Climate Smart Agriculture: Can It Be Achieved?

The following paper was submitted as the main assessment for the course 'Climate Resilient Development' in partial fulfillment of the requirements for a Master of Science degree in Climate Change and Development, from the University of Sussex.

1.0 Introduction

The changing climate is hitting smallholder farmers hard. It is doing so especially in the African continent which is regularly pronounced as most vulnerable to the impacts of climate change (Newsham and Thomas, 2009; IFAD, 2012). Climate change brings droughts and floods, pests and diseases; it means poorer crops, less food, and lower incomes. Added to which, it also accelerates land degradation. With two-thirds of the world's poor depending upon the land, their livelihoods are at risk (World Bank, 2011a). The impact of climate change also has repercussions that extend far beyond the supply of food. Agriculture accounts for twenty-nine percent of the Gross Domestic Product (GDP) in developing countries, and it provides employment for sixty-five percent of their populations (Smith, 2011). Hence, the economic health of these countries is closely linked to the fortunes, or misfortunes of farming communities.

The aforementioned impacts can all be attributed in part to the rapid increase in greenhouse gas (GHG) emissions from human activities. With developing countries experiencing unprecedented levels of economic growth, there is mounting concern that future growth in energy demand and the accompanying increase in GHG emissions will be dominated by these countries (OECD, 2002; IEA, 2012). As such, reducing these emissions has become one of the cornerstones towards a future international climate change agreement under the United Nations Framework Convention for Climate Change (UNFCCC). However, imposing caps to developing countries' GHG emissions has met strong resistance in past negotiations, as caps are perceived as a constraint to future growth prospects (Linares and Pueyo, 2012). Hence, there has been a race to find new, unconventional initiatives to avert the rising emissions.

In recognition that agriculture is not only a victim and villain (Hedger, 2011), but also a potential solution, in relation to climate change, one possibility that surfaced at the international arena was that of sequestering carbon dioxide into soils using an approach known as 'Climate-Smart Agriculture' (CSA). First coined by the Food and Agriculture Organization (FAO), CSA is defined as '*agriculture that sustainably increases productivity, resilience, reduces or removes GHGs, and enhances achievement of national food security and development goals*' (FAO, 2010). In other words, CSA strategies are those that achieve so-called 'triple wins' of adaptation, mitigation and development (Naess, 2011). Despite the growing momentum and support for this integrated approach which aims to bridge agricultural adaptation to, and mitigation of, climate change, policy actions have been slow to materialize at the global level; as many countries continue to greet this initiative with strong resistance (Asaduzzaman, et al., 2012).

It is against this backdrop that this paper seeks to examine whether CSA can be achieved in practice. To inform this discussion, this paper engages with the growing body of literature on CSA in order to dissect the underlying issues which have led to modest progress in its adoption. In particular, this paper focuses heavily, though not exclusively, on empirical evidence from Sub-Saharan African countries. The rationale for doing so inherently relates to the limited availability of applicable literature on this topic, which happens to be concentrated within that region.

Alongside this introduction, this paper also sets out to highlight the proponents' perspectives in relation to the climate-smart vision. As such, this section examines how agriculture may be considered both a problem and a solution to climate change. The latter is demonstrated with the use of concrete examples emerging from a suite of developing countries claiming to represent local successes of the approach.

The remainder of this paper directs its attention to the emerging critiques that oppose the CSA approach. While this section essentially synthesizes the broader challenges and insights noted by critics, emphasis is placed on assessing whether the adoption of 'no-till agriculture', (one of the main Conservation-Agriculture (CA) practices actively promoted under CSA), is capable of generating the 'triple-win' in reality.

Finally, based on the balance of evidence gathered, this paper will culminate in determining not only the extent to which CSA can be achieved in practice, but also, whether the proposed interventions, and the main actors driving the agenda, have in their vested interests the needs of smallholder farmers.

