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Chapter 2:
On heretics and God's blanket salesmen: Contested claims for Conservation Agriculture and the politics of its promotion in African smallholder farming

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'Erosion > natural soil formation = NOT sustainable.
Tillage is incompatible with sustainable agriculture!
Further promotion of tillage–based agriculture in Africa is irresponsible.

…research questions are NOT WHEN and WHERE Conservation Agriculture is applicable, but "HOW it can be best made work and upscaled.'
(Friedrich and Kassam 2011)

INTRODUCTION

Conservation agriculture (CA) has captured the imagination of an impressive array of organisations including the FAO, DFID, the EU, international research and development organisations (CIMMYT, CIRAD, ICRAF and ICRISAT) and numerous NGOs. Defined by FAO (2008a) as having three essential components – (1) zero or minimal soil disturbance, (2) a permanent soil cover provided by a growing crop or a mulch of organic residues, and (3) crop rotation[1] – CA is now promoted widely to smallholder farmers in sub–Saharan Africa.[2] Next to international agricultural research and policy institutes, faith–based organisations, international donors and NGOs have been at the forefront in such promotional efforts. Often building on the – Judeo-Christian notion of environmental stewardship, which follows from the belief that it is the responsibility of man to look after the Earth (Passmore 1974), some of these organisations equate CA to 'farming God's way'.[3]

This chapter investigates the development of this conglomerate of faith–based, science–based and policy organizations as a distinct epistemic community. Following Haas (1992), an epistemic community is understood as a network of professionals with recognized expertise in a particular domain, who help decision–makers to define problems, identify policy solutions and assess policy outcomes.[4] An epistemic community thus pushes a particular policy enterprise, excluding or silencing alternative policy options and expertise. We illuminate how CA became a policy success sanctioned by religion, despite earlier agronomic research suggesting the value of other options, evidence of dis–adoption and contestation over the suitability of particular CA technologies. The focus is on this epistemic community's particular institutional manifestation and its related agronomic narrative.

As illustrated by the opening quotes the agronomic narrative around CA stresses sustainability and the universal applicability of its three main principles. Sometimes adopting a idiosyncratic definition of sustainability[5] – which disregards

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the fact that soil erosion is also a natural process – this narrative portrays the plough as the major cause of soil degradation (Marongwe et al 2011; Thierfelder and Wall undated) and as 'an enemy of sustainability'.[6] Adopting CA principles thus becomes a universal prerequisite for sustainable agriculture or, in the narrative of its Christian proponents, the only way to farm that is faithful to God. In such a narrative the socio–economic and agro–ecological environments cease to be structuring forces of agronomic practice. Instead, practising CA becomes a righteous act, an act of faith, where agronomic practices also have religious meanings, such as mulch cover being understood as 'God's blanket' (Oldreive 2009: 52).

Thus we may understand the apparent tension between the blanket, or perhaps more aptly, 'God's blanket' recommendations for CA and the recent trend toward more adaptive, on–farm and farmer–led agronomic research. The focus here is largely on Zimbabwe where both agronomic research on CA technologies targeting African smallholder farmers, and faith–based promotion of CA to African smallholders have their origins.

We first explore the history of research on conservation tillage in Zimbabwe, and show how the current drive to promote CA is largely disconnected from earlier on–station and on–farm experimentation. We argue that: (1) this disconnect relates to growing attention to CA in international policy discourse in the late 1990s and early 2000s (Benites et al. 1998; Vaneph and Benites 2001) and a shift in donor support from government–linked agricultural research to the (faith–based) NGO sector following Zimbabwe's political and economic crisis in the early 2000s; and (2) that these two developments gave rise to a distinct epistemic community of faith–based NGOs, international agricultural research institutes and policy organizations (such as the FAO). Subsequently, CA was turned into a successful policy model for smallholder farming in southern Africa, following positive reports on smallholder CA farming in Zambia. This was done by bringing together different technologies promoted by various research and development organizations into a standardized CA package. In many areas, practicing a form of CA based on planting basins became a requirement if resource poor smallholder farmers were to receive inputs. The widespread extension of this planting basin–based CA package was the impetus for current attempts to mainstream CA in the sub–region through national agricultural policy. Although there are now different CA packages, the suitability and applicability of CA in highly diverse smallholder farming systems remains contested. It is suggested that actual adoption of CA will be patchy at best as it is only suited to the circumstances of a limited number of farmers and farming systems.

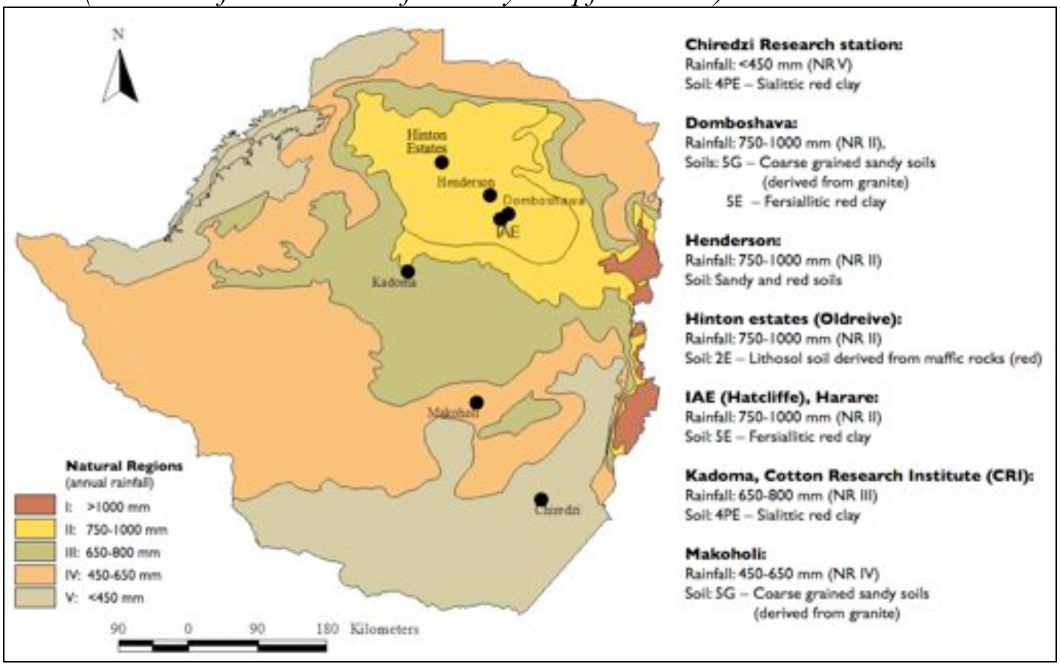
EXPERIMENTATION WITH CA TECHNOLOGY IN ZIMBABWE

