriculture Organization of the United Nations
GART	Golden Valley Agricultural Research Trust
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
MACO	Ministry of Agriculture and Co-operatives
SADC	Southern African Development Community
SIDA	Swedish International Development Cooperation Agency

Units of measurement

1 acre = 0.41 hectare (ha)

1 ha = 2.47 acres

Executive summary

Africa's rising population growth and the continuous degradation of agricultural lands have raised questions about the suitability of the current agricultural system. There is a growing need to investigate different crop production systems that prevent soil degradation while increasing productivity. Conservation agriculture (CA) offers a promising solution.

Conservation agriculture is a climate resilient technology and management system that has demonstrable potential to secure sustained productivity and livelihood improvements for millions of climate-dependent farmers working in semi-arid areas around the world. Success stories are recorded for some countries in Asia, and in Australia and Brazil. However, for sub-Saharan Africa adoption of the technology has lagged behind these other countries, and concerns have been raised as to the suitability of the technology within the smallholder farming context.

Some of the concerns include: the potential decrease in yields due to poor adaptation of CA; increased labour requirements when herbicides are not used; competing uses of crop residue as mulch for soil cover and livestock feed; and potential redistribution of farm labour, placing a higher demand on women's time. It has also been noted that weak input supply chains in most countries are a major limiting factor for smallholder farmers to properly adapt CA. The critical issue, however, is not whether CA works – even strong critics (Giller et al., 2009) of it agree that the technology works – but whether it is the best approach for smallholder farmers in sub-Saharan Africa given the context within which they operate.

Conservation agriculture encompasses three principles: (i) continuous minimum soil disturbance; (ii) permanent retention of organic soil cover; and (iii) diversification of crop species grown in sequence or associations. It is based on sustainable integrated soil and water management including conservation farming. It is generally defined as any tillage sequence that minimizes or reduces the loss of soil and water and achieves soil cover of at least 30 per cent using crop residues. There are three distinct operational forms – manual, animal draught power and motorized power – using either minimum or no-tillage systems. No-tillage is often practised on a large scale using motorized systems or on a smaller scale requiring specialized equipment, such as seeding equipment, that can plant seeds into undisturbed crop residues and soil. Minimum tillage, on the other hand, only requires the preparation of planting basins or rip lines where crops will be grown. In practice this involves disturbing about 15 per cent of the land area.

The principles of CA are not new to the African agricultural system, but the simultaneous application of its three principles has only recently been introduced. The technology is being used by some communities at the project level throughout Africa, in the form of soil conservation and water conservation practices. The total area of coverage is estimated to be less than 1 per cent. The technology is gaining ground in some countries including: Angola, Ghana, Kenya, Lesotho, Malawi, Mozambique, South Africa, Uganda, the United Republic of Tanzania, Zambia and Zimbabwe. Various key reasons for slow technology uptake are: the lack of an enabling policy environment; low levels of national budgetary investments in the agricultural sector; and weak technical capacity at the level of institutions, communities and various stakeholders. Uptake of CA in Africa has been driven mainly by donors and NGOs, and thus experiences of technology adoption remain diverse.

In East and Southern Africa, CA is being coordinated mainly by the Regional Conservation Agriculture Working Group, with focal points from national task forces. In 2009, Ministers of Agriculture, Environment and Natural Resources from Member States of the Common Market for Eastern and Southern Africa (COMESA) committed to "up scaling of climate resilient food production technologies such as conservation agriculture. The region should ensure that one million farmers have access to conservation farming technology by 2012."

Conservation agriculture in **Zimbabwe** has been actively promoted among smallholder farmers since 2004 by NGOs, the Food and Agriculture Organization of the United Nations (FAO) and donors, particularly the United Kingdom's Department for International Development's Protracted Relief Programme. Adoption levels for hoe basins have risen to over 100,000 farmers in the country. According to FAO, mechanized CA has been widely used by commercial farmers in Zimbabwe since the 1970s. However, for smallholder farmers it has been limited to the use of tied ridges and animal-drawn ripper tines. In Zimbabwe, the main challenge in the scaling up of conservation agriculture has been the limited means for farmers to buy equipment and herbicides to control weeds. Therefore, basins will remain an important part of CA in the near future.

A report published by FAO in 2009 indicates that about 47,000 hectares of land in **Malawi** were under 'some form' of CA involving over 5,400 groups of farmers. Of this area, an estimated 1,000 hectares could be considered as being under true CA. An evaluation by Henry Mloza-Banda and Stephen Nanthambwe in 2010, suggests that the point of entry for CA in the country was project focused and site specific. Other efforts to promote the technology were built on the earlier seed and fertilizer relief and subsidy programmes promoted by the government and other agencies, and focused on households that were classified as vulnerable. Elsewhere in the country, CA has been introduced as work-for-asset programmes or financed through credit and revolving funds in support of livelihood programmes. An even more simplified version of the technology has been reintroduced in Malawi. Instead of the back-breaking work of making basins, farmers punch holes into the ground using pointed sticks, and seeds and fertilizers are then placed in the holes. Scaling up activities in Malawi requires that CA be mainstreamed into government policy and appropriate technical backup supplied to extension services.

Namibia is a clear case of slow adoption of CA technology and the 'trailing behind' attitude that is common in Africa. Instead of aggressively looking for alternatives to conventional tillage, they have opted for a gradual adoption of technologies that will lead to a full CA package. Mechanization is reportedly the predominant method of farming instead of sinking hand-hoe basins.

Modern CA in **Zambia** emerged as a by-product of technology transfer by large-scale commercial farmers. Commercial farmers adopted foreign minimum tillage systems for their own use, and later supported scaled-down versions for smallholder farmers living in regions of low to medium rainfall. The Conservation Farming Unit (CFU), an affiliate of the Zambia National Farmers Union, formally introduced the technology to smallholder farmers in Zambia in 1996, following the 1995 drought.

Promotion of CA is stipulated within the 2004-2015 Zambian National Agricultural Policy. The Ministry of Agriculture and Co-operatives has a climate change adaptation and mitigation agenda, and potential adaptation areas have been identified – CA being one. The Conservation Agriculture Programme (2006 to 2011) is the largest programme currently being implemented by the CFU and financed by the Government of Norway. The programme aims to have 240,000 small-scale farmers using conservation farming techniques by the year 2012. By the CFU's own estimates, more than 65 per cent of the target has already been reached.

Zambia tops the list of high uptake levels for sub-Saharan Africa as a result of:

- targeting CA to smallholder farmers with a commercial interest in farming as opposed to very resource-poor farmers producing largely for subsistence
- promoting CA as part of a distinct farming system, not just as a technology per se
- substantial CFU investments in training of public and private extension services
- the development of tools/equipment to reduce labour input in farming operations
- a supportive policy environment from the government

Manual minimum tillage is the most common form of CA technology promoted in Zambia. It is characterized by planting stations (basins) that rely heavily on hand hoes and also to some extent on animal draught power ripping. The level of mechanized minimum tillage is very low, while no-tillage technology is applied by few farmers. The main constraints for the adoption of CA include competition for crop residues in mixed crop-livestock systems, low-level use of herbicides which places a huge demand on an already stretched rural labour force, and difficulties in accessing and using external inputs.

Significant differences in yield levels between conservation and conventional tillage systems have been recorded on farmers' fields in Zambia – from one to five tons per hectare. In some cases, improvements in livelihoods were observed from recently upgraded family dwellings, clearly indicating improved financial conditions. Benefits from adoption of the technology extend beyond immediate financial returns and include environmental benefits – which benefit the whole country – such as preventing land degradation and improving soil fertility.

The promotion of CA technology in Zambia includes four distinct areas of support: (i) technical or productive aspects of the technology; (ii) input support (this is very minimal and is obtained through regular government seed and fertilizer subsidies); (iii) extension and training; and (iv) research and development. Although widely acknowledged as an issue, market access for smallholder produce has received little attention. In fact, most farmers choose to grow maize when they are supposed to be growing legumes because there is an established marketing system for maize. The farmers interviewed indicated that their cropping patterns were primarily determined by household food requirements and market opportunities, not necessarily by maximum income-earning potential.

The CFU, with financing from the Government of Norway, is at the forefront of the promotion of conservation farming in Zambia. It works closely with the Golden Valley Agricultural Research Trust (GART) in Chisamba to promote the development and extension of minimum tillage technologies for smallholder farmers. Other financiers and actors involved in conservation farming in

Zambia include the World Bank, European Union, Canadian International Development Agency, FAO and some NGOs.
Conservation agriculture and farming are identified as priority areas for funding within IFAD's Strategic Framework 2007-2010. There are many financing agents promoting this technology in Zambia, and this is an obvious indication of the positive and significant impacts the technology has had on smallholder farmers' livelihoods. Given the strong evidence of the environmental and financial benefits of CA in Zambia – albeit varied, based on the degree of adherence to the ideal principles – any investment support in crop production will have little alternative but to support the principles of CA, either in their entirety or at least some aspects of them.

It is recommended that IFAD consider supporting the development of market chains for legumes, an identified missing link. It is further recommended that dialogue be considered with the government on the existing policy of high import duty on steel. This policy has led farmers to rely on imported implements – most of which have already proved unsuitable. There is a need for government to extend the duty exemption on agricultural implements and vehicles to agriculture-bound steel. This would promote local manufacture of CA implements and allow for the widespread adoption of CA itself, thus boosting the development of private agrodealers in manufacturing and related service provision.

In **Botswana** the Agricultural Services Support Project (ASSP) will introduce mechanization to the smallholder farmer setting. It will serve no useful purpose to promote the more rudimentary form of the technology – manual basins and furrow preparation – given the very short planting season and the existing relatively high-level mechanization. Mechanized minimum tillage is the future of conservation agriculture and this could be introduced at a very early stage in the promotion process. In addition, the support services for inputs to be provided by the ASSP will complement the provision of mechanized tillage services. Strong government support in the form of policies that are conducive to the promotion of the technology is needed from the outset.