2.0 Agriculture: A Problem and a Solution?

According to Hedger (2011), agriculture is both a victim and villain in relation to climate change. The sector represents a victim based upon estimates indicating that climate change is likely to reduce agricultural productivity, production stability, and incomes in some areas that already experience high levels of food insecurity e.g. South Asia and Sub-Saharan Africa (Branca, et al., 2012). On the other hand, agriculture is also considered a villain in that the sector signifies a key source of GHG emissions: it is the largest source of global emissions for nitrous oxide, as well as carbon emissions from land use change. Overall, agriculture directly accounts for 14 percent of global emissions, or approximately 30 percent when considering land-use change (IFAD, 2011, 2012; World Bank, 2011b). It is within this context that FAO (2010) suggests that agriculture in developing countries must therefore undergo a significant transformation in order to meet the related challenges of achieving food security and responding to climate change. Despite its significant contribution and vulnerability to climate change, agriculture may still play a critical role in the search for a global solution. In fact, as indicated by Gattinger, et al. (2011), there is considerable potential for soil carbon storage which can be realized in most developing countries where coincidentally, 74 percent of all agricultural emissions originate.

It is on this premise that the unifying concept of climate-smart agriculture emerged with the hope of integrating the issues of food security, poverty, climate change and environmental sustainability. As suggested by the World Bank (2011c), CSA includes proven practical techniques including: agroforestry, crop rotation, mulching, conservation agriculture, intercropping, integrated crop-livestock management, improved grazing, and improved water management, each of which may contribute towards achieving a triple-win for food security, adaptation and mitigation.

Moreover, a number of concrete examples have demonstrated that CSA is already at work in many parts of the world. For instance, in Niger, agroforestry techniques applied on five million hectares have benefited over 1.25 million households, increased grain yields by an extra half-million tons, and sequestered carbon (World Bank, 2011c). Likewise, in Zambia, CA has enabled many farmers to double their maize yields as well as adapt to climate change: as the organic matter afforded by this technique protects the soil from high temperatures thus reducing water needs of crops by as much as 30% (World Bank, 2011c; Smith, 2011). Additionally, in Kenya, the first agriculture soil carbon sequestration pilot project (Kenya Agricultural Carbon Project - KACP) is presently underway. This project, implemented by the World Bank currently engages with 60,000 Kenyan farmers, and is geared towards mitigating climate change, supporting adaptation and increasing food security through various land management interventions (Suppan and Sharma, 2011). Furthermore, this project is estimated to generate a total of 1.2 million metric tons of carbon dioxide by the end of its twenty year lifecycle (Braimoh, 2013; World Bank, 2011c).

3.0 Climate Smart Agriculture: Trojan Horse or Triple Win?

While on the surface the approach of CSA appears to resonate well with the demands of farmers and civil society organisations (as evident from the examples cited), linking agricultural production and climate resilience objectives with carbon sequestration objectives has been met with great skepticism, concern and even outright opposition at the global level. To this end, a number of critics have argued that the climate-smart vision is fraught with a multitude of problems.

3.1 The Many Faces of Climate-Smart Agriculture

Amongst the most pressing concerns relate to the economic viability of climate-smart practices. In general, the design and implementation of land management interventions require large financial investments, and the World Bank has proposed that this should come from carbon markets (Sivakumaran, 2012). While soil carbon sequestration is currently excluded under the Clean Development Mechanism (CDM), critics have expressed fear that the potential expansion of carbon markets to accommodate this could spell disaster for smallholder farmers. In particular, they question the viability of carbon markets, and more importantly, whether its payments to farmers would be more than symbolic (Naess, 2011). Using the Kenyan Agricultural Carbon Project as a reference point, Maryknoll (2012) emphasized that the promised rate of return for smallholder farmers under this model is miniscule. It is important to note that, while the pilot project in question estimates to earn $2.5 million from carbon credits, high start-up and transaction costs will absorb a significant share of the expected revenues (Suppan and Sharma, 2011). With 60,000 Kenyan farmers participating in this pilot project over a 20-year lifecycle, the project is only estimated to receive an average of $22.83 USD, or about $1 USD per farmer per year; assuming stable carbon prices of $4 USD/tCO2 (Pearce, 2011; Maryknoll, 2012; Sivakumaran, 2012). In light of such negligible financial returns, this paper therefore questions the practicality in replicating this approach elsewhere. To this end, Sivakumaran (2012) has noted that the World Bank's case studies used to demonstrate the success of CSA all received a large amount of financing which would not be provided for similar projects adopting CSA. In the absence of the World Bank's financial support, Sivakumaran posits that this model is simply not replicable for other African countries. This has therefore led ActionAid et al. (2011) to conclude that such projects are either financially unviable, or would require public finance to sustain.