Reduced tillage practices were developed following the dust bowl in North America in the 1930s. These practices were seen as a means to reduce soil erosion and thus conserve the soil. Agronomic research has subsequently developed practices involving what have become the three principles of CA: reduced or zero–tillage, permanent soil cover and crop rotation. In mechanized agriculture where herbicides are used, CA practices offer huge advantages for farmers with sufficient capital (Bolliger et al 2006). Apart from being effective in controlling soil erosion and increasing soil moisture, direct planting into the residue of a previous crop can reduce energy costs (for ploughing), increase the area that can be managed by a given labour force, and reduce or eliminate the fallow time between crops. In some areas, reduced fallow time allows for an extra crop being grown within a year. It is thus a means of intensification that increases the efficiency of land, energy, water and nutrient use and prevents soil erosion. Such practices have been adopted on a massive scale on large–scale farms in North and South America, Australia, South Asia and southern Africa.

The spread of CA was not restricted to very large mechanized farms. Researchers developed animal–drawn zero–till planters suitable for use by Brazilian 'smallholders' on farms typically less than 50 ha in size (Bolliger et al 2006).

Although the American dust bowl also inspired a pre–occupation with soil conservation among colonial officers in southern Africa (Bolding 2004: 60; Beinart 1984), here reduced tillage systems were introduced primarily in response to escalating fuel, machinery and maintenance costs (Smith 1988). Such cost considerations were probably most acute in Southern Rhodesia (now Zimbabwe), following the economic sanctions imposed on the white minority regime after 1965. Testing of various reduced tillage techniques, including ripping[7] and conservation tillage ensued at Henderson Research Station, the Institute of Agricultural Engineering (IAE) and the Cotton Research Institute (Figure 1). Findings were evaluated in terms of their effects on maize and cotton yields and geared towards the large–scale commercial farming sector (Smith 1988). Results indicated that conservation tillage practices could have a marked influence on soil properties, moisture conservation and yield, but 'that seasonal climatic variations have more direct influence on crop yields than any tillage treatment' (Smith 1988: 207). The erosion–reducing effects of conservation tillage practices were considered to be most relevant for smallholder farming in the Communal Areas but were not systematically tested under smallholder conditions.

***Figure 1** Agro-ecological circumstances (rainfall and soil characteristics) at different research stations in Zimbabwe, and reduced tillage projects implemented at these stations (soil classification taken from: Nyamapfene 1991)*



Following Zimbabwe's independence in 1980, agricultural research was re–oriented towards the smallholder sector (Taonezvi 1994). Often supported by international donors, government research institutes now focused on conservation tillage techniques that were more suitable for smallholder farmers (Mupangwa et al 2006; Twomlow et al 2006). Practices such as no–till tied ridging (McClymont and Winkfield 1989; Norton 1987; Elwell and Norton 1988) and no–till with tied furrows[7] now started to be systematically investigated and recommended to smallholders (Nyamudeza and Nyakatawa 1995). Because mulch is not a requirement for either practice they were seen as better adapted to the smallholder sector, where crop residues are scarce as they are normally fed to livestock during the dry season.

The Contill Project

In 1988, the governmental research and extension service, Agritex, and the Germany Technical Agency (GTZ) initiated a collaborative research project on conservation tillage on the granite–derived sandy soils at Domboshava and Makoholi research stations (Figure 1). Aiming to test and develop sustainable conservation tillage practices for smallholders farming on similar soils, four conservation tillage practices were compared with conventional mouldboard tillage: (1) no–till tied ridging, (2) mulch ripping, (3) clean ripping into bare ground, and (4) hand hoeing into bare soil before the onset of the rains (Munyati 1997). To complement the on–station trials looking at yield, soil loss and run–off, the project introduced adaptive on–farm research in 1990, seeking to test socio–economic, technical and environmental feasibility in farmers' situations (Hagmann 1993; Nyagumbo 1999). Although the on–farm trials suggested that 'from a soil and water conservation point of view, [both] mulch ripping and no–till tied ridging [showed] high potential', only the latter technique was taken for testing and further development with farmers as 'stover mulch is normally fed to cattle' (Chuma and Hagmann 1995: 48). Yet, as crop emergence proved a problem in no–till tied ridging, it was recommended that farmers delay planting until the ridges were fully moist, a practice that may reduce yields (Munyati 1997: 31). Other techniques, such as clean ripping and hand hoeing in bare ground were considered unsustainable as 'surface run–off and erosion rates… were still above tolerable levels', albeit lower than with conventional tillage. In addition, at the drier Makoholi site 'hand–hoeing appeared to reduce yields' (Chuma and Hagmann 1995: 54, 56), while at Domboshava 'high weed infestation prevent these systems from being sustainable' (Munyati 1997: 32, see also: Vogel 1994).

The results from the on–station trials at Domboshava and Makoholi (Tables 1 and 2) show that both ripping and no–till tied ridging were effective at keeping soil loss and runoff below what was considered the tolerable rate of 5 t ha^{-1} $year^{-1}$ (Elwell 1980). Yet, only mulch ripping was found to be a 'truly [ecologically] sustainable tillage technique' as it 'was able to maintain high organic matter levels, reduce soil erosion to a minimum and to achieve the highest water use efficiency… [T]he organic matter status of the soil could not be sustained at the desired level' with no–till tied ridging (Chuma and Hagmann 1995: 54).

Yields showed more diverse trends in comparison with conventional tillage. At Domboshava planting on ridges produced significantly better yields than all other treatments in seasons with above average rainfall (Munyati 1997: 29), but at Makoholi mulch ripping generally outperformed no–till tied ridging. Yet, in contrast to the on–station trials, no–till tied ridging performed generally better than conventional ploughing in the on–farm trials, albeit that there was much variability from farmer to farmer. Treatment effects appeared 'to be extremely site, soil and farmer specific' (Chuma and Hagmann 1995).

