Constraints to adoption and scaling-up of conservation agriculture in Rwanda: Smallholder farmers' perspectives

Kazuyuki Sasaki and Serge Muvunyi
Centre for Research and Action towards Sustainable Peace and Development ‐ Protestant Institute of Arts and Social Sciences, Rwanda

Abstract

In the face of the formidable challenges posed by climate change, there is growing concern that the goal of food security for all must be pursued in a climate-resilient and environmentally sustainable manner. Conservation agriculture (CA) has been drawing increasing recognition as a climate-smart farming system that addresses the interconnected challenges of food security and climate change. Drawing from a case study of smallholder CA practices conducted in four different areas in eastern and southern provinces of Rwanda, this paper discusses key constraints to the adoption and scaling-up of CA as perceived by smallholder farmers in these areas. These constraints range from those stemming from farmers' limited access to agricultural resources and services necessary for productive CA, to those posed by the government's programme for agricultural intensification and commercialisation that considerably limits farmers' choices with regard to the farming system and methods they may adopt. This paper proposes the allocation of considerable resources to address resource and service-related constraints suffered by smallholder farmers. It also calls for attention to be paid to the limitations caused by government policies. Together, these proposals encourage continuous effort to be made in policymaking and implementation to give smallholder farmers more space and increased support for experimenting, adopting, and expanding a farming system with greater productivity and climate resilience.

Keywords: agricultural intensification, climate change, adaptation and mitigation, conservation agriculture, climate smart agriculture, smallholder farmers, Rwanda

1. Introduction

In the face of the formidable challenges posed by climate change, there is growing concern that the goal of food security for all must be pursued in a climate-resilient and environmentally sustainable manner. Revolving around three core principles of minimising soil tillage, covering soil with organic materials, and diversifying crops in time and space, conservation agriculture (CA) has been drawing increasing attention as a sustainable farming system that addresses the interconnected challenges of food security and climate change. The government of Rwanda acknowledges the potential importance of CA, as evidenced by the recent establishment of the Rwandan Institute of Conservation Agriculture (RICA) as well as the official recognition of CA as a form of climate-smart agriculture (CSA) in the most recent strategic plan for agricultural transformation published in June 2018 (MINAGRI 2018). However, in reality, it is in its early stages of adoption and has primarily been promoted through relatively small-scale initiatives carried out by non-governmental organisations (NGOs).

In recognising the significance of CA for resolving food insecurity issues experienced by smallholder farmers in the face of increasing climate variability in Rwanda, this paper presents and discusses key findings from a case study of smallholder CA farmers who are participants in NGO-led CA focused food security projects. The case study was conducted from September 2019 to February 2020 in four rural areas in the eastern and southern provinces of Rwanda in order to address two primary questions:

- To what extent and in what particular form has CA been adopted by smallholder farmers in the study areas?
- What are, from the perspective of CA farmers, the major constraints to adopting and scaling-up CA, specifically in the context of smallholder farming in Rwanda?

Our fieldwork yielded eight themes that smallholder CA farmers in the study areas perceived as significant factors in preventing CA from being more widely adopted and scaled up in the context of smallholder farming in Rwanda. The first six themes are closely linked to smallholder farmers' limited access to agricultural resources and services that are necessary for productive CA. The last two themes stem from the government programme for agricultural intensification and commercialisation under the Crop Intensification Programme (CIP), which considerably limits farmers' choice regarding the farming system and methods they may adopt.

Based on the findings of the case study and, specifically, the eight themes that our fieldwork yielded, this paper proposes that the government and other organisations concerned with the agricultural sector should allocate considerable resources to address the constraints smallholder farmers face due to their limited access to agricultural resources and services necessary for productive CA. It goes on to emphasise the necessity of addressing the constraints stemming from government policies so that continuous effort will be made, both in policy making and implementation, to give smallholder farmers greater space and increased support for experimenting, adopting, and expanding a farming system with greater productivity and climate resilience in years to come.

2. Rwanda's agricultural reform and the interconnected challenges of food security and climate change

2.1. The Crop Intensification Programme as the centrepiece of agricultural reform

As one of the most densely populated countries in Africa, Rwanda faces interrelated problems of increasing land scarcity, rural poverty, and food insecurity. Over 70% of the Rwandan population engages in subsistence or semi-subsistence agriculture, in which smallholder farmers, with an average landholding of 0.6 ha, produce diverse food crops (NISR 2016). In 2008, the government of Rwanda launched a Crop Intensification Programme (CIP) as the centrepiece of its policy for transforming traditional subsistence farming into a modern, market-oriented type of farming. The CIP has two principal aims: 1) increasing agricultural productivity through the use of purchased inputs, and 2) achieving economies of scale through the production of single commercial crops, determined by the government, on larger consolidated land plots. The type of farming system promoted under the CIP is characterised by a monoculture of market-oriented crops with increased use of improved seeds, mineral fertilisers, and crop protection chemicals (Cantore 2011).

More than ten years have passed since the introduction of the CIP, and the government emphasises its positive contributions towards increased agricultural productivity, improved food security, and reduced poverty. The implementation of the CIP in the first few years, from 2008 to 2011, resulted in a sharp rise in the production of priority crops. Maize production increased five-fold, wheat and cassava three-fold, Irish potatoes, soybeans, and beans by about two-fold, and rice by 30% (Kathiresan 2011:16). Between 2008 and 2016, the average annual food crop growth rate was 5.65% (MINAGRI 2018). The sharp rise in food production induced by the CIP and related agricultural reforms in the agricultural sector is believed to have significantly contributed towards poverty reduction and enhanced food security. This occurred not only through increased food availability in the local markets and increased incomes from higher food crop sales but also through increased off-farm employment opportunities in rural areas (Kathiresan 2011:17).