However, resorting to public finance to meet initial investments has raised yet another crucial concern among critics. As such, many have argued that CSA is politically unjust, as it shifts the responsibility of mitigation onto developing countries, and in particular, smallholder farmers (Maryknoll, 2012). Further, some also believe that the shared-vision of CSA is biased towards mitigation efforts, which is in danger of diverting developed countries' attention away from their adaptation funding commitments. As cogently pointed out by Anderson (2011) and TWN (2012), CSA could potentially undermine farmers' rights, adaptation strategies and adaptation finance.

The concerns and doubts surrounding CSA interventions are indeed far-reaching. As such, another concern raised by critics relates to the common misconception that CSA practices; inclusive of Conservation Agriculture (CA), are agro-ecological. As indicated by both TWN (2012) and Zundel (2012), CSA is certainly not agro-ecological, since it undermines the fundamental strength and social benefit derived from agro-ecology: agro-ecology does not need to be combined with other approaches that use fossil-fuel based chemicals, hence, it reduces farmers' dependency on external inputs. Added to which, its profits tend to be decentralised. However, as argued by critics, CSA approaches are closely linked to the actors who promote fertilisers, pesticides and industrial agriculture. In other words, the adoption of CSA interventions can lead to a lock-in and dependency upon these external resources. To this end, Thibodeau (2011) purports that CSA practices are therefore being disguised and packaged as an agro-ecological image, in order to facilitate the consolidation of profits by agro-corporations.

Furthermore, as CSA proponents continue to claim that CA is the panacea for the problems of poor agricultural productivity and soil degradation (Giller, et al., 2009), a growing body of scientific evidence equally contradicts these claims. In particular, critics have persistently challenged the notion of no-till agriculture as a CA practice, and more specifically, whether it is capable of delivering a 'triple win' in reality. As the term implies, no-tillage or zero-tillage, is a soil cultivation system in which seeds are deposited directly into untilled soil (Gattinger, et al., 2011). From an adaptation standpoint, the practice of no-till appears to resonate well with many critics who endorse its ability to reduce erosion, improve soil structure, and enhance water retention. These properties they posit, can increase farm systems' resilience and improve the capacity of farmers to adapt to climate change (Branca, et al., 2011; Gattinger, et al., 2011). However, as a counter-argument to this, Cannon and Mueller-Mahn (2010) suggest that, since CSA approaches focus specifically on making farming more 'climate resilient', this can result in the system losing resilience in other ways. They further stress that CSA interventions can therefore depoliticize the casual processes which put people at risk. In particular, both Giller, et al. (2009) and Zundel (2012) have indicated this to some extent, noting that no-tillage can create an extensive weed problem which increases farmers' dependency upon herbicides. Where such inputs are not accessible, no-tillage can also mean decreased labour-saving due to the requirements of weeding; and as noted by Giller, et al., (2009), this can have adverse gender effects particularly on women who take up this additional role.