The absence of farmer organizations in Botswana is one of the main challenges for the adoption of the technology. The fragmented and geographically dispersed nature of smallholder farming makes the transaction costs of providing services, such as extension services, market information and technology dissemination, prohibitive. It is recommended that efforts to organize farmers into groups are launched at an early stage of project implementation, along with adaptive research activities focusing on the development of locally made conservation farming equipment.

I. Introduction

Background

Africa's rising population growth (with some countries such as Kenya recording a 10 per cent growth in the last decade), the continuous degradation of agricultural lands because of over- and poor utilization, and increasing scarcity of water on the continent have raised questions about the suitability of the current classic agricultural system. Worldwide, there is growing need to investigate different crop production systems that prevent soil degradation while increasing productivity. Conservation agriculture (CA) is considered a promising solution.

Conservation agriculture is a climate-resilient technology and management system that has demonstrated the potential to secure sustained productivity and livelihood improvements for millions of farmers in semi-arid areas around the world. In Australia, Brazil and some countries in Asia, the technology has demonstrated the potential to improve yields and incomes of farmers in an environmentally sustainable manner. However, in sub-Saharan Africa the adoption of the technology is still in its infancy. The good news is that early results from practitioners are promising and have given impetus to its promotion.

At the national and sub-Saharan African regional level, efforts are being intensified to promote the technology despite concerns raised about its suitability within the smallholder farming context. Some of these concerns include: the potential decrease in yields due to poor adaptation of CA; increased labour requirements when herbicides are not used; competing uses of mulch for soil cover and livestock feed; and the potential redistribution of farm labour, placing even more demands on women's time. It has also been noted that weak input supply chains in most countries are a major hurdle for smallholder farmers in the proper application of the technology.

The critical issue however, is not whether CA works – even strong critics (Giller et al., 2009) agree that it works – the question is whether it is the best approach for smallholder farmers in sub-Saharan Africa given the context within which they operate.

BOX 1

What kind of conservation agriculture are farmers practising?

In reality, farmers in Africa do not adopt all the principles of conservation agriculture for various reasons. These include: limited access to inputs; labour constraints; or insufficient resources to grow cash crops. Therefore, what farmers practise may be quite different from the 'ideal' conservation agriculture.

Source: Giller et al. (2009).

The Food and Agriculture Organization of the United Nations (FAO) is among the proponents of conservation agriculture. Also there are a growing number of national policymakers, researchers and, increasingly, funding agencies all of whom are encouraging investments in CA. Recently however, the application of the technology has received critical scrutiny and analysis, and the debate around some key CA elements remains charged. This should help to address adaptation challenges in sub-Saharan Africa.

Overview of conservation agriculture

The term 'conservation agriculture' has been defined in many ways, but generally it refers to a resource-saving crop production method that generates high and sustained yields, while concurrently conserving the environment (see page 41 for Glossary).

As defined by FAO and Zimbabwe's Conservation Agriculture Task Force, 'conservation farming' (CF) is a form of CA that can be practised by smallholder farmers using small implements such as the hand hoe to create planting basins, or an ox-drawn ripper to form planting lines. It also aims to achieve soil cover and is a modification of pit systems once common in Southern Africa (Mazvimavi et al., 2008).

This report addresses CF, which is being promoted among smallholder farmers, within the **broader** concept of CA.

Conservation agriculture and farming technology

Conservation agriculture spans very different combinations of practices, but at its core are three main principles that are not new to African agriculture. However, what is new is their integrated and simultaneous application. The three principles as defined by Zimbabwe's Conservation Agriculture Task Force are:

- **Minimum mechanical soil disturbance** through minimum or no-tillage, making basins or ripping planting lines. This helps to maintain soil organic carbon and its aggregates. The long-term benefits include improved organic soil matter and structure; the establishment of a system of continuous macro pores, facilitating water infiltration and aeration of the soil, as well as root penetration into deeper zones; and the reintroduction of macro- and micro-fauna and flora within the soil, resulting in better soil fertility.
- **Maintenance of at least 30 per cent soil cover using organic material** involves the maintenance of crop residues or special cover crops as surface mulch after harvesting to protect the soil from erosion and limit weed growth throughout the year.
- **Use of crop rotation and interaction** means alternating crops between cereals and legumes to reduce management costs associated with pest and disease control, resulting in healthier crops through improved soil fertility.

The three principles above, combined with appropriate agronomic management practices (timely planting, weeding and establishment of precise plant populations), result in timely and precise farming operations that ensure efficient use of inputs and impact positively on crop productivity. In general, CA improves soil health and enables efficient use of water, thus reducing the risk of crop failure during periods of drought.

In practical terms there are three main operational forms of CA: manual, animal draught power and motorized operational systems. The technology could apply either to minimum or no-tillage based on the preparation of land for seeding. However, the retention of mulch, growing of leguminous cover crops and crop rotation are common to both forms. Where resources

FIGURES 1 AND 2

Tractor- and ox-drawn drills

A conservation farming method used for planting seeds. Using specific tractor- and ox-drawn drills, such as these produced in Brazil, the seeds are mechanically drilled directly into the soil in one pass without any preliminary tillage.

Source: Conservation Farming Unit, Zambia.

allow, chemical control in CA systems has replaced the conventional system of controlling weeds through ploughing and hand-hoe weeding. No-tillage involves growing crops on the same piece of land yearly, without disturbing the soil by tillage or ploughing. The practice generally involves spraying the field with herbicides to kill the weeds but most farmers weed by hand. However, if early weed control, winter weeding and soil cover are done, weed pressure is significantly reduced.

Withered weeds that are not removed serve as mulch for the plants. No-tillage is often practised on a large scale using motorized systems or on a smaller scale requiring adaptation of the technology. It requires specialized equipment, such as seeding equipment, that can plant seeds into undisturbed crop residues and soil.

Minimum tillage requires only preparation of land areas called planting basins or rip lines (see Figure 3) where crops will be grown. The hoe or animal power is used to create the planting basins or ridges where seeds are planted, which involves disturbing about 15 per cent of the land area. Land preparation is usually carried out in the dry season in anticipation of the rains, which encourages early planting when the first rains arrive. Minimum tillage allows farmers to make better use of limited and unreliable rainfall by avoiding evaporation losses. Table 1 gives a summary of CA practices and equipment used as well as farmers' observations in the Southern Africa region.

Purpose of the report

This report reviews CA in Zambia, and to a limited extent in other countries in the region, in terms of farmers' practices and their experiences in its adoption and adaptation in order to provide a sound basis for possible IFAD support under the next country programme in Zambia. Subsequently, the review will inform the next country strategic

FIGURE 3

Minimum tillage using the Magoye ripper

A family practises small-scale conservation farming during the dry season by ripping furrows using a Magoye ripper.
Source: Conservation Farming Unit, Zambia.

TABLE 1

Summary of farmers' perceptions and recommendations on specific conservation agriculture practices and equipment

<table>
<tr><th>Component</th><th>Positive aspects</th><th>Constraints to full adoption</th><th>Possible interventions</th></tr>
<tr><td>Herbicides</td><td>• Reduce manual weeding, hence save time
• Ease labour bottlenecks
• Very effective if used carefully</td><td>• Usually expensive
• Disastrous and ineffective if not used correctly
• Concerns over harmful residual effects on subsequent crops</td><td>• More research on compatibility of herbicides
• Obtain chemicals at subsidized prices
• Input loan schemes
• Enhance information dissemination
• Training in the safe use of herbicides</td></tr>
<tr><td>Ripper</td><td>• Utilizes less energy and labour
• Less strenuous, ideal for use with early rains (However, this is when animals are still weak)
• Time saving, hence early planting possible</td><td>• Requires availability of draught animals
• Doesn't incorporate seed and fertilizer
• Drags piles of residues, frequent stoppages to remove residues</td><td rowspan="3">• Participatory technology development
• Provide equipment for renting by farmers
• Provide facilities for local manufacture
• Private-sector involvement</td></tr>
<tr><td>Jab planter</td><td>• Precision in seed and fertilizer placement</td><td>• Difficult to use in wet clay soils
• Not suitable for larger plot holdings
• Relatively expensive and not readily available</td></tr>
<tr><td>Direct seeder</td><td>• Saves time and labour
• Minimum soil disturbance
• Higher yields achievable</td><td>• Careful calibration needed
• Relatively expensive and not readily available</td></tr>
<tr><td>Crop residues</td><td>• Protects soils from direct sun and direct raindrop impact
• Conserves moisture, microbial activity</td><td>• Also needed to feed livestock
• Threats from uncontrolled fires
• May harbour pests (white grubs)
• Disturb equipment operation, frequent stoppages</td><td>• Incorporate fodder or agroforestry
• Live fencing
• Policy for restricting fires and livestock</td></tr>
<tr><td>Crop rotation</td><td>• Improves soil fertility
• Reduces costs of production (use of inorganic fertilizers)</td><td>• Preference for staple food crops
• Unavailability of alternative crops seeds and other inputs
• Difficulties in marketing other crops</td><td>• Development of legumes markets</td></tr>
</table>

opportunities programme (COSOP) for Zambia. The report highlights lessons learned from Zambia's 14-year engagement with the technology that could be applied to other countries in the region such as Botswana.

Methodology and approach

A two-pronged data collection approach was used in the review. In the first instance, a desk study was carried out to review the available literature on CA. Later it was followed by a field mission to Zambia to observe farmer field practices and their results first hand and to hold discussions with farmers, researchers, and other CA supporting agencies.

This exercise was by no means an elaborate scientific one, but rather for obtaining information through the experiences of farmers and other stakeholders on the general state of CA in Zambia.

Desk review. Existing academic literature and information and development institutions' publications were reviewed, and government officials, NGO staff and farmers were interviewed to obtain a clearer idea on the practices and technologies of CA. In addition, CA project progress reports, case studies, briefing notes, manuals, implementation handbooks and workshop reports were reviewed continuously during the course of this assessment. Reports and documents from agencies such as the Conservation Farming Unit-Zambia (CFU), Golden Valley Agricultural Research Trust (GART), International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), FAO, and African Conservation Tillage Network provided valued insights and supporting evidence on the status and prospects of the technology.