Table 1 *Grain yield, surface runoff and soil loss for different tillage treatments, Domboshava 1988/89-1994/95 (Sources: Nehanda 1999; Munyati 1997)*

		Yield (t ha-1)			**Surface run-off (mm)**			**Soil loss (t ha-1 yr-1)**		
Season	Rainfall (mm)	Conven. tillage	No-till tied ridging	Mulch ripping	Conven. tillage	No-till tied ridging	Mulch ripping	Conven. Tillage	No-till tied ridging	Mulch ripping
1988/89	905	3.8	5.0	3.8	62.9	2.3	86.2	1.7	0.2	2.0
1989/90	1180	2.8	4.6	2.1	274.3	116.5	109.1	9.5	2.2	2.6
1990/91	739	3.1	4.6	4.0	15.0	1.4	4.8	1.1	0.3	0.6
1991/92	438	1.2	0.8	0.3	9.4	0.1	1.0	1.0	0.1	0.3
1992/93	797	5.1	6.6	4.3	105.0	13.0	15.2	11.8	0.9	1.1
1993/94	610	4.6	6.0	5.7	13.0	0.7	1.7	1.5	0.2	0.6
1994/95	480	2.4	2.4	3.5	99.5	5.9	4.4	10.3	0.7	0.6
Average	**736**	**3.3**	**4.3**	**3.4**	**82.7**	**20.0**	**31.8**	**5.3**	**0.7**	**1.1**
Std. dev.	258	1.4	2.0	1.7	93.7	42.8	45.7	5.0	0.7	0.9

Table 2 *Grain yield, surface runoff and soil loss for different tillage treatments, Makoholi, 1988/89-1994/95 (Sources: Nehanda 1999; rainfall – Chuma and Hagmann 1995)*

		Yield (t ha-1)			**Surface run-off (mm)**			**Soil loss (t ha-1yr-1)**		
Season	Rainfall (mm)	Conven. tillage	No-till tied ridging	Mulch ripping	Conven. tillage	No-till tied ridging	Mulch ripping	Conven. tillage	No-till tied ridging	Mulch ripping
1988/89	425	2.8	2.1	3.2	7	0.3	5	0.7	0.0	0.5
1989/90	742	6.6	3.0	7.1	93	26	28	1.3	0.1	1.0
1990/91	342	1.9	1.5	3.0	41	0.2	2	5.8	0.1	0.6
1991/92	174	0	0	0	1	0.1	1	0.7	0.1	0.3
1992/93	679	5.8	4.8	7.0	92	34	35	11.8	2.7	3.7
1993/94	472	2.4	3.0	2.6	95	16	5	40.2	3.0	0.2
1994/95	no data	0.9	1.1	2.2	49	4	4	6.8	0.1	0.1
Average	**472**	**2.9**	**2.2**	**3.6**	**54.0**	**11.5**	**11.4**	**9.6**	**0.9**	**0.9**
Std. dev.	212	2.4	1.6	2.6	40.5	14.0	13.9	14.1	1.3	1.3

Conservation tillage trials were also established at the Institute of Agricultural Engineering in 1991. Among the tillage treatments tested were conventional ploughing, mulch ripping and no–till tied ridging, as in the Contill project. Results over five seasons revealed no clear trends nor significant differences between different tillage treatments in terms of crop yields, but average yields tended to be larger in no–till treatments (Nehanda 1999). As the Contill and IAE experiments were conducted on contrasting soils (Figure 1) they provide insights into the effects of tillage on soil organic matter. The physical protection afforded by (1) the binding of organic matter to clay particles (the textural effect) and (2) aggregation (the structural effect) in clay soils means that the negative effect of tillage on soil organic matter can be significant in clay–rich soils (Chivenge et al 2007). By comparison, in sandy soils – which predominate in Zimbabwe's Communal Areas – there is little physical protection and thus tillage does not have a strong effect on organic matter. Sandy and clay soils thus require different management in order to maintain soil organic carbon (see also: Grant 1995).

Conservation tillage experimentation: what determines success?

This brief history of experimentation with conservation tillage in Zimbabwe reveals three marked institutional changes. First, initial interest in conservation tillage was motivated primarily by escalating costs – for fuel and imported farm machinery – rather than conservation concerns. The experimentation served the large–scale farming sector. Second, following independence agricultural research was re–oriented towards the smallholder sector, and experimentation on conservation tillage followed suit (Norton 1988; Prestt 1986; Shumba et al 1992). With this re–orientation, soil conservation and coping with climate variability became more prominent in the narrative around conservation tillage (e.g. Chikowo 2011). Soil conservation was a well established theme even during the colonial period in Zimbabwe, as smallholder farmers were historically concentrated on degradation prone soils with highly variable rainfall (Andersson 2007). Third, as the development and promotion of conservation tillage practices for the smallholder sector intensified in the 1990s, research increasingly shifted from formal trials on research stations to adaptive on–farm experimentation with farmers. This latter approach not only sought to adjust emerging technology to the socio–economic circumstances of resource poor farmers in agro–ecologically marginal areas, but also to 'empower' farmers (Hagmann et al 1995; cf. Okali et al 1994). Experimentation with farmers in the Contill project not only revealed contradictory yield results from on–farm and on–station trials: the performance of different tillage techniques proved to be highly variable depending on soil, site and farmer–specific conditions. Hence, researchers concluded that given the diversity in agro–ecological and socio–economic conditions, 'different techniques and systems should be promoted as options' (Nyagumbo 1999: 114) as 'it is impossible to develop blanket recommendations' (Chuma and Hagmann 1995: 56)

The results further suggest that the most appropriate technologies from a technical point of view, such as mulch ripping, may not suit the circumstances of the majority of resource poor smallholders who lack both sufficient mulch and the animal draught power required to pull rippers.

FAITH–BASED CA:
THE EMERGENCE OF PLANTING BASINS AND GOD'S BLANKET

Unlike the conservation tillage technologies discussed above, the current drive to extend CA to African smallholder farmers is not well rooted in scientific experimentation. Rather it has its origins in a different epistemological tradition, building on the experience of one large–scale commercial farmer in Zimbabwe, Brian Oldreive, who developed a minimum tillage technology in the early 1980s (Oldreive 2009, 1993).

Oldreive was a tobacco grower, but as a newly converted Christian he considered tobacco cultivation unethical and switched to maize. Following two years of drought and poor harvests the banks made the next loan conditional on Oldreive returning to tobacco. However he refused, and as a result had to sell his farm. He then went to manage a farm in northern Zimbabwe where yields were declining. His experimentation with conservation tillage in the early 1980s was motivated by both costs and conservationist concerns:

> On this [large-scale, mechanized] farm the common practice was to plough very deeply after having burnt off all the stover from the previous crop. This caused the soil structure to break down and large clods, the size of footballs, were being ploughed up, which then had to be broken down with two harrowings and two rollings, which was very expensive. The soil structure had collapsed resulting in water running off the surface and the topsoil washing away. *Our costs were rising steeply, while our yields were going down...* (Oldreive 2009: 7 [emphasis added]).