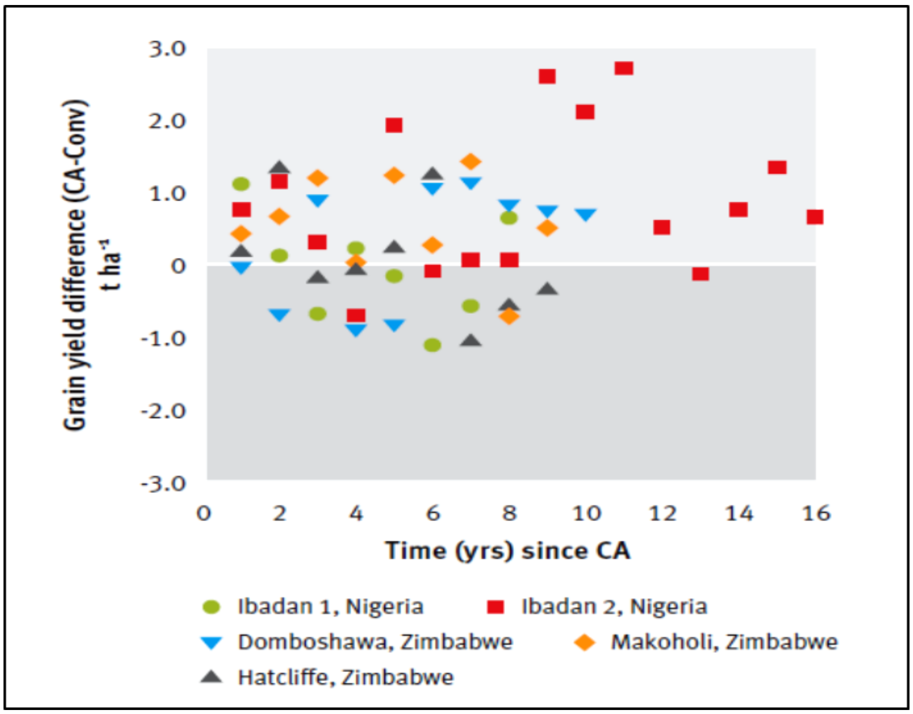

Figure 1: Maize grain yields (t ha^{-1}) under conservation agriculture practice compared with conventional tillage over time (Gattinger, et al., 2011)

It is a common assumption among CSA advocates that the resultant soil properties associated with no-tillage should provide a basis for higher crop yields. However, as pointed out by Giller, et al. (2009) and Gattinger, et al. (2011), the introduction of no-tillage can generate no yield benefits or even yield reductions during its first few years. For example, six years of no-tillage with the application of herbicides produced only marginal improvements in the yields of wheat and lentils in Ethiopia (Erkossa et al., 2006 cited in Giller, et al., 2009). Similarly, as Figure 1 illustrates, maize yields also varied over the first five years of no-tillage in both Nigeria and Zimbabwe. According to Branca, et al. (2011), the full benefits in terms of more stable yields would only be realized in the long-term, whereas investments are incurred up-front.

Moreover, a parallel concern raised by Sivakumaran (2012) and Conway, et al. (2011) is that it is often assumed that if CSA can increase food production, this may lead to higher global food security. However, as they both pointed out, this relationship is not direct, especially since the majority of food producers also comprise the majority of food insecure. In other words, while increased productivity is necessary, it is not sufficient to ensure food security (access to affordable food). On this premise, this paper posits that strategies such as CSA need to find ways not just of steering people towards climate resilient pathways, important though this is, but they also have to contribute to addressing the underlying issue of food insecurity. As suggested by Sivakumaran (2012), CSA programmes must therefore provide mechanisms that guarantee higher incomes and improved livelihoods for the poorest in order to overcome the wider challenges of hunger and malnutrition; rather than focusing solely on increasing food productivity.

Furthermore, in relation to the mitigation goal of CSA, issues surrounding soil carbon quantification have also emerged within the current discourse. Notably, for the mitigation benefits of CA techniques to be realized, this would depend on the level of accuracy involved in Monitoring, Reporting and Verification (MRV) of soil-carbon sequestration. However, as noted by several critics (Anderson, 2011; Paul, 2011), soil carbon measurements are highly complex and contested; especially since sequestration rates vary among soil types and depths, and the fact that carbon storage can be easily reversed through farming practices e.g. ploughing (Branca, et al., 2011). As indicated by Suppan and Sharma (2011), the World Bank's pilot study in Kenya would depend upon computer-based models rather than actual soil sampling to deduce sequestration measurements. This they argue would not reflect an accurate representation of the soil conditions, as models are based on inherent assumptions/ limitations, and down-scaling can further amplify errors. Given such complexities, this paper argues that the mitigation pillar of CSA remains stifled with technical uncertainties, which may therefore diminish its contribution and any assurance towards a 'triple-win'. In other words, without scientifically robust MRV, the mitigation goal remains highly questionable.