Field mission. The mission formed a major part of this assessment. As the Government of Norway is the major financier of CA in Zambia, discussions were held with their CA expert at the embassy in Lusaka. Very informative and fruitful discussions were also held with the Senior Operations Officer at the CFU head office in Lusaka. Visits were made to the Golden Valley Research Station in Chisamba where GART, a government research unit, is undertaking CA adaptive research activities. A visit was also made to the GART research centre in Magoye, where the government is testing and modifying hand, oxen and tractor prototype equipment from other countries, such as Brazil and Zimbabwe. Discussions were held with the CA focal persons at the headquarters of the Common Market for Eastern and Southern Africa (COMESA), FAO in Lusaka and at SARO Agro Industrial Limited.

Farmer field visits were carried out in the Central and Southern Provinces in Chikankata, Chisamba, Choma, Kafue, Magoye and Mazabuka where CA is practised. Discussions were also held with farmers and CFU field officers at these locations (see list of organizations and people met in Annex II). Personal observations and interactions with farmers, extension staff and researchers of CA technology in the field were a useful way to understand the constraints and challenges, as well as the opportunities for adoption of the technology by smallholder farmers.

Limitations. The field mission was undertaken over a period of 10 days at the end of August 2010 – a post harvest period for field crops. While this provided an opportunity to observe the outputs of CA farming and the land preparation methods applied well before the rains start, it was not possible to observe farmers in action as they planted their fields. However, the information generated was credible and could be useful in the preparation of the COSOP for Zambia, as well as providing some insight for the Botswana Agricultural Services Support Project (ASSP).

II. Conservation agriculture

Global perspective

Modern CA has now emerged as a response to the soil erosion crises in Argentina, Australia, Brazil and the United States. Today CA, or some elements of it, has made significant progress in these regions. Similarly, the technology has advanced in places such as China, and South and Central Asia, but has made little advancement in sub-Saharan Africa. Globally, it is estimated that approximately 47 per cent of CA technology is practised in South America, 39 per cent in the United States and Canada, 9 per cent in Australia and about 3.9 per cent in the rest of the world, including Africa, Asia and Europe.

Brazil has become an outstanding success story. After farmers, researchers, policymakers and NGOs adopted the technology, the public and private sectors joined together to support farmers and their societies and networks. This has helped create effective and dynamic innovation systems that have contributed substantially to the dissemination of CA technology in South America, where it is practised by both large-scale and smallholder farmers. The successful adoption of these technologies, however, came after overcoming initial adoption and adaptation constraints, and particularly after the introduction of specialized no-tillage equipment and machinery, herbicides and agro-inputs, extension services and supportive policies.

In Brazil, adoption of CA by farmers has reportedly been greatly influenced and facilitated by the presence of commercial activities of large agrochemical and agricultural equipment manufacturers, such as Monsanto and Semeato. These companies have invested significantly in the diffusion of CA technology, meaning that the availability of better and cheaper herbicides, coupled with the development of more diverse and improved no-tillage seeding machines on the market, have resulted in the widespread adoption of CA. However, although government support was slow in promoting its adoption it is now official policy in some Brazilian states. Over half the cropland in Paraguay, about one-third in Argentina and one-sixth in the United States is cultivated using CA. A major contributing factor to this high adoption rate is that practitioners are well organized in local and national farmers' associations. Consequently, it is relatively easy to administer support from international funding and technical agencies such as FAO, the German Agency for Technical Cooperation (GTZ) and the World Bank.

In Europe, a study by Knowledge Assessment and Sharing on Sustainable Agriculture (KASSA), corroborated the fact that CA adoption rates are much lower in Europe compared with other regions, and that minimum tillage is more widespread than no-tillage. The study found that the use of groundcover and diversified crop rotation is rarely practised by European CA farmers because of climate and soil limitations, short growing periods in northern latitudes, lack of adapted crop varieties and the difficult management of crop residue in wet conditions. However, the KASSA study also revealed that the availability of affordable and effective herbicides made it easier for farmers to adopt the technology.

Conservation agriculture in sub-Saharan Africa

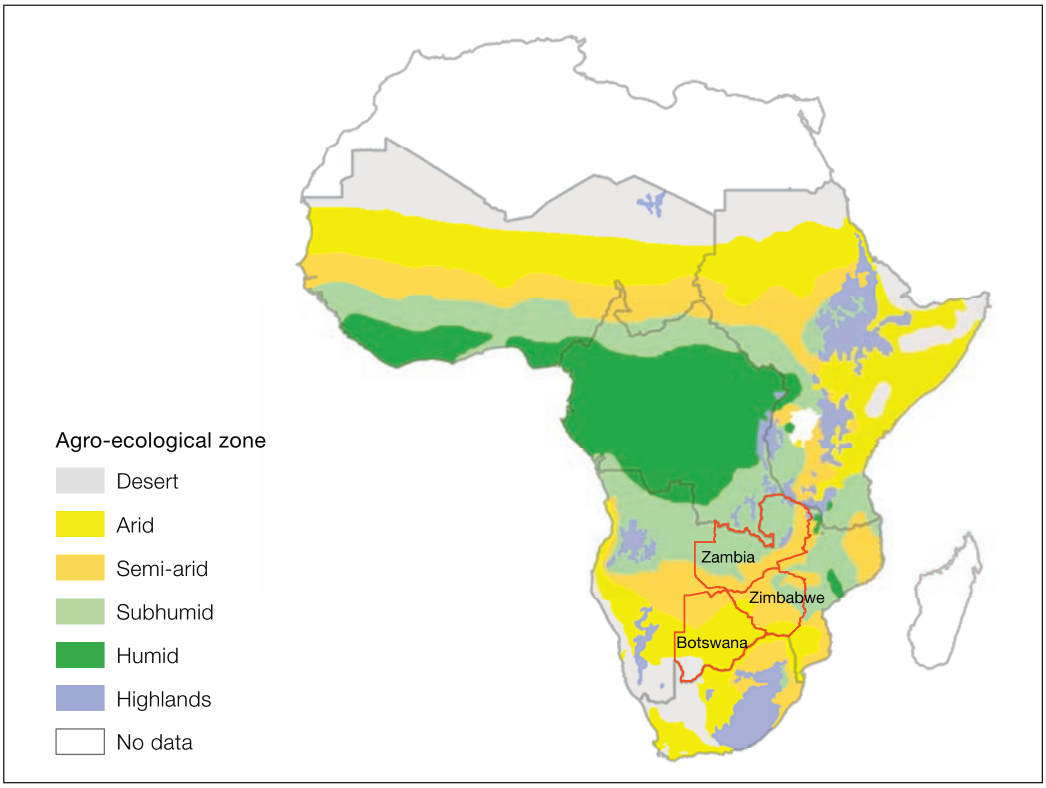
As stated above, CA is gaining momentum in Africa as the continent struggles to address the worrying increase in population, which is outstripping food production rates, escalating the deterioration of agricultural land and increasing the scarcity of water – frequently leading to internal conflicts.

Africa has a wide range of soils and climatic conditions. However, most soils are of poor quality compared with other parts of the world. In sub-Saharan Africa, degradation of soil fertility is considered one of the critical hurdles to achieving food security. Erratic rainfall and frequent, long dry spells have created uncertainty for rainfed agricultural production, and there are diminishing opportunities for farmers to increase or change their cultivated area. This necessitates concerted efforts to halt and reverse degradation as well as boost agricultural productivity in Africa. Strategies adopted to improve farming systems include rainwater harvesting technologies, soil and water conservation, and rangeland restoration. Conservation agriculture, which is a more integrated approach, is seen as being able to reduce land degradation and, therefore, increase food security in a more sustainable way.

The principles of CA are not new to the African agricultural system. However, the simultaneous application of the three principles known as CA began only recently. In a number of countries the technology is being adopted by communities or is being introduced by pilot projects. However, the

FIGURE 4

Agroecological zones of sub-Saharan Africa



Source: FAO/IIASA (2000).

level of adoption is still very low, with the total area of coverage estimated to be less than 1 per cent. Despite the sound technical, agronomic and environmentally-friendly merits of CA, its uptake in Africa has been hindered by a number of factors. Key among them is an inadequate enabling policy environment to promote its adoption. Although some countries have national policies that are supportive of CA, its implementation and enforcement at field level is often inadequate because of low national investments in the agricultural sector as a whole, the weak technical capacity of institutions, communities and various stakeholders, and the mindsets of farmers in adopting the technology. Uptake of CA in Africa has been driven mainly by donors and NGOs. Therefore the experiences of adoption of the technology remain diverse.

Conservation agriculture in East and Southern Africa

In East and Southern Africa, CA techniques have best taken root in Zambia and Zimbabwe. However, other countries following suit are: Kenya, Lesotho, Malawi, Mozambique, Namibia, South Africa, Swaziland, Uganda and the United Republic of Tanzania. Conservation agriculture is now government policy in Lesotho, Malawi, Mozambique, the United Republic of Tanzania and Zambia. At the regional level, CA is coordinated by the Regional Conservation Agriculture Working Group (CARWG), supported by focal points from national task forces, regional organizations – African Conservation Tillage Network, the New Partnership for Africa's Development (NEPAD), Southern African Development Community (SADC) – and research centres – International Maize and Wheat Improvement Center (CIMMYT), ICRISAT and the World Agroforestry Centre (ICRAF). Under the Common Market for Eastern and Southern Africa's (COMESA) climate change programme, the use of CA has been pronounced as an appropriate adaptation and mitigation action for African agriculture. The Victoria Falls Town Declaration made at the Second Joint Meeting of the COMESA Ministers of Agriculture, Environment and Natural Resources in 2009 states that, "COMESA Member States commit themselves to up scaling of climate resilient food production technologies such as conservation agriculture. The region should ensure that one million farmers have access to conservation farming technology by 2012."

Despite these regional efforts and pronouncements, there continue to be wide variances in the application and use of CA techniques, leading to a number of misconceptions in the principles and practices of it and its benefits (some of which are discussed below). In general, because of weak institutional capacities and the absence of an enabling policy environment, uptake of CA in this region varies and has been mainly driven by donors and NGOs.