Although Oldreive knew about zero–tillage and the American dust bowl his inspiration came from elsewhere:

> I would go into the virgin bush for times of prayer, and one day God began to reveal me His ways in nature (Romans 1: 19–22). There I saw that there is no mechanism in nature in which the soil is inverted and there is a thick blanket of fallen leaves and grass which covers the surface of the soil. I realized that these two factors in nature prevented the soil from being washed away (Oldreive 2009: 7).

As his mechanized no–till experiments with mulch gave positive results he increased the no–till area, and reversed the downward trend in production. Oldreive won several agricultural prizes, and approached the research community for advice on conservation tillage. Apparently, he was told it would not work in the region where he farmed (Oldreive 2009: 7). He nevertheless continued, and saw it as his Christian duty to extend the principles of conservation tillage to smallholder farmers, convinced that 'the same principles may be applied to any scale of operation' (Oldreive 1993: xi). Without mechanization or draught power, farmers could simply dig planting basins in the period before the onset of the season when there was little demand for labour. Whereas his handbook on conservation farming initially targeted farmers in the higher rainfall areas (Natural Regions II and III) (Winkfield 1993: v), the training and extension programmes Oldreive set–up – such as the 'Hinton Estate Outreach Programme' and 'Operation Joseph' (Twomlow et al 2008b: 3) – extended the principles of conservation farming throughout Zimbabwe through demonstration plots, training and extension leaflets. Without scientific testing under various agro–ecological circumstances, Oldreive's faith–based approach to CA, also known as Conservation Farming (CF) (Box 1), focused on planting basins or shallow planting furrows in conjunction with mulch ('God's blanket'), seeds, fertilizer and a cereal–legume rotation (Twomlow et al 2008b). Its promoters claim that CF is scale neutral and suitable across different agro–ecological circumstances, yet dependent on good management (Oldreive 1993; see also: IIRR-ACT 2005, p.ix) (Figure 2).

Figure 2 *Foundations for Farming (formerly: Farming God's Way) demonstration plot in Harare, 2010 (photo: J.A. Andersson)*

***Box 1** Definitions and descriptions of CA, CF, PCA, Basins and Zaï pits*

'**Conservation Agriculture (CA)** is a broader term that encompasses activities such as minimum tillage and zero tillage, tractor powered, animal powered and manual methods, integrated pest management, integrated soil and water management, and includes CF. …it is any tillage sequence that minimizes or reduces the loss of soil and water; operationally a tillage or tillage and planting combination which leaves 30% or more mulch or crop cover on the surface, equivalent to more than 3 t ha^{-1} of crop residues' (ZCATF 2008: 3).

'**Conservation Farming (CF)** refers to the particular technology of using planting basins and mulch cover which was developed by Brian Oldreive. This is a modification of the traditional pit systems once common in southern Africa and is a variation on the *Zaï* pit system from West Africa, which may also be considered as a CF technology' (ZCATF 2008: 3).

Precision Conservation Agriculture (PCA) was initially used by ICRISAT to refer to the hand–hoe, basins–based CA package as promoted through relief and recovery programmes in Zimbabwe. It is a modification of the CF planting basin approach that includes the precision application of small doses of nitrogen fertilizer (Twomlow et al 2008b: 3), 'irrespective of the quantity of surface residues retained as mulch', Twomlow et al 2008a: 41). As mulch is not required, it is not always considered CA.

The Sahelian ***Zaï* pit system,** described as an indigenous strategy for soil rehabilitation, originating from Burkina Faso (Roose et al 1999), combines water harvesting and targeted application of organic amendments by the use of shallow pits (diameter of 20–30 cm 10–15 cm deep) dug into the hardened soil (Fatondji et al 2001; Mando et al 2006). As no mulch is used, it generally not considered CA.

Planting Basins as promoted as part of CF and PCA in Zimbabwe are smaller than *Zaï* pits. Recommended dimensions are 15×15×15 cm, spaced at either 75×60 cm for Natural Region II and either 75×75 cm or 90×60 cm for Natural Regions III, IV and V (Twomlow et al 2008a, 2008b; ZCATF 2009: 37). In Zambia, farmers adapted Oldreive's planting basins by making them wider (30-40 cm) and deeper, breaking plough or hoe pans that may form at depth of 15–20 cm. As planting basins involve a degree of soil inversion, some do not consider it proper Conservation Agriculture.

Combining the promotion of the gospel and CF (Oldreive 2009), Oldreive's Foundations for Farming (formerly Farming God's Way) organization became a hub in a regional network of faith–based NGOs extending CF to smallholder farmers.[8] The inclusion of an adapted version of his CA approach in donor–funded relief and recovery programmes in Zimbabwe in 2004 (Twomlow et al 2008b) provided further legitimization, as it resulted in close collaboration with donors, NGOs and international research institutes. Participation in this emergent epistemic community arguably contributed to the profile and success of Oldreive's organizations.

FROM ADAPTIVE RESEARCH TO FAITH IN BLANKET RECOMMENDATIONS

The apparent epistemological contradiction between scientific experimentation and Oldreive's faith–based approach to CA can only be understood through an appreciation of Zimbabwe's political and economic crisis and the politics of humanitarian relief and development aid. While Zimbabwe's government had isolated itself internationally through a violent land re–distribution programme and the controversial 2002 presidential elections, the pace of the country's economic decline increased rapidly. In response to this and drought conditions in 2001/02 and 2002/03 (Andersson 2007), donors used NGOs to distribute food aid and seed for planting (Rohrbach et al, 2004b). These initial responses lacked coordination, but staff from the donors, NGOs, government and international agricultural research institutes soon began to work together through an Agriculture Coordinating Committee.