In addition to the difficulties noted with MRV, some critics have also questioned the outright sequestration capacity afforded by no-tillage. While CA advocates maintain that no-tillage combined with residue mulching reduces carbon emissions since the soil remains undisturbed, discouragingly, recent empirical evidence appears to refute this claim. In particular, Giller, et al. (2009) and Gattinger, et al. (2011) have highlighted that this notion is flawed since it is largely based on studies of carbon change restricted to the upper 10 cm of soil; where soil organic matter (SOM) is likely to accumulate. Given the lack of soil-mixing under no-tillage, these critics have argued that the CA benefits of overall increases in SOM may therefore be overestimated. To this end, it is worth noting that a recent meta-analysis of soil carbon storage under CA has revealed no carbon benefits, and even carbon deficits at depths below 20 cm; thus confirming the stratification of SOM in the top soil only (Giller, et al., 2009). On this premise, critics have determined that it is not conclusively proven whether reduced tillage leads to increased SOM contents and enhanced soil fertility. Hence, the potential contribution to carbon sequestration and reduced emissions under no-tillage remains questionable.

The concerns regarding no-tillage extend far beyond its sequestration capacity. In particular, since no-tillage currently comes packaged with monocultures, genetically modified (GM) crops, and extensive herbicide usage, Naess and Newell (2012) have expressed fear that investments in this technique will be skewed away from the concerns of the poorest and towards large-scale agriculture. Moreover, the fact that the FAO has called for the inclusion of offsets from no-till agriculture (despite its uncertainties and inconclusive situation), reinforces this bias towards large-scale agriculture. As suggested by Ernsting, et al. (2009), the FAO's recommendation clearly reflects vested interests in GM crops and the biotech industry at large. While GM crops have not yet been formally proposed for offsetting, it is worth noting that large agri-businesses such as Monsanto already claim that their Roundup Ready GM crops should be eligible for carbon offsets. They argue that the application of their glyphosate herbicide on their herbicide-tolerant GM crops, reduces tillage for weeding, and therefore reduces loss of carbon emissions from the soil (Anderson, 2011).

Although offsets from soil sequestration are currently excluded from carbon markets, critics warn that a future inclusion could potentially intensify the land grab epidemic already taking place in Africa (Anderson, 2011;Maryknoll, 2012; Sivakumaran, 2012; TWN; 2012). Such intensification may also lead to subsequent displacement of smallholder farmers who currently lack land tenure security, thus reinforcing their marginalization (Sivakumaran, 2012). Additionally, as cautioned by Pearce (2011), the continuous promotion of no-tillage may also facilitate a lock-in and increased dependency of marginalized farmers upon external inputs. Added to which, linking agriculture to carbon offset schemes may lead to farmers cultivating only what is incentivized rather than their traditional crops.

3.2 Adoption Does Not Guarantee a Triple-Win

Based on the critical insights presented in this paper, it is evident that the potential of no-tillage to guarantee a triple-win remains questionable and bounded by uncertainties. Moreover, this paper has recognised that CSA interventions in general are mainly driven by particular actors (donor agencies and NGOs), and while these proponents continue to advocate for the scaling-up and replication of best practices, this will with no doubt conform to the vested interests of multi-national corporations as oppose to smallholder farmers. Like the many opponents of CSA, this paper is inclined to agree that, expanding carbon markets to include soil sequestration will result in soil being treated as a commodity, rather than a necessity for food security; thus leading to competing goals and evitable tradeoffs.

In light of the overwhelming concerns noted in this paper, the proponents of CSA have called for potential reforms to be made in order to foster widespread adoption of climate-smart practices. According to Naess (2011) and FAO (2011a,b), the uptake of CSA interventions would be contingent upon stronger political leadership, supportive and coherent government policies and strategies, land tenure arrangements that make investments worthwhile, as well as access to markets and inputs. Moreover, the provision of financial support for smallholder famers is also considered a crucial requirement during the transition towards CSA. In particular, FAO (2011a) has indicated that the introduction of credit programmes or subsidized programmes would be necessary to enable farmers to overcome one-off investment barriers. However, given that the returns to agriculture might be accrued only in the long-term (as evident with no-tillage), some form of financing to support farmers during this transitory phase would also be necessary (FAO,2012). To this end, the proponents have suggested a broad range of instruments to support farmer's income. Such activities include: upfront payments for environmental services, the development of alternative income sources e.g. handicraft or the establishment of agricultural processing activities that can generate employment, and access to productive social safety nets. The latter as posited by FAO (2010), represents a form of social insurance for farmers, and possible programmes include: cash transfers, food distribution, seeds and tools distributions, and conditional cash transfers.