Zimbabwe

Land degradation, reduced soil fertility, increased incidence of drought and El-Niño-induced floods are some of the major challenges facing sustained smallholder agricultural production in Zimbabwe. This, combined with a depleted social capital because of HIV/AIDS, a decade of economic crisis and a very limited asset base, has slowed the development of CA among smallholder farmers. In Zimbabwe, CA technology was introduced into humanitarian programmes early in 2000 to increase the impact. In 2004 it was rolled out to all farmers by FAO, NGOs and donors – particularly by the UK's Department for International Development's Protracted Relief Programme. These processes have been complemented by research and adaptive trials by ICRISAT, the University of Zimbabwe and CIMMYT. And more recently there have been efforts to integrate and train extension staff in its use, but these efforts have been fragmented. Adoption levels for hoe basins have risen to an estimated

100,000 farmers in the country. According to FAO, mechanized CA has been widely practised by commercial farmers since the 1970s, while for smallholder farmers it has been limited to the use of tied ridges and animal-drawn ripper tines.

The target groups for promotion of CA by development partners have been the poorest and most vulnerable smallholder households with limited access to draught animals. Conservation agriculture has therefore focused almost entirely on the hand-hoe basin technology, with little or no attention to mechanized CA, thus promulgating the perception that it is for poor households. For smallholder farmers, most of whom are poor, CA offers an excellent way to increase yields with minimum external inputs. According to ICRISAT, the other driving force for adoption of the CA approach by smallholder farmers, is the provision of free inputs as a package to support those who adopt it. Based on ICRISAT findings, yield levels across different agroecological regions and crops in 2008 to 2009 showed improvements of up to 67 per cent for maize, sorghum and groundnuts. Much of the improvement, however, was attributed to improved management, early planting, frequent weeding and fertilizer application by the households. Impact on household food security was limited due to the small sizes of CA plots (0.25 hectares per household). Farmers tend to expand CA areas on the basis of input availability from NGOs or governments, as capacity to acquire inputs from the market is very weak. This situation is progressively changing with the improved economic situation and as external support is transitioning from humanitarian to development.

After donor withdrawal, the continued practice of CA will face challenges. According to an ICRISAT survey carried out in 2009, 39 per cent of farmers said they would continue with various CA components, such as basins and mulching, but leave out rotation cropping. Crop rotation seems complex because of the lack of seeds for alternative legume crops, the marketing of surpluses of non-grain crops, planting densities that differ between crop types and the small size of plots. This makes it difficult to compromise on the staple crop and food security staple crop preferences. During 2010, the country saw significant improvements in markets. However, the uptake of CA will continue to be a donor-driven technology until input and output markets are completely restored and functional.

In Zimbabwe, mulching is a misunderstood CA technique. This confusion seems to be widespread among NGOs, extension staff and farmers. Grass is cut from surrounding areas and applied to fields as mulch, exposing the surrounding areas to degradation. This practice contradicts the very objective of reducing land degradation, whether in the field or in grazing areas. There has been competition for use of crop stovers as mulch or livestock feed, especially in the drier areas in the south of the country. Where livestock systems have a comparative advantage, preference will normally be given to the use of stovers as a winter feed, which reduces the organic matter returned to the soil in the longer term. In drier areas, crop production is always a high-risk activity and priority should be on how CA can support livestock to improve livelihoods (e.g. the development of appropriate fodder crops). The full adoption of CA (all three principles) is a longer process and its application is varied.

The introduction of CA tillage technologies using the ripper tine or direct seeder, and the use of herbicides to control weeds so that larger areas can be planted, are the main challenges facing the scaling up of CA. These require intensive on-farm demonstrations involving a limited number of farmers until the concepts are accepted and understood. Only when a large number of farmers successfully use ripper tines or direct seeders will more of them adopt these practices. To mitigate initial high level labour requirements, villagers form groups to dig basins and contour ridges. Use of appropriate and efficient tools remains a challenge. Although demonstrations of ripper tines have been carried out, these are not readily available in many local areas. Access to draught power is a challenge as 50 per cent of farmers do not own draught power according to the Zimbabwe Vulnerability Assessment Committee. Jab planters are also relatively new to the communities.

Malawi

In Malawi, soil degradation threatens the attainment of household food sufficiency for smallholder farmers. The natural approach to this is to reduce tillage and adopt technologies that promote maximum cover and control weeds in ways that comply with CA. Smallholder farmers in Malawi are used to the traditionally promoted ridge tillage system despite the negative effects associated with it. According to a CFU-Zambia report, attempts to convert smallholders to minimum tillage were carried out by Sasakawa-Global 2000 between 1998 and 2006. The key recommendations made for growing maize included reducing the ridge spacing from 90 to 75 cm, and accurate fertilization combined with a substantial increase in plant populations with individual maize seeds sown at 25 cm on the ridge, which solved the problem of ridge culture and associated effects. Some practices under the programme have been incorporated into CIMMYT conservation agriculture projects.

Interest in CA was only rekindled after a national workshop at Bunda College of Agriculture in 2002. This workshop resulted in the formation of a National Task Force on Conservation Agriculture, although it remained largely inactive until 2008. According to FAO, in 2009 Malawi had 47,000 hectares under 'some form' of conservation agriculture involving 5,407 groups of farmers. Of the 47,000 hectares, an estimated 1,000 hectares were under true CA. In 2010, an evaluation carried out by Henry Mloza-Banda and Stephen Nanthambwe indicated that the point of entry for CA in the country was project focused and site specific. Other efforts to promote it were built on the earlier seed and fertilizer relief and subsidy programmes by the government and other agencies, which focused on households that were classified as vulnerable. Elsewhere in the country, CA has been introduced as work-for-asset programmes or financed through credit and revolving funds in support of livelihood programmes. Most recently, farmers have reintroduced the use of pointed sticks to punch holes into the ground to prepare land for planting. Seeds and fertilizers are placed in these holes. Farmers have opted for this simplified version of the technology instead of the back-breaking method of making basins.

Despite these efforts, adoption by farmers has remained low because of constraints that have included, but are not limited to the following: inappropriate soil fertility management options (rotation); limited application of effective weed control regime under no-tillage systems; limited access to credit for seed, fertilizers and herbicides; weak appropriate technical information systems for change agents and farmers; blanket introduction of CA that ignores the resource status of rural households; and competition for crop residues in free-range communal grazing livestock systems.

In Malawi, the shift from conventional agricultural practices to CA requires implementing several initiatives. These include: the development of CA suited to the different agroecological conditions; exposing farmers to different CA practices, particularly through participatory activities and on-farm demonstrations; and training them in the practical use of new technologies, combined with flexible funding mechanisms and incentives, particularly during the period of transition.

Namibia

In 2008, the Namibian Agronomic Board commissioned a study to look into commercial pearl millet production in the northern part of the country. The study made a convincing case for the adoption of CA to halt and reverse land degradation and improve yields and food security. A project with funding from the Swedish International Development Cooperation Agency (SIDA) is spearheading the adoption of conservation tillage, moving to CF and finally to complete CA. The first three seasons of the project have demonstrated that yields were improved by over 100 per cent. The technology was simple and affordable for quick adoption and this has seen the number of users increasing.

Namibia is a clear case of slow uptake of CA technology and the 'trailing behind' attitude that is common in Africa. Instead of aggressively looking for alternatives to conventional tillage, they have opted for a gradual adoption of technologies that lead to a fully mechanized CA package.

III. Conservation agriculture in Zambia

The problem

Zambia is a food insecure country despite excellent soils, relatively good rainfall (with the exception of normal climatic variation) and a population density of only 14 per/km^2 compared with 150 per/km^2 in Malawi. Food relief is a common feature in rural Zambia. The spectre of climate change and its impact on agricultural production is a matter of added and increasing concern. A number of factors that contribute to this situation are:

- Land degradation, mainly due to consistent monocropping of maize, fuelled, since the mid 1970s, by a succession of government policies of input supply and marketing subsidies to small-scale farmers.
- Conventional methods of production, involving ploughing and the repeated use of acidifying fertilizers leading to depletion of nutrients and loss of soil structure.

According to FAO, Zambia has the second-highest deforestation per capita in the world. FAO also notes that the increase in maize production is a result of the expansion of cultivated land rather than increased yields (65 per cent increase between 1981 and 1991). Based on estimates from the European Forest Institute, deforestation ranges from 450,000 to 900,000 hectares per annum. There is consensus that conventional small-scale agricultural practices ('slash and burn' or the Chitemene system) and charcoal burning are the largest contributors to forest loss.

History of conservation agriculture in Zambia

Modern CA in Zambia emerged as a by-product of technology transfer by large-scale commercial farmers. Commercial farmers adopted foreign minimum tillage systems for their own use, and later supported scaled-down versions for smallholder farmers living in low to medium rainfall regions. The technology was formally introduced to smallholder farmers in Zambia in 1996 by the CFU following the 1995 drought.

The government's strategy for promoting CF is aimed at reversing deforestation and adopting CA to achieve the following:

- bring soils back to life and increase yields and incomes
- enable sedentary farming (farming in the same place), in perpetuity
- enhance household food security and diet through crop diversification and rotation
- increase resilience of crops to droughts and poor rainfall distribution

Soil exploitive farming systems, such as Chitemene, have led to soil erosion, loss of soil structure and soil micro-organisms, acidification, oxidation of organic matter and compaction (as shown in Figure 6). Soils are said to literally die, crop yields decline and total crop failure occurs in seasons of moderately poor rainfall. Eventually the land is abandoned.

FIGURE 5
Deforested farmland due to ‘slash and burn’ or the Chitemene system

Slashing and burning or the Chitemene system used to deforest land in the Northern Province of Zambia.
Source: Conservation Farming Unit (2007c).

FIGURE 6
Degraded land that has been abandoned

An example of soil exploitative farming systems such as the Chitemene being used in the Southern Province of Zambia. The land has been stripped of its nutrients and is left with little organic matter. As in this case, crops grown on such soils are likely to fail during seasons of poor rainfall and the land will eventually be abandoned.
Source: Conservation Farming Unit, Zambia.