Coordination of short–term relief programmes was vested in the FAO emergency office. Donors such as the EU and USAID were only willing to fund short–term relief programmes that assisted people in re–establishing their livelihoods: they would not provide development assistance or actively collaborate with the government. Other donors, such as the UK's DFID were more concerned with the longer–term impacts of relief programmes (Rohrbach et al 2004a: 3, 35). In 2003 they began to add technical advice to fertilizer support aimed at poor and vulnerable farmers, including testing of ICRISAT's micro–dose fertilizer technology (Twomlow et al 2010). Subsequently, relief programmes became more encompassing and of longer duration, and the distinction between short–term relief and development became blurred, as reflected in the DFID initiated Protracted Relief Programme (PRP) of 2004 (PRP 2010). This programme, which channelled donor–funding to crisis–ridden Zimbabwe while minimizing direct collaboration with the country's government, evolved into a collaborative multi–donor and NGO initiative. Its main aim is to 'reduce extreme poverty in Zimbabwe'.[9] In this way new agricultural interventions were added to the relief agenda, including improving seed markets, the introduction of new open–pollinated varieties, improving extension advice, and enhancing farming and land use systems through CA. The FAO had become more involved in CA promotion a few years before, co-organizing the 1st world congress on CA in Spain in 2001 (Vaneph and Benites 2001).

Meanwhile, ICRISAT's monitoring of the seed relief programmes revealed that yields improved where fertilizer and technical support was provided alongside the seed. It was also found that access to draught power, rather than the availability of seed determined the area that poorer households could cultivate (Rohrbach et al 2004b). Such findings resonated well with ICRISAT's interest in the fertilizer micro–dose technology and planting–basins (with or without mulching) for water harvesting in semi–arid areas (Mazvimavi et al 2007). The basin technology was attractive because it appeared to enable farmers without draught power to plant early.

Within DFID and the FAO, both key organizations within the concerted relief effort for Zimbabwe, there was excitement about work being done on Conservation Agriculture in Zambia.[10] Inspired by Oldreive's planting–basins in Zimbabwe, the Zambian National Farmers Union had formed a Conservation Farming Unit (CFU) in 1995, 'to adapt the hand hoe basin system to Zambian conditions and to actively promote it among smallholders' (Haggblade and Tembo 2007:14–15). DFID and FAO initiated the Zimbabwe CA Taskforce (ZCATF), a broad based partnership in which the FAO, CGIAR institutes such as CIMMYT and ICRISAT, and Oldreive's River of Life Church play prominent roles (Twomlow et al 2008a, 2008b). Members of these different policy, scientific and religious institutions may thus be seen as institutionalising an epistemic community on CA. Funded by the EU and DFID, the CA taskforce monitors and disseminates information on CA to NGOs and government agencies, advocates for and coordinates research and training in CA, and has developed standardized CA packages for extension to smallholder farmers (ZCATF 2008; Twomlow et al 2008b). The River of Life Church, through its subsidiary Foundations for Farming, became an important training centre for NGO extension staff implementing the combined relief and CA efforts. Wide–scale CA promotion was further supported by demonstration plots, monitoring and evaluation and research undertaken by CGIAR institutes.

The specific CA package that was developed and promoted by this epistemic community – Conservation Farming (CF) – targeted vulnerable households with limited access to draught power. It encompassed four major principles: (1) a high management standard (for instance, frequent weeding and timely operations); (2) minimum tillage planting basins dug with a hand hoe to concentrate limited water and nutrient resources; (3) fertilizer micro–dosing to achieve higher nutrient efficiency (especially in areas where ICRISAT operated); and (4) improved seed for higher productivity (Twomlow et al 2008b). Notably, mulching (God' blanket), a major element in Oldreive's original CF work, is not stressed in taskforce or ICRISAT publications but is often actively promoted in the field by NGO staff trained by the River of Life Church. Labour–saving technologies such as herbicides and farm implements are not included in these combined food security/CA extension programmes, while input support is often conditional on the use of planting basins (Figure 3). In local vernacular CF is sometimes referred to as '*hondavation* agriculture' (*kuhonda* means 'to slim') or *diga–ufe* (dig–and–die) (Andersson et al 2011).

Figure 3 *'Have you come to bring me fertilizer?' asked this farmer on arrival of visitors. Fertilizer support is often conditional on farmers' digging of planting basins. Murehwa district, Zimbabwe, November 2010 (photo: Jens A. Andersson)*

UNDERSTANDING POLICY SUCCESS: CA AS THE ONLY WAY TO GO

The previous sections have described the institutional development of a distinct epistemic community around CA and the emergence of a particular CA policy package based on basins and mulching. While evidence-based policy is nowadays the watchword in development policy discourse, this standardized package (promoted by all but a few organizations) was a result of negotiations between research, faith-based and policy organizations. The basin/mulch package thus represents a disconnect with earlier science–based experimentation with minimum tillage which had revealed problems of mulching and the needs for a diversified farmer-oriented approach. This section focuses on the apparent policy success of the CF model in southern Africa, acknowledging that such success is not necessarily based on empirically verifiable facts which drive its own diffusion (Latour 1987) – e.g. that CA works in smallholder farming systems. As Rap (2006: 1304) has argued, policies and their success 'are subject to a continuing process of production and promotion aiming to mobilize and maintain political consent among the epistemic community to which they are directed and which they shape' (see also: Haas 1992). In addition, there is a material component, as the production of policy success requires the mobilization of substantial financial resources.

The concurrence of both processes – the promotion of policy and resource mobilization – is central for our understanding of the policy success of CA in southern Africa. Powerful international donors and agencies, including DFID and FAO, were critical to the formation of this epistemic community. First, they provided the resources that allowed its institutionalization in the Zimbabwe CA Taskforce. Second, their strategic position in the coordination of humanitarian relief enabled them to link CA promotion to the humanitarian relief effort. Third, in the process they extended and reformulated the aims of these humanitarian programmes, which in turn increased the resource base for CA promotion through them. Fourth, the engagement of international research organizations in the formulation, implementation and evaluation of combined input support and CA programmes had a significant if unintended legitimizing effect. While building on scientific work by international agricultural research institutes, the large–scale promotion CF provided scientific legitimization to Oldreive's faith–based approach.