Although these recommendations and reforms are appealing, whether they will foster widespread adoption of CSA interventions still remains to be seen in practice. This is especially because the current evidence of CSA adoption has been restricted to pilot studies driven by overwhelming donor support. In addition, this paper also posits that the uptake of CSA practices would not guarantee the delivery of environmental and economic benefits for smallholder farmers. In other words, adoption of CSA interventions does not necessarily imply the achievement of the triple-win goals. This notion is inherently based on the premise that there are too many open questions and uncertainties concerning the impact of CA practices on crop yields and carbon sequestration. Given that the current body of scientific literature does not substantiate the high expectations of these practices, the present and future role of CSA interventions remains questionable.

Furthermore, while the proponents of CSA maintain that equipping smallholder farmers with the necessary building blocks may help to facilitate widespread adoption, this still does not dismiss the grievances that such an approach can essentially undermine farmers' interests and the very goals the vision sets out to achieve. After all, CSA continues to be touted and packaged as an agro-ecological image, but in reality, its principles are underpinned by industrial agricultural practices; a strategy that can potentially do more harm than good for smallholder farmers. Moreover, this paper strongly argues that, the local successes portrayed by the donor community are far from being unbiased reference points in deciding whether CSA can actually exist beyond the project level; let alone, independent of donor support. At the same time, it has been recognised that the proponents in their call for potential reforms have continued to overlook the more critical issues of social injustice imposed upon farmers in their responses to emerging criticisms; thus leaving more questions than answers within the CSA discourse.

To this end, this paper maintains that while the prospects of CSA are appealing, they remain contentious. It is for this reason that this paper opines that the bigger question smallholder farmers may now have to ask themselves is whether the uptake of CSA practices will foster the kind of transformation in farming systems and livelihoods that are in their vested interests, or will it result in an increased dependency upon external inputs, and reinforced perpetual poverty? Given that CSA is still within its infancy stage, the answer to whether it can be achieved in practice is one which remains largely indeterminate. Nevertheless, the balance of evidence offered in this paper has presented an illuminating glimpse of what a future with CSA might hold. From all indications, the climate-smart vision, as currently packaged, does not appear have in its vested interests the needs of smallholder African farmers, but rather, those of multi-national corporations.

4.0 Conclusion

This paper sought to examine whether the shared vision of a climate-smart agriculture can be achieved in practice. In light of the ideas and arguments presented, this paper suggested that the achievement of the climate-smart vision is one that remains largely indeterminate.

This outlook was based on the premise that each of the triple-win goals, though appealing, was highly contentious. In particular, the findings presented clearly demonstrated that the current scientific evidence available did not substantiate the high expectations of CA practices such as no-tillage. In effect, there were too many open questions/ concerns, scientific uncertainties and inconclusiveness surrounding the triple-win goals of mitigation, adaptation, and food productivity/ security. To this end, this paper suggests that there is a need for more robust evidence to be generated in order to improve the validity of the triple-win claims, especially those related to soil carbon quantification / sequestration capacity, and the influence of CA practices on crop yields.

Additionally, it should be noted that the overall conclusion made in this paper was not driven by the level of scientific uncertainty alone. In fact, the wider socioeconomic concerns of farmers' marginalization, weak viability of carbon markets, and speculative land grabbing also contributed to the skepticism in determining whether widespread adoption of CSA would actually benefit smallholder farmers. Unfortunately, based on the balance of evidence in this paper, the key actors leading the CSA agenda do not appear to have in their vested interests the needs of smallholder farmers, but rather, those of large, multinational corporations. In this regard, it is doubtful that the climate-smart vision as currently packaged can lead to a transformation in farming systems and livelihoods without undermining the sovereignty of smallholder farmers.

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