Thousands of hectares of land have been abandoned and at least 10 cm of top soil or 1,000 tons have been lost (see Figure 7). Prior to the mid-seventies, Southern Province was a net exporter of between 200,000 to 300,000 tons of maize. Today it is a net importer and the provision of food relief is commonplace. Over the past 20 years thousands of families have migrated northwards to other provinces (Conservation Farming Unit, 2007).

Government policy, strategy and programmes

Promotion of CA is stipulated in the Zambian National Agricultural Policy 2004-2015. The Ministry of Agriculture and Co-operatives (MACO) has a climate change adaptation and mitigation agenda. Potential areas for adaptation have been identified and CA is one of them. These areas include:

- **Building adaptive capacity** to enable farmers to better cope with increasing vulnerability from climate change. In line with this aspiration, an agricultural research protocol has been set up under the Zambia Agricultural Research Institute together with research efforts at GART that aim to achieve, among other things, research protocols for CA.
- **Government-led sustainable land management** in Miombo, ecosystem management in Mkushi and Serenje Districts, with efforts to scale up support in the Copperbelt, Northern, Luapula and North-Western provinces.
  Among the interventions being demonstrated are ecosystem management (with alternative livelihoods) and CA with liming.

FIGURE 7

Degraded land

An extension worker in Southern Province demonstrates the amount of topsoil lost through conventional farming methods. At least 10 cm of topsoil has been lost and only the infertile subsoil remains. Experts indicate that it could take at least 30 years to regenerate this land.

Source: Conservation Farming Unit (2007c).

- **Conservation Agriculture for Sustainable Agricultural Development (CASAD) Programme** aims at harnessing early land management potentials for in-situ rainwater harvesting for both crop, fish and livestock production. With support from the Government of Norway and the European Commission, a number of projects and scaled-up CFU and MACO activities are being implemented.
- **Adaptation to climate variability and change in the agroecological regions I and II of Zambia**. The goal is to improve food security through enhanced adaptive capacity to respond to the risks posed by the effects of climate change and variability in agroecological regions I and II of Zambia. This will involve revising the National Fiscal, Regulatory and Development Policy to promote adaptation responses in the agriculture sector.

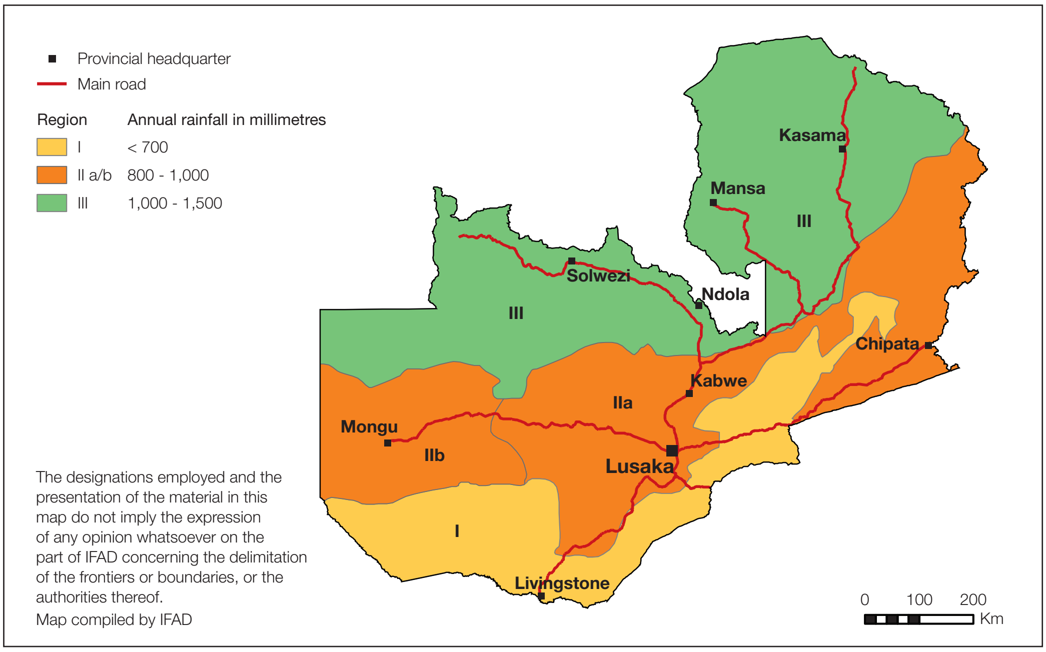
The ongoing, completed and planned CA programmes and projects in Zambia are presented in Annex I. The largest programme currently being implemented by the CFU, and financed by the Government of Norway, is the Conservation Agriculture Programme (from 2006 to 2011). The programme's aim is to have 240,000 small-scale farmers using CA techniques by the year 2012. According to CFU estimates, more than 65 per cent of the target has already been reached.

Geographical areas under conservation agriculture in Zambia

Zambia's main agroecological regions are: I in the extreme south, II, IIa, IIb in the middle belt and III in the extreme north of the country (see Figure 8 below). Farmers in agroecological zones I and IIa are the largest group of adopters of the technology. The specific geographic locations where CA activities are currently being undertaken are indicated in Figure 9.

FIGURE 8

Zambia's main agroecological regions



Source: Conservation Farming Unit (2007b).

Promotion of conservation agriculture technology in Zambia

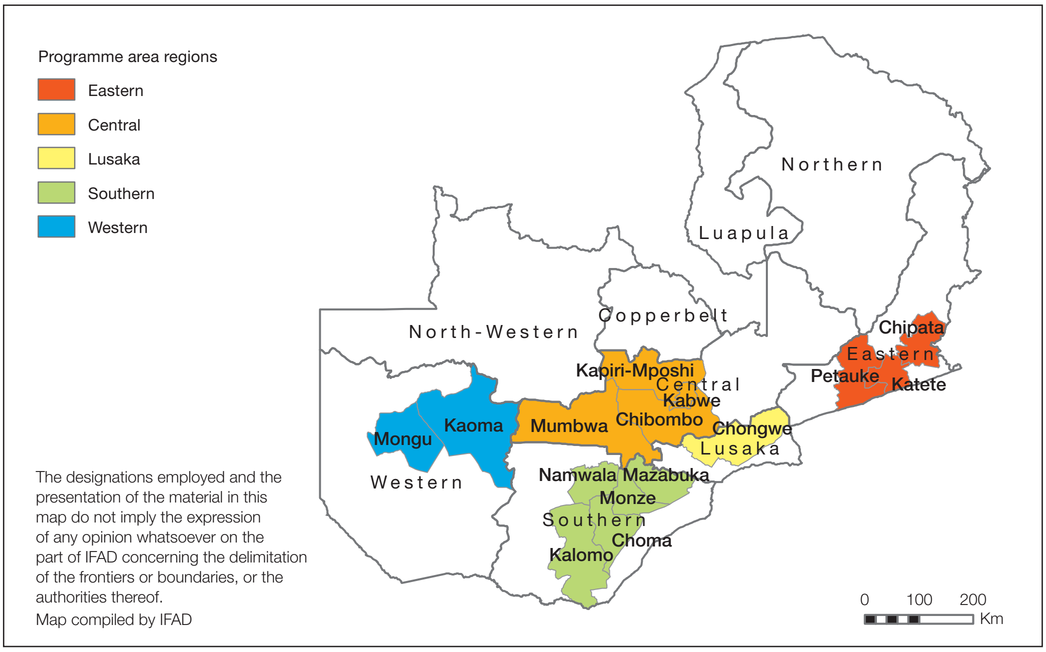
In Southern Africa, CA technologies are the most advanced and widespread in Zambia. The reasons for this are many, but chief among them are:

- **The targeting of CA to smallholder farmers with commercial interests in farming as opposed to very resource poor farmers producing largely for subsistence.** The CFU of Zambia deliberately targeted cotton farmers who had access to inputs and extension advisory services from the cotton companies. They expected farmers to be interested in higher yields and higher incomes from cotton, and also anticipated that it would be easier to demonstrate the positive results of CA to other resource poor farmers, using evidence from smallholder cotton growers' fields.
- **The demonstration of CA as part of a distinct farming system not just as a technology per se.** Maize and a legume crop (cowpea in Central, Eastern and Western parts of Zambia) were promoted as a component of the cotton CA system.

Maize was also included in the crop system because farmers already grew it as a main food crop. In addition, maize production was used as a source of soil nutrients. Farmers would add fertilizer to the crop and not to cotton or cowpeas. Using the rotation system, it was recommended that cotton be planted after a fertilized crop of maize, therefore benefiting from the residual fertilizer. The cowpea crop also served two purposes: as a source of organic fertilizer (nitrogen fixation from the legume) and a good source of protein in the diet. When a maize crop followed cowpea in the rotation, the amount of fertilizer added to it was also reduced because of the nitrogen contribution from the cowpea crop. The cowpea crop also benefited from the system, being highly susceptible to insects. To obtain reasonable yields, cowpea requires insect pest control. To attain good yields in a cotton-cowpea system, the cotton is sprayed as it suffers more from insect pest damage than cowpea. In this system the insecticide sprayed on the cotton drifts to the cowpea and effectively controls cowpea pests at no extra cost.

FIGURE 9

Areas under the Conservation Agriculture Programme in Zambia



Source: Conservation Farming Unit (2010).

- **High CFU investments in the training of public and private extension services.** They in turn trained lead farmers to provide technical support to other farmers for the up scaling of CA in Zambia. Most of the training at the farmer group level is done by farmer facilitators. There is minimal 'free input' distribution to farmers under the CFU programmes. The fertilizer and seed are provided by the cotton companies in a loan package.
- **The development of tools and equipment to reduce labour input in farming operations.** These include planting devices, weeding and other tools to facilitate the opening of the planting holes under minimal soil disturbance operations. The equipment developed ranges from hand-hoe, animal- and tractor-drawn implements.
- A supportive **government policy environment**.