At the level of policy implementation, monitoring and evaluation, the CF model has proven equally powerful. First, the input–supported extension practices have affected CF adoption rates among resource poor farmers, and confounded the effects of fertilizer application and CF (Mazvimavi and Nyamangara 2010). Claims of rapid yield increases thus feature prominently in the promotion of CA in southern Africa, while in capital-intensive systems elsewhere in the world (where fertilizer rates used are often higher), the benefits of CA mostly revolve around cost reductions and the possibility of an additional crop in the season. Second, the fact that CA is promoted as a package obscures the effects of individual practices and technologies. It also allows disappointing results to be explained away because of 'not implementing all components'. Third, and closely related to the last point is the inclusive nature of the CA policy discourse. While CA involves only three main principles, other agronomic practices and technologies are often claimed as CA practices. Examples are the FAO and Oldreive's emphasis on a high level of agronomic management (Figure 2, ZCATF 2009), and the adding–on of technologies such as micro–dosing ('Precision CA', Twomlow et al 2008a), agroforestry and bio–fuel crops as in the Zambian Conservation Farming Unit's definition of CA.[11] Thus, many different interventions can be sold to donors as CA. Fourth, to understand the policy success of CA for African smallholders requires an appreciation of the ways in which this epistemic community creates consensus. Festinger et al's seminal work on cognitive dissonance – an uncomfortable feeling caused by holding conflicting ideas simultaneously – provides useful insights. In *When Prophecy Fails*, Festinger et al (1956) analysed the responses of a cult group to the failure of their prediction that the world would end on a certain date. Instead of disintegrating, the group expanded, as members started to share their beliefs with others. Thus they gained wider acceptance and in doing so, reduced their own dissonance. Observations during one of the meetings of Zimbabwe's CA Taskforce suggest that a similar mechanism may be at work.

Some weeks after the first rains of the 2010/11 season the CA Taskforce meets in Harare. Among those gathering is Brian Oldreive as well as representatives of the FAO, CIMMYT, ICRISAT, USAID and Agritex (the national research and extension service). The meeting commences with an update on the CA strategy document as formulated by the taskforce. It is reported that it is with the Ministry of Agriculture, and that a CA strategy is expected to be officially launched in 2011.

Then, an ICRISAT scientist presents results of an ongoing panel study of Conservation Farming (CF) uptake in Zimbabwe. Started in 2004/05, this study of over 200 vulnerable households covered 15 districts across Natural Regions II to V (Mazvimavi and Dimes 2009; Mazvimavi and Twomlow 2009). The presentation focuses on the uptake of eight CA components during the 2005/06 to 2009/10 seasons: more than 20 per cent of households in the study have quit CF altogether, and with the exception of crop rotation, the uptake of seven other practices associated with CF shows a strong downward trend. Since 2005/06, the sharpest declines have been for winter weeding (from 87 to 46 per cent); mulch application (from 75 to 30 per cent); timely weeding (from 98 to 54 per cent); application of basal fertilizer (from 75 to 42 per cent); and application of top dressing fertilizer (from 92 to 60 per cent). The percentage of households digging planting basins reduced only marginally, from 99 per cent in 2005/06 to 86 per cent in 2009/10). A university professor at the meeting suggests that this is because farmers may get, or hope for, input support on the basis of having prepared basins. The meeting agrees with this interpretation.

In the ensuing discussion a representative of the River of Life church wonders whether the study is not misleading. He suggests that one dilutes uptake 'if you keep the same denominator when the numbers are decreasing.' Another taskforce member wants to know how uptake is measured, for instance in relation to mulching. Is it yes/no adoption or on a scale? An FAO representative suggests that since the relief efforts started, there has been a shift in the category of farmers targeted. By stressing that the emphasis of the CA extension effort is no longer on the poorest of the poor, he seems to suggest that this panel study is not (or no longer) representative for CA adoption in the country. *'These people are not even farmers!'* he exclaims, and the meeting agrees. Another member seems more concerned with moving forward: 'Let's accept that mulch is a problem, but let's look at ways to create mulch.' Concern is also raised about the distribution of the presentation. It is felt that the data may be misinterpreted as outsiders will 'not have the background info you give us here'.

Then, the meeting leaves the discomforting findings of the panel study and continues with the next agenda items: the institutionalization of CA in a governmental CA unit instead of the CA Taskforce; a new publication for a CA training module in agricultural colleges (Nyamangara and Matizha, 2010); and an update on imported CA equipment that is to be tested during the 2010/11 season.

Obviously, these observations are not representative for the whole epistemic community on CA, however defined. Yet, the dynamic that emerges from them illustrates how people with shared vested interests may respond to incongruent information, and gravitate towards a (new) public consensus. Confronted with evidence of farmers abandoning CA, the group did not question the value of particular technologies, but rather the commitment or 'mindset' of smallholder farmers.

Stewardship and changing mindsets: the legitimization of CA by higher powers

Although the use of chemical inputs such as fertilizers and herbicides has been central to the success of CA in large–scale agriculture, the positive ring of 'conservation' is a strong mobilizing force, both within environmental and the development circles. Soil conservation and better husbandry also resonate with the concept of sustainability. Further, the idea of conservation speaks to the religious psyche as stewardship is a central tenet in the Judeo-Christian tradition: people are the custodians of God's earth and should not despoil it (Passmore, 1974).

Several evangelical churches promote CA with what can only be described as missionary zeal, referring to the misguided ways of non–believers. Arguably, the convergence of religious discourse, environmentalism and development is most visible in the widespread call to change farmers' 'mindsets', as if those promoting and practising CA are the chosen ones, an enlightened group of pioneers who are breaking from the mould into new territory (FAO 2008a, 2008b). Thus, the less innocent aspects of the CA epistemic community come to the fore as the (scientific) professionals that legitimize CA policy portray 'non–believers' as unqualified, ignorant and intransigent, stuck in the 'mindset of the plough' and in need for 'conversion'. Such evangelical language is common in the literature promoting CA. The ACT Network website reports 'Currently more than 100,000 small–scale farmers in Zambia have *converted* to conservation agriculture (emphasis added)'.[12]

CONTESTING THE SUITABILITY OF CA IN AFRICAN SMALLHOLDER FARMING SYSTEMS

So why should CA not work in Africa? The simple answer is that it does, as evidenced by the uptake of CA on large-scale commercial farms in southern Africa during the 1990s (Giller et al 2009). The arguments concerning the potential benefits of CA for smallholder farmers have been rehearsed by Giller et al (2009), and in a subsequent electronic debate.[13] Here we address the question: is CA suited to the circumstances of smallholder farmers in Africa? However we are acutely aware that in addressing this question in general terms we run the risk of being trapped by our own arguments. Africa has a huge diversity of smallholder farms and farming systems (Giller et al 2011), in terms of soils, climate, crops, livestock and grazing areas, which makes any generalizations dangerous and potentially misleading. But having acknowledged this, poor productivity and a dominance of cereal crops, notably maize, typify smallholder farming systems where CA is being promoted actively and the discussion that follows therefore focuses on these.