Manual minimum tillage is the most common form of CA technology promoted in Zambia. It is characterized by planting stations (basins) that rely heavily on hand hoes and to some extent on animal draught power ripping. The level of mechanized minimum tillage is very low, while no-tillage is applied by very few farmers. Ideally, the technology involves the application of seven main practices, namely:

- land preparation during the dry season
- establishment of a precise and permanent grid of planting stations, furrows or contoured ridges within which successive crops are planted each year and within which fertilizers can be accurately applied
- restricting land tillage and nutrient application to 15 per cent of surface area where crops are sown
- rotation of a cereal and a cash crop with nitrogen-fixing legumes
- retention of at least 35 per cent of crop residues in fields and cessation of residue burning
- application of cattle manure or fertilizers in basins
- retention of mulch or residues from the previous season's crop

The progression to CA from CF is a logical and essential step for farmers in the maize belts, and involves the introduction of perennial crops and trees into a CA system that is based on the production of annual crops. The most important tree for farmers to establish over their crop fields is *Faidherbia albida*. This is a key component of the Conservation Agriculture Programme implemented by the CFU. Rural households and the country as a whole, will benefit from the adoption of CA practices by smallholders (including the planting of *Faidherbia*), which will help reinforce the advantages of CA.

In Zambia, CA technologies are adapted to grain-based farming systems of the low to medium rainfall areas. However, they are not suitable for the cassava-based farming systems of the higher rainfall areas. For instance, basin planting is proposed for the maize growing areas, while in cassava growing areas farmers use mounds. Some 'mongrels' are now being promoted in the northern part of the country by experts making blanket recommendations, including planting basins. As a result some farmers now first make a mound then dig a little basin on top of it. This is a clear example of practitioners sending mixed messages to farmers.

The benefits of smallholder farmers adopting CA include:

- eventual government reduction and gradual withdrawal from provision of fertilizer subsidies for maize production
- farmers are no longer dependent on chemical fertilizers, which would increase input use efficiency and reduce production costs, allowing farmers to effectively compete in the regional maize market
- improvement in household food security and dietary intake, ending food relief, except for the most disadvantaged and vulnerable households
- enhanced resilience to future climate change shocks and effects

- more robust and diversified production base and the regeneration of soil fertility – farmers would be in a much stronger position to grasp future economic opportunities
- small-scale agriculture able to sequester carbon or contribute to emissions reduction rather than contributing to its increase

Main constraints to farmers' adoption of conservation agriculture

Traditionally, crop residues are not retained as mulch but burned as a quick way to clear agricultural fields, therefore facilitating further land preparation and planting. This is a conventional method of production in parts of the country where farmers own few livestock and rely on hand hoes for tillage. However, in areas such as the Southern Province there is competition for crop residues in mixed crop-livestock systems.

In Zambia, many small-scale farmers do not use herbicides as they cannot afford them and this places a huge demand on an already stretched rural labour force. Without the use of herbicides, adoption of CA increases labour requirements, especially for weeding and preparing basins during the early years of adoption. Labour constraints also limit the amount of land that can be cultivated. Often farmers face difficulties in cultivating more than two hectares of land without the use of herbicides.

Farmers experience difficulties in accessing and using external inputs. Most importantly, the government fertilizer and seed subsidy scheme for smallholders is often tardy, and only a few growers benefit (estimated at 20 per cent). There are ongoing efforts to adapt various types of CA equipment for smallholder farmers. The CFU and GART are working with private-sector partners to develop local CA equipment. However, one challenge they face is the high import duty levied on steel by the government. The high taxes on imported steel makes it economically unviable for the local manufacture of CA equipment as the prices of the final products are too expensive for smallholder farmers.

Most farmers who adopt CA do not practise adequate crop rotation, and instead many of them choose to cultivate more maize. Some farmers consider the recommendations for permanent planting basins unsuitable for growing other crops such as legumes. Furthermore, the limited markets for such crops reduce incentives for their cultivation.

Impact of conservation agriculture on incomes and livelihoods

In Zambia, significant differences in yield levels between conservation and conventional tillage systems have been recorded in farmers' fields. While the average yield of maize under conventional farming is between 1 to 1.5 tons per hectare, commercial farmers adopting CA

BOX 2

Faidherbia Albida tree leaves as source of plant nutrients

Decades of research have shown that through leaf and pod fall, nitrogen fixation and associations with soil micro-organisms, fertility accumulation under mature canopy per hectare is as follows: 75 kg N; 27 kg P205; 183 kg Ca0; 29 kg MgO; 19 kg K20 and 20 kg S. This is equivalent to 300 kg of complete fertilizer and 250 kg of lime. This is worth US$163, and can sustain maize yields of 4 tons per hectare, as compared to smallholder farmers' average yield of less than 2 tons per hectare in good seasons.

techniques have recorded more than 5 tons per hectare. And almost all small-scale farmers have much higher crop-yield levels per hectare under CA.

Conservation agriculture farmers interviewed during the field visits reported significant increases in crop yields and incomes due to the technology. In some cases, improvements in livelihoods were observed from recently upgraded family dwellings, clearly indicating improved financial conditions. Benefits from adoption of the technology extend beyond the immediate financial returns and have environmental advantages, such as preventing land degradation and improving soil fertility.

Scaling up of conservation agriculture activities

While one would like to see CA scaled up more substantially so that the technology moves from plot level to large-scale impacts, questions still linger about the agronomic and environmental merits of it. The ingredients for scaling up do exist. With a more concerted effort, the country could reach landscape-level adoption with significant benefits that would help address household and national food security. The Conservation Agriculture Programme has been very successful and is being used as a model for CA scaling up in Zambia and elsewhere in Africa.

Uptake of CA technologies has mainly been driven by donors and NGOs. However, these efforts are frequently not well coordinated and there is a need for more coordinated support of CA.

BOX 3

Zambia Conservation Farming Unit staff and conservation agriculture

When asked, “Do you believe in this technology?” a Senior Officer at the Conservation Farming Unit in Lusaka replied “I practise it.” He went on to explain that it is a prerequisite for all staff of the CFU to own farms cultivated under CF to demonstrate the technology to farmers they train – the results are impressive.

BOX 4

Transformation

Thirty-nine-year-old Request Mulwani is a farmer from Mukwela in Kalomo District with a family of eight. With three spans of oxen he was able to plough about 15 hectares of land, 10 hectares of which were dedicated to maize and 5 hectares to soybeans. His average yields from the plots were 3.5 tons per hectare and 0.8 tons per hectare of maize and soybean.

Request came into contact with conservation farming in 2008 through the CFU. With the technical knowledge acquired from CFU trainings, he was able to harvest about 7.5 tons per hectare from 5 hectares of land managed under the CF technology. The results have encouraged him to put more land under CF cultivation for the coming years.

Request is currently a CFU Farmer Coordinator and has helped to showcase the successes of the technology for other farmers in the Southern Province.

Areas of support for development partners

There are four distinct areas of support in the promotion of CA technology in Zambia. These include: (i) technical or productive aspects of the technology; (ii) input support which is minimal and is obtained through regular government seed and fertilizer subsidies; (iii) extension and training; and (iv) research and development. Although it is widely acknowledged that markets are important, market access for smallholder farmers' produce – other than maize – has received little attention. In fact, most farmers grow maize because there is an established marketing system. The farmers interviewed indicated that their cropping patterns were primarily determined by household food requirements and market opportunities, and not necessarily by income earning potential.

The CFU, financed by the Government of Norway, is at the forefront of promoting CA in Zambia. It works closely with GART in Chisamba, and promotes the development and extension of minimum tillage technologies for smallholder farmers. Other financiers and actors involved in CA include the World Bank, European Union, Canadian International Development Agency (CIDA), FAO and various NGOs.

Financial support to conservation agriculture in Zambia

Table 2 (page 30) shows funding allotted to the various programmes and projects from development partners. In addition to the financing indicated, some donors provide funds for agriculture projects that include CA components. Various funding agencies have expressed their interest in financing CA activities through the Conservation Agriculture Programme. However, it is difficult to determine the total amount of financing invested in CA activities because some donor support takes the form of components of other development projects.

BOX 5

Conservation agriculture: father and son

Jeremy Simoloka and his son Stembridge are both farmers in Choma. Jeremy owns about 88 hectares of land, and allocated 20 hectares to his son to engage in arable farming. When Stembridge heard about CF, he sought information about training opportunities and then underwent training with the Conservation Farming Unit. His father, on the other hand, remains suspicious of the technology and will have nothing to do with it.

Jeremy harvests, on average, about 70 bags of maize of 50 kilograms each from the 4 hectares he cultivates. Stembridge, on the other hand, cultivates all 20 hectares. Prior to adoption of the technology, his maize yield was between 250 to 300 bags (50 kilograms each). After incorporating CF technologies into his farming practices, his yields have increased to more than 450 bags for the same piece of land. Although he admires his son's success with the technology, Jeremy remains sceptical about CF, as his own earlier attempts at it were unsuccessful.

Stembridge praised the benefits of the technology, but raised the issue of access to inputs – obtaining fertilizer, in particular, is a major challenge for him. He also cited weed management as another challenge.

TABLE 2

Conservation agriculture programmes and projects in Zambia financed by development partners

Name of conservation agriculture programme or project	Period	Activities	Financier	Implementing agency	Approximate amount (US$)
Reversing Food Insecurity and Environmental Degradation	2006-2011	Research and development Extension and training	Norway	CFU of Zambia National Farmers Union	23.6 million (NOK 146 million)
Upscaling Conservation Agriculture for Increased Productivity and Production among small-scale farmers in Zambia	2008-2010	Extension and training Technical aspects	Norway	FAO	8.5 million (NOK 52 million)
Conservation Agriculture Scaling Up for increased Productivity and Production (CASPP)	2008-2010	Extension and training	Norway	FAO	5.0 million
Climate Change Mitigation and Adaptation Component of Global Climate Change Alliance Project	2010-2015	Technical aspects Extension and training Input support	Norway	Alliance for Commodity Trade in Eastern and Southern Africa (ACTESA) (COMESA)	50.0 million
			European Commission	ACTESA (COMESA)	5.2 million (EUR 4.0 million)
Conservation Agriculture Programme	2009-2011	Technical aspects Extension and training	European Union	FAO	9.8 Million (EUR 7.5 million)

IFAD's institutional framework and investment in conservation agriculture

Within the IFAD Strategic Framework 2011-2015, the Fund has given priority to assisting smallholder farmers in coping with the effects of environmental degradation and climate change. Therefore, support to CA in Zambia is consistent with IFAD's institutional strategic focus. In response to the 2010-2012 L'Aquila statement, which corresponds to the Eighth Replenishment of IFAD's Resources, three of the areas IFAD pledged to focus on among others were: (i) agricultural adaptation to climate change; (ii) marketing and input supply; and (iii) agricultural policy support.

Furthermore, at the February 2010 Governing Council, IFAD management presented a number of key issues that affect farmers in developing countries involved in agriculture and rural development. The two issues that were highlighted and the modalities for addressing them are directly relevant to supporting CA in Zambia. They are:

- Issue 2: Government responses have been inadequate to climate change and environmental degradation: land degradation, water shortages and production failure will contribute to food shortfalls. IFAD highlighted the need for investment in areas such as adaptation of agriculture to climate change and environmental degradation, and in land and water reclamation.
- Issue 6: Appropriate agricultural technology for the future: 'Green Revolution', CA, biotechnology. To address this issue, management indicated the need for all stakeholders to assume respective roles with situation-specific considerations; the need for investment and regulation in public policy; and the need to share knowledge at the international level.

Conclusions and recommendations

The debate on the merits of CA technology continues. Based on the literature and on discussions with farmers, extension staff, research experts and donors, the multidimensional benefits and advantages of CA systems on the agricultural, economic, social and environmental levels have been demonstrated in Zambia. However, the application of the basic principles of CA in the geoclimatic and socio-economic context has yet to be properly adopted.

From observations and information gathered during the field visits, most CA farmers do not adopt all principles of the technology due to their limited access to inputs (quality seeds, fertilizers, herbicides, mulch), labour constraints, insufficient resources or limited markets. As a result, the CA practised by most smallholder farmers is often far from the 'ideal' that is being promoted. Nevertheless, despite this partial adoption of CA technologies, all the farmers practising or observing those that do practise them, attested to evidence of significant increases in yields under CA in comparison to conventional methods. However, there remain issues to address with respect to the socio-economic preconditions for adoption and the existence of well-functioning agricultural service systems.

Two of the overwhelming concerns of the farmers interviewed (CA adopters and non-adopters) were the Food Reserve Agency payment delays and frequent low prices for maize produce, and the absence of developed market access for other crops being promoted under the CA system. Farmers saw a disconnect in that the government promoted maize production and yet increased supply led to depressed prices. The lack of or limited commodity markets for legumes meant that most CA farmers simply ignored one of the three core CA principles – crop rotation. This was especially true for legumes. Maize marketing channels are well developed within the country through district-based Food Reserve Agencies, whereas cotton markets are well established through private companies.

Of an estimated 9 million hectares of arable land with good to moderate potential for arable agriculture in Zambia, only 16.6 per cent is currently cultivated by about 1.4 million farming families. Of these, less than 200,000 individual farmers practise CA. However, based on current trends, it is inevitable that CA will take off.

Conservation agriculture and farming is an area that is clearly in line with IFAD's Strategic Framework and funding priorities. Although there are many financing agents promoting CA in Zambia, the positive and significant impacts on smallholder farmers' livelihoods through the application of the technology are evident. There is proof that there are environmental and financial benefits to be gained from CA, based on the degree of adherence to ideal principles.

Therefore, any investment support in crop production will have little alternative but to support the principles of CA in their entirety or some aspects of them. The four main areas of support are: (i) inputs and equipment; (ii) extension and training; (iii) research; and (iv) market development.

It is therefore recommended that IFAD consider supporting the development of market chains for legumes, which are critical for the success of CA systems.

It is further recommended that consideration be given to undertaking a dialogue with the government on the existing policy that calls for high import duty on steel. This policy has forced farmers to rely on imported implements, most of which have already proved unsuitable for Zambia. There is need for the government to exempt duty on agriculture-bound steel to promote local manufacturing of CA implements. Local manufacturing of this equipment is necessary if widespread adoption is to take effect, and to stimulate the development of private agrodealers in the manufacturing and provision of related services.

IV. Prospects of conservation agriculture in Botswana

Context of arable farming

Botswana is able to guarantee national food security through its ability to import food. However, this is not the case at the household level, especially in rural areas where food security is threatened by low yields because of drought, low and unreliable rainfall, poor soils and poor crop husbandry.

Programmes such as the Integrated Support Programme for Arable Agricultural Development (ISPAAD)[1] have supported farmers in Botswana, resulting in the expansion of rainfed cropped areas. However, there have not been corresponding improvements in productivity. The yield gap (in comparable climate and soil conditions) between small-scale and commercial farmers is very large, estimated at more than ten-fold. Commercial farmers realize up to 2 tons per hectare for maize and sorghum, compared to an average of less than 250 kilograms per hectare among smallholder farmers under similar agroecological conditions. Low productivity comes at a high cost considering that the government has been subsidizing small-scale rainfed agriculture for at least three decades. Unit area input costs are considerably higher than those in most neighbouring countries.

In Botswana, the main constraints to arable crop production are:

- poor agronomic practices – seed planting by broadcasting, late planting, poor weed control
- limited access to quality seeds
- poor soil management – often higher application levels of fertilizers and lime

BOX 6

Average maize yields in selected countries and regions (2009/2010)

Country/region	tonnes/hectare
World	4.5
Africa	1.7
South Africa	2.9
Zambia	1.6
Malawi	1.4
Namibia	1.4
Mozambique	1.0
Zimbabwe	1.0
Angola	0.6
Botswana	0.2

Source: Giller et al. (2009).

1 ISPAAD is one of the main agricultural support schemes introduced in 2008 to address challenges in the arable subsector; especially poor technology adoption by farmers and low productivity within the subsector.

- weak linkages between agricultural research and extension
- labour constraints – scarce labour in rural areas and very expensive to hire even when available
- failure to access readily available credit

Agroecological conditions

Botswana has a semi-arid climate characterized by low rainfall that is unreliable, unevenly distributed and highly variable. Average annual rainfall varies from less than 250 mm in the extreme south-western part of the country to over 650 mm in Kasane, in the extreme north. The rains fall mostly in the summer months between November and March. Very little, if any, falls in the winter months from May to September. The effectiveness of the rainfall is reduced because of high evaporation rates caused by the prevailing high temperatures during the rainy season. There are three main agroecological zones:

- In the centre and west, the Kalahari Desert covers over two-thirds of the total area. Although it has low rainfall, the predominant landscape is not desert but savannah grasslands interspersed with woodland. The sandy soils are not well suited for cultivation but support considerable numbers of cattle, goats, other livestock and wildlife.
- The east of the country, consisting of loamy clay soils, has a less harsh climate and more fertile soils than the Kalahari. Rainfall is generally in excess of 400 mm annually. The predominant landscape is savannah grasslands and woodlands, with a small amount of forest.
- In the northwest, the Okavango Delta presents vast areas of open water and lush, green wetlands with an abundance of wildlife. The area of the Delta varies according to season and rainfall.

  To the east of the Delta lie the Makgadikgadi Pans: vast, flat, salty depressions where there was once a huge lake at the endpoint of the Okavango River.

It is estimated that only about 5 per cent of the total land area in Botswana is suitable for arable agriculture and only about 1 per cent is under cultivation, with the best soils concentrated in the eastern parts of the country. The agricultural sector is dualistic, composed of traditional and commercial farmers, the main difference between them being land tenure, use of technology and marketing of agricultural outputs. Crop production is hampered by traditional farming methods, recurrent drought, erosion and disease. Smallholder farmers live on communal lands where they practise mixed farming of crops and livestock. They depend on rainfed agriculture and low-input, low-output farming systems. Commercial farmers, who constitute about 1 per cent of the total number of farmers, occupy medium- to large-scale farms on freehold land and apply modern and capital-intensive farming techniques, including irrigation. They also tend to specialize in cattle production. Agricultural activities include the rearing of livestock, crop production and, to a lesser extent, fishery and forestry. Livestock, particularly cattle grazing, is by far the most important agricultural activity, accounting for about 80 per cent of the output of agriculture.

Studies have shown that in sub-Saharan Africa almost all ecological zones that are suitable for arable farming are also suitable for CA. Most crop production takes place in the eastern part of the country and this is the area where the recently designed ASSP will be implemented.

Farming conditions present a good opportunity for smallholder farmers to shift from conventional farming practices to adoption of CA technologies and improved agronomic practices. Given the scarcity of farm labour in rural areas, minimum tillage CA, coupled with the use of herbicides, is necessary to boost the performance of small-scale agricultural production systems.

Conservation agriculture experiences in sub-Saharan Africa relevant to Botswana

The experiences of CA in Zambia and other countries in the region are also relevant for Botswana. The reasons that underscore the high rates of adoption of the technology in Zambia (see page 25) are important pointers to key areas and issues that need addressing to facilitate adoption in Botswana.

Strong government support in the form of favourable policies that facilitate adoption and encourage private entrepreneurs in input provision is crucial. This must be complemented with adaptive research and training, especially at the initial stages, to ensure that farmers acquire the necessary knowledge and adopt improved agronomic practices.

Most small-scale farmers practise mixed farming systems of arable farming and livestock rearing. This presents potential challenges to the adoption of CA with regard to one of the three principles of CA – the need to maintain land cover. Stovers and other crop residues are usually used as animal feed in such instances. Experts advise farmers to practise controlled grazing so that some amount of land cover is achieved while providing animals with feed. Over time, as crop production increases, there is abundant residue to adequately accommodate livestock feed and land cover.

Botswana has a very short rainy season, calling for more efficient mechanized farming methods to closely adhere to the tight cropping calendar. Invariably, mechanized farming is more desirable and appropriate than the use of basins.