God's blanket is rather thin… The problems of mulching

In CA, successful erosion control requires the soil to be covered with a mulch of organic matter. Mulching has a number of advantages: the erosive energy of rainfall is reduced as it is intercepted by the mulch; the mulch protects soil particles from being dislodged; and soil porosity tends to increase due to old root channels and the activity of earthworms and termites so runoff is reduced as most rainfall infiltrates directly into the soil. A thick layer of mulch can also help to suppress weeds. The retention of crop resides leads to increased soil organic matter that in turn enhances soil structure, infiltration and the supply of nitrogen for crop growth through mineralization.

In mechanized CA where fertilizer is used, it is largely crop residue that provides the mulch, although sometimes green manure crops are grown specifically to provide soil cover. But in African smallholder farming this is not so straight forward. The poor productivity of many smallholder farming systems means that the amount of crop residue produced is limited. Cereals such as maize often yield only 0.5 to 2 t ha^{-1} of grain and 1.5 to 3 t ha^{-1} of stover. A rule of thumb often used with CA is that 30per cent of the soil should be covered at the beginning of the cropping season (FAO 2008a) which requires roughly 2–3 t ha^{-1} of plant material (Giller et al 2009). Thus to ensure adequate soil cover all available crop residues would need to be returned to the soil, but in many situations this is impossible because of competing uses, most notably as livestock feed. For instance, farmers with cattle remove crop residue from the field at harvest and store it at their homesteads for use as feed.

Given the long dry season in southern Africa, any crop residue left in the field disappears between crop harvest and the start of the next season due to the action of termites (Baudron et al 2012). Termites can have positive benefits – in West Africa it was found that particular soil dwelling termites (*Odontotermes* and *Macrotermes*) improve nutrient release and crop performance on crusted soils (Mando 1998). These species are responsible for the formation of macropores in *Zaï* pits (Mando et al 2006: 393) which improves infiltration and capture of rainfall into the soil. However farmers in Zimbabwe complain that leaving maize residue as mulch attracts termites that, especially in drier areas or during dry spells, feed on the next crop causing lodging and yield loss.

Both the practice and benefits of reduced tillage and mulching are interdependent. Tillage helps to control weeds. In the absence of mulch, runoff and erosion can be exacerbated by not tilling the soil. Tillage increases surface roughness and infiltration, particularly if soils are poor in organic matter. Tillage also has other benefits: the soil disturbance stimulates a flush of mineralization releasing nitrogen from the soil organic matter which is then available for crop growth (Chikowo et al 2004). Thus not tilling can translate into yield penalties on poor soils (Guto et al 2011). Without a thick mulch cover, not tilling also leads to increased weed pressure.

Weeds – the Achilles' Heel of CA

Smallholder farming is labour–constrained due to seasonal peaks in labour demand. Inversion tillage with a mould–board plough is effective in burying and controlling weeds. Although reduced tillage may alleviate the peak labour demand for land preparation and planting, if herbicides are not available it increases the peak in labour demand at weeding. Especially on more fertile soils in hot areas, weed pressure can lead farmers to abandon up to a third of the area planted (Baudron et al 2012). Where weeding is primarily done by women, their labour burden may increase with reduced tillage (Giller et al 2009). Thus, the benefits of CA for smallholders are restricted by the expense and availability of herbicides and knapsack sprayers. Even in high–input, large–scale agriculture, weed control in CA is not without problems. In Australia, over–dependence on the herbicide glyphosate has led to build up of herbicide–resistant weeds, so that occasional cultivation is recognised as a better management option than no cultivation at all (Kirkegaard 1995).

CA–rbon sequestrated or overrated?

It is claimed that CA leads to increased soil carbon, but the scientific evidence is ambiguous. Two detailed meta–analyses failed to find consistent increases in soil organic carbon (SOC) with reduced or zero–tillage (Govaerts et al 2009; Luo et al 2010). It is well known that increasing the amount of organic residue returned to the soil increases SOC. This is why crop fertilization that results in greater residue production can increase SOC (Vanlauwe and Giller 2006). The effect of tillage on soil C is less clear however. Although soil disturbance causes a flush of microbial activity and mineralization of C and N, this effect is short–lived and the rate of decomposition falls back to that of undisturbed soil within a matter of days. This means that the stimulation of decomposition rates has a relatively small effect on SOC. As physical protection of soil organic matter depends on binding to clay particles or entrapment in aggregates, the effect of tillage on SOC is greater in clay soils, but there is little effect on the sandy soils which predominate in Zimbabwe (Chivenge et al 2007).

So why is it so commonly claimed that CA increases soil organic matter? On the face of it, simply measuring the effect of CA on soil C stocks appears to be a trivial problem: take before and after soil samples and measure SOC. And in many cases observers say they can see the difference – the top layer of soil is darker. But unfortunately, the situation is more complex than this. The lack of tillage leads to increased soil C in the surface horizons, whereas ploughing mixes organic matter into the surface 15–25 cm of soil. Thus the concentration of SOC is diluted. Further, untilled soil tends to become compacted and the bulk density increases. This means that sampling to the same depth in tilled and untilled soils may actually sample a different mass of soil leading to the artefact that there is more SOC with CA. Thus sampling on a soil mass basis appears to be the only way of ensuring valid comparisons of soil C stocks under different tillage treatments (Ellert and Bettany 1995).

There also seems to be a sweeping assumption with regard to soil organic matter that ‘the more the better’. But increasing the amount of organic matter inputs, particularly via legume green manures, can lead to crop loss due to infestation with cut worms (Chikowo et al 2004). These white insect grubs thrive when large inputs of readily decomposable material – either as mulch or incorporated – are added to soil. As the name suggests they cut the roots and can wipe out the following crop completely.

Crop rotations: an old problem resurfaces

A clear example of the mismatch between CA and smallholder agriculture relates to the third principle of CA, namely crop rotation, preferably with legumes. The technical benefits of growing legumes in rotation with cereals or root crops to break a monoculture are well–known (Giller 2001). As early as the late 1920s, the colonial Department of Agriculture promoted crop rotation in Zimbabwe's African farming areas (Kramer 1997), but uptake has proved problematic ever since (Baudron et al 2012). A standard recommendation is for one season of a grain legume to be followed by two seasons of cereals, which would require a third of the land area to be cropped to legumes. Yet, the labour requirement for the cultivation of common legumes such as groundnuts and Bambara nuts (*Vigna subterranea*) is higher than for cereals, and farming households need only a small area of grain legumes to meet their food needs. Unless there is a market for the extra produce there is little incentive to grown more legume grain than the household will consume.