Conclusions and recommendations

Since the ASSP[2] will promote mechanization in the smallholder farmer setting in Botswana, it will serve no useful purpose to promote the more rudimentary form of the technology – manual basins and furrow preparation. Therefore, mechanized minimum tillage is the future of CA and this could be introduced at an early stage in project implementation. The project support services in agronomic practices and mechanization will complement the government's input support programme.

Strong government support in the form of policies that are conducive for the promotion of the technology is needed from the onset.

It will be necessary to address the cultural dimension of the CA technology with regard to changing farmers' mindsets about the way to farm. In most cases farming is synonymous with ploughing and therefore CA will be regarded as radical for many farmers. Small-scale farmers in particular, require intense and sustained education, training and demonstrations to believe in the technology and to gradually alter preconceived notions about farming.

Farmer organizations are an excellent means of achieving high levels of adoption of the technology. They help stimulate learning and knowledge-sharing among farmers.

2 The ASSP will improve farmer access to equipment for agriculture mechanization and provide other essential agricultural services to farmers such as appropriate inputs (seeds, fertilizers, agriculture chemicals), technical assistance for farmer skills training and information on agronomic practices and marketing, as well as linking farmers to appropriate credit facilities.

Adaptive research on the various aspects of the technology is necessary before the technology can be introduced into the country on a significant scale. It will be useful to link the project with activities under the second phase of the CA regional project implemented by CIMMYT. Conservation agriculture is an evolving suite of technologies. The project rightly included adaptive research activities to advance that process in the country.

ANNEX I

Conservation agriculture programmes and projects in Zambia

National projects

(i) **Conservation Farming in Zambia (since 1996)**
Since 1996, stakeholders from the private sector, government and donor communities have been promoting conservation farming (CF) among smallholders in Zambia. The CF system involves minimum tillage (either ox-drawn rip lines or hand-hoe basins), retention of crop residue, permanent planting stations and crop rotation. One of the main proponents of CF in Zambia is the Conservation Farming Unit (CFU) of the Zambia National Farmers Union. The CFU is supported by the Norwegian Agency for Development Cooperation (NORAD) and the Golden Valley Agricultural Research Trust (GART). The current phase of support to the CFU is for the Conservation Agriculture Programme, which started in 2006 and will end in 2011. The CFU has been implementing conservation agriculture (CA) since 1996 with support from NORAD.

(ii) **Conservation Agriculture Scaling Up for Increased Productivity and Production (CASPP) (OSRO/ZAM/901/NOR) (2008-2012)**
The Government of Norway funded another two-year (2009-2010) CA programme within the Conservation Agriculture for Sustainable Agricultural Development (CASAD) programme concept. The programme was executed by FAO and implemented by MACO with support from the CFU and targeted 120,000 farmers in five provinces. Conservation agriculture technologies were promoted in conjunction with agroforestry interventions (e.g. live fencing and the use of *Faidherbia albida* as organic fertilizer). The programme complemented the existing CA being implemented by the CFU, as well as providing capacity-building for MACO staff, on-farm facilitators and lead farmers. CASPP will also reduce costs of farming inputs. Thirty farmer field schools are to be established. Tentatively the programme will focus on the following districts; Chibombo, Chipata, Choma, Chongwe, Kalomo, Kapiri, Katete, Mazabuka, Monze, Mumbwa and Petauke.

The European Commission financed a two-year Farmer Input Support Response Initiative (FISRI) following CA principles. The programme is a scaled-up version of initiatives being implemented under the CFU and MACO.

(iii) **CARE Agricultural Programme**
CARE is funding a food security programme with a CA component. The focus is on improved agricultural techniques and on small loans for small businesses.

(iv) **Assistance to Stabilization of Agricultural Production in Southern Zambia (OSRO/ZAM/201/NET and OSRO/ZAM/202/NOR) (2002-2004)**
Projects funded by the Netherlands and Norway and implemented by FAO, aimed to improve farmers' self-reliance through increased production and access to food, and reduced dependency on food aid.

These projects had strong CA components. The targeted beneficiaries were 25,000 farmers from all districts of Southern Province, 25,000 farmers from Mumbwa, Chibombo, Chongwe and Kafue in Central Province and Lusaka, and 10,000 farmers from the Nyimba, Chadiza and Chipata districts of Eastern Province.

(v) **Smallholder Agribusiness Promotion Programme (2010-2017)**
The programme engages private-sector partners at several levels, including the design and implementation of interventions at critical points in agricultural value chains that adds value to products and connects farmers with input suppliers and markets.

The programme allows farmers to:

- access technology so that they can increase their yields and improve the quality of their produce
- enhance their capacity to carry out activities such as sorting, grading, drying and storing
- make better commercial decisions based on appropriate market information
- get higher and more stable prices through farming contracts

Multinational projects

(i) **Strengthening HIV/AIDS and Food Security Mitigating Mechanisms among Smallholder Farmers (2005-2008)**
Botswana, Lesotho, Namibia and Zambia
GART coordinated the regional project above from September 2005 to December 2008 with funding from the Governments of Sweden and Norway through the SIDA-managed Africa Team – HIV/AIDS Food Security Programme. The aim of the programme was to help improve the nutritional status of targeted beneficiaries and improve farm productivity (labour-saving technologies, increased incomes and food security).

(ii) **Farm-level Applied Research Methods in Eastern and Southern Africa (GCP/RAF/334/SWE) (1996-2001)**
United Republic of Tanzania, Zambia, Zimbabwe (and Kenya, Uganda)
The Farm-level Applied Research Methods in Eastern and Southern Africa (FARMESA) was a regional FAO project, supported by SIDA. It researched and disseminated various improved agricultural technologies and production methods, including conservation tillage and water harvesting. FARMESA provided training through advising on curriculum development and training of trainers. The project produced various technical guidelines and videos. Associate countries were Botswana, Malawi, Mozambique and South Africa.

(iii) **Facilitating the Adoption of Conservation Agriculture in Maize-based Systems (CIMMYT, since 2004)**
Malawi, Mozambique, Zambia, Zimbabwe (United Republic of Tanzania)
IFAD is running a long-term programme of facilitating the widespread adoption of CA in the maize-based systems in Southern Africa. The programme started in Malawi, the United Republic of Tanzania, Zambia and Zimbabwe, and is now concentrating activities in Malawi, Mozambique, Zambia and Zimbabwe. The programme is executed in cooperation with the International Center for Tropical Agriculture (CIAT), national agricultural research institutions and NGOs. The evaluation of a range of CA techniques and equipment is part of the programme.

Proposed projects

Scaling-up Conservation Agriculture in Sub-Saharan Africa (TerrAfrica)
This initiative is part of the Comprehensive Africa Agriculture Development Programme's sustainable land management programme and developed by TerrAfrica. Stakeholders in the initiative include national and international NGOs, research institutions, universities, regional economic communities (COMESA, the East African Community and the Southern African Development Community) and other development partners. The aim of the initiative is to enhance agricultural productivity and adaptation to climate change through CA in sub-Saharan Africa. Initiatives at both the regional and country level are envisaged.

One of the approaches to be scaled up is Conservation Agriculture with Trees (CAWT), which combines the practices of CA with those of agroforestry. The regional and continental partners mentioned above aim to scale up CAWT to millions of households in a few years. Initially, the focus will be on five countries, namely Ghana, Kenya, Malawi, the United Republic of Tanzania and Zambia.

ANNEX II

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FARMERS IN KAFUE, MAZABUKA, MAGOYE, CHISAMBA, CHIKANKATA AND CHOMA DISTRICTS

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Choma

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Mrs Agnes Ngandu
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Glossary

Conservation agriculture

Is a resource-saving crop production method that generates high and sustained yields, while concurrently conserving the environment. Broadly, it encompasses activities such as: minimum tillage and zero tillage, tractor and manually powered methods, integrated pest management; optimal application of inputs such as agrochemicals and nutrients of mineral or organic origin in a manner and quantity that does not interfere with or disrupt biological processes; and sustainable integrated soil and water management, including conservation farming. It is generally defined as any tillage sequence that minimizes or reduces the loss of soil and water and achieves at least 30 per cent of soil cover using crop residues.

Conservation farming

As defined by the Food and Agriculture Organization of the United Nations and Zimbabwe's Conservation Agriculture Task Force, conservation farming refers to the planting stations (basins) technology, which is only one type of conservation agriculture.

Tillage

Tillage refers to all the work that a farmer does to prepare land for planting. In other words, all the operations undertaken to prepare a seedbed so that the seeds can germinate properly. The term 'cultivation' is usually used to describe all the work that is done after planting to keep the crop free from weeds.

Conventional tillage

There are three methods of tillage that are commonly used by farmers in agroecological regions I and II in Zambia in order to prepare their land for planting. These three methods of conventional tillage are as follows:

- **Soil inversion (digging or ploughing)**: The soil on the entire surface area of the field to be planted is disturbed. This could involve one or all of the following operations: digging by hoe, ploughing, disking and harrowing.
- **Ridging**: A hoe or plough drawn by livestock is used to form ridges. This is usually done in October or November by splitting the previous season's ridges to form new ones in the old furrow. It may also be done after the first rains. Ridges should always follow the contour, but seldom do.
- **Minimum tillage**: Minimum tillage means reducing tillage operations to the minimum required to plant a crop. For hoe and ox farmers it usually involves scratching or ripping out the row where the crop is to be planted and leaving the rest of the land untouched until weeding is required. Alternatively, hoe farmers may just dig holes where the seed will be sown.

No-tillage

Also referred to as 'direct seeding', this describes the sowing of seeds into soil that has not been previously tilled in any way to form a 'seedbed'.

Cover crops

The main purpose of cover crops is to benefit the soil and/or other crops. Farmers prefer cover crops that serve as food or feed to those that do not. Such crops improve soil quality and fertility, control erosion, suppress weeds and control insects.

Crop rotation

The practice of growing a series of dissimilar types of crops in the same area in sequential seasons for various benefits, such as to avoid the build-up of pathogens and pests that often occur with continuous monocropping.

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