CAWT by one's own petard

Recently the World Agroforestry Centre (ICRAF) has joined the push for what they are calling 'CAWT – Conservation Agriculture with Trees', or 'Evergreen Agriculture' (Garrity et al 2010). They propose various approaches for integration of mainly nitrogen fixing trees into CA. Some approaches, notably parklands where trees such as *Faidherbia albida* are maintained within cropped fields and managed for firewood and fodder, are common in West Africa and a few parts of East and southern Africa. Learning from the Conservation Farming Unit in Zambia, ICRAF now proposes to extend CA under *Faidherbia albida* and is providing tree seedlings to NGOs. Little regard seems to be taken to the ecology of *Faidherbia albida* – its reverse phenology means that crops under it are not shaded, but the tree has a full canopy during the long dry season when growth depends on its roots being able to reach a permanent water table. It is therefore unlikely that it will grow well in many of the areas where it is being promoted, where shallow soils predominate.

CONCLUSION

One of the most prolific authors on reduced tillage agriculture in Africa, Rattan Lal, once bemoaned the lack of organic residues and manure available in smallholder systems. In an editorial, he concluded:

> Under these conditions, loosening of soil by any tillage (manual by a hoe, animal drawn traditional and/or tractor driven mouldboard plow or sub–soiler) improves porosity and structural characteristics of a compacted soil, albeit temporarily. In addition, plowing also enhances mineralization of whatever little soil organic matter still remains in the soil. The enhanced mineralization releases essential nutrients (N, P, K), which also improves plant growth especially in traditional agriculture where chemical fertilizers are rarely or minimally used. …. *resource–poor farmers will have to continue practicing plow tillage while fully realizing that it is not a sustainable practice.* (Lal 2007; emphasis added)

Other authors have also highlighted how little consideration is given to what Sumberg (2005) calls 'adoption constraints that are endogenous to the fit between the innovation and the target group', or … whether … [CA] 'actually fulfils a concrete need from the point of view of targeted smallholders' (Bolliger 2007). Yet others continue to propose the best approaches to promote and extend CA (e.g. Kassam et al 2009) without questioning *if* (where and for whom) modified tillage systems and the CA 'package' are indeed appropriate.

The aim of this chapter was neither to add to nor resolve contestation around the agronomic basis of CA. Rather, the focus was on the ways in which science, development policy and religion have become intertwined. One result of this is that questions about the workings and appropriateness of CA are labelled 'irrelevant', and farmers' tillage practices are labelled as 'ignorance'. Thus, this chapter has illustrated the silencing effects of a powerful epistemic community as it pursues a specific policy enterprise. This represents a rupture of the trend towards more farmer–oriented, participatory approaches to technology development.

Although CA promotion in southern Africa may be regarded as an extreme case, the analysis demonstrates that agronomic knowledge is produced within a particular political arena. Agronomy and agronomic research are not apolitical. This case of CA promotion in southern Africa demonstrates the power of an epistemic community when it becomes institutionalized. With its policy enterprise financed by development–oriented donors and policy organizations, and producing knowledge that is sanctioned by higher powers (God), such an epistemic community may operate largely independent of state institutions, yet strongly influence national policy. The widespread endorsement of CA by governments in southern Africa evidences this dynamic (FAO 2009).

While CA increasingly dominates debates about agricultural development in Africa, we wonder whether international organizations should be so active and univocal in their promotion of CA. Although supported by some committed and sincere scientists and development practitioners, only time will tell whether the missionary zeal of the 'blanket salesmen' warranted the disregard of farmers' practice.

NOTES

1 This is the most widely accepted definition, although there is considerable confusion and many different approaches and practices are referred to as CA (Giller et al 2009).

2 For instance, in Zimbabwe alone the FAO channeled some USD 20 million to smallholder CA projects during the period 2008–2012 (FAO 2010: 49–50). This figure is an underestimate as it excludes natural resource management and food security projects that also promote CA.

3 See: http://kenya.careofcreation.net/. See also: http://www.farming–gods–way.org/; http://www.foundationsforfarming.org/ (visited 29/03/2011). The notion of *Man's Responsibility for Nature* (Passmore, 1974) or environmental stewardship, is a particular interpretation of the statement in Genesis (1:26) that God gives man dominion over all creatures. Proponents of this view, which include faith-based organizations promoting CA, differ from 'deep ecologists' (Naess, 1973) who reject the inherent anthropocentrism of this perspective.

4 Although their academic and professional backgrounds may vary, members of an epistemic community have shared sets of normative, principled and causal beliefs, shared notions of validity, and a common policy enterprise (Haas 1992: 3). Members of an epistemic community may thus be regarded as sharing a particular mindset.

5 As the opening quote suggests, Friedrich and Kassam (2011) appear to define as sustainable those situations in which natural soil formation rates are equal or higher than soil erosion rates.

6 'The plough is an enemy of sustainability… [To] suggest its adoption as a possibility seems to be based on the fact that ploughs gain adoption easily. So does Fast Food, but it's not necessarily a good thing.' Personal communication, Robert M. Boddey, Embrapa Agrobiologia, Brazil (email, 23/9/2008).

7 Unlike ploughing, ripping does not involve soil inversion, but merely the opening of the soil. Mulch ripping involves ripping mulch-covered soil. The no–till tied ridging technology makes use of ridges that are cross–tied at regular intervals with small dams. The basins thus formed between the ties and ridges prevent water from flowing off the field. Once the ridges are established the land is not ploughed for a number of years.

8 See: http://kenya.careofcreation.net/ and www.farming–gods–way.org, which incorporates activities of the South African Bountiful Grains Trust. Other examples include the 'Growing Nations' organization in Lesotho. See: www.new–ag.info/focus/focusItem.php?a=485 (all visited, 20/11/2010).

9 www.prpzim.info (visited 01/05/2011)

10 Personal communication, Steve Twomlow, former ICRISAT scientist (e–mail: 6/3/2011).

11 See: www.conservationagriculture.org/CFU/ (visited 4/5/2011).

12 http://www.act–africa.org/ (visited 2/3/2011).

13 http://conservationag.wordpress.com/2009/12/01/ken–gillers–paper–on–conservation–agriculture/ (visited 16/06/2011).

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