2.2. Conservation agriculture as a response to the interconnected challenges of food security and climate change

Despite the remarkable gains in food production, food security remains a serious problem in Rwanda, particularly in its rural areas. In 2015, a national survey revealed that 38% of children under five years of age had stunted growth, and 2% suffered from acute malnutrition (Cioffo 2018:1–2). The existing food insecurity can be partly attributed to the heavy dependence on rainfed agriculture in Rwanda. This makes the sector highly vulnerable to increasing climate variability exacerbated by climate change. The inter-annual and seasonal variability of rainfall patterns (e.g. rainfall onset and cessation, rainfall amount, frequency, and intensity) and periodic floods and droughts are common features of Rwanda's climate and are expected to have even more adverse impacts on agricultural production and food security in the future (MINAGRI 2018:21).

In response to the interlinked challenges of food security and climate change, Rwanda's Strategic Plan for Agriculture Transformation 2018–24, known as PSTA Phase 4 (hereafter, PSTA 4), identifies 'productivity and resilience' as a priority area, alongside 'innovation and extension', 'inclusive markets and value addition', and 'enabling environment and responsive institutions' (MINAGRI 2018). PSTA 4 places a new and strong emphasis on 'the need for increased climate resilience and vulnerability management' in order to 'ensure that productivity increases are resilient, with sustainable soil and water management, and to start preparing for future climate change' (ibid.44). The expected outcome of this priority area is stated as 'increased productivity, nutritional value, and resilience through sustainable, diversified, and integrated crop, livestock, and fish production systems' (ibid.45).

In line with the 'productivity and resilience' priority area and its outcome, PSTA 4 promotes a range of practices that received little emphasis in previous PSTAs: 'climate smart practices' for 'sustainable land husbandry and crop production intensification' (ibid.), which include those relating to soil and water-conservation measures (e.g. tree belts, grass strips, planting grasses or perennial vegetation on contours or bunds/ridges), various agroforestry practices, minimum tillage, mulching or crop residue retention, use of cover crops, crop rotation, intercropping, increased use of organic fertilisers, and natural pest control (ibid.46–47). Importantly, many of these climate smart practices promoted in PSTA 4 are key elements of an *agroecological* approach to farming: an approach that aims to increase productivity of farming and minimise its adverse effects on the environment by enhancing ecological processes. These practices are highlighted as measures that will address the threefold goals of increasing agricultural productivity, building resilience to climate variability, and mitigating climate change (ibid. 46).

Conservation agriculture (CA) is an approach to agriculture that revolves around three key principles: 1) minimising soil tillage, 2) covering soil with organic mulches or cover crops, and 3) diversification of crops in time (crop rotation) and space (crop association mainly in the forms of intercropping or mixed cropping[1]). Following the adoption of non-tillage farming in the United States in the 1960s, CA became widely adopted in the 1980s and 90s, primarily by large-scale farmers throughout North America and then in South America and Australia (Kassam *et al.* 2019:3–5). The rapid expansion of CA

[1] In this paper, mixed cropping refers to the form of crop association in which two or more plants or crops are planted simultaneously in the same piece of land without following clear-cut planting pattern, whereas intercropping refers to the form of crop association in which two or more plants or crops are planted simultaneously in the same piece of land in a specific row pattern.

in Brazil and other South American countries in the 1990s led to development agencies and international research organisations, such as the Food and Agriculture Organization (FAO) of the United Nations and the French Agricultural Research Centre for International Development (CIRAD), to allocate significant amounts of financial resources to research projects on the applicability of CA to other contexts, including Africa (ibid.4). By the early 2000s, FAO officially incorporated CA as a 'core element' of its worldwide strategy for sustainable agricultural intensification (Bot and Benite 2001). Since 2010, with a growing global awareness of the need to address climate change, CA has been portrayed as a form of climate-smart agriculture (CSA), making a significant contribution to climate change adaptation and mitigation (Lipper and Zilberman 2018, Pretty and Bharucha 2014 cited in Giller *et al.* 2015:2).

Strong support from the FAO and other international development agencies over the last two decades has meant that CA has gained increasing popularity in several African countries, such as Zimbabwe, Tanzania, and Kenya. These countries have adopted it as a key element of their agricultural policies (Giller *et al*. 2015:2, Fredrich *et al*. 2012). In Rwanda, CA is often referred to as '*bunga bunga ubutaka*', which literally means 'care for the soil' in Kinyarwanda, Rwanda's national language. Despite the government acknowledging the potential of CA, as evidenced by the recent establishment of RICA in 2019 and its identification as a CSA practice in PSTA 4 (MINAGRI 2018:46), CA is currently still in the early stage of its adoption and is primarily promoted through relatively small-scale initiatives carried out by non-governmental organisations (NGOs).

2.3. Challenges to adopting and scaling-up CA

As CA has gained popularity, various challenges have been recognised with regard to its application in the context of resource-poor smallholder farming (Giller *et al.* 2015, Mango *et al.* 2017). The rate of CA adoption by smallholder farmers remains extremely limited. CA covers only 0.3% of the total arable land (Giller *et al*. 2015:2). This suggests a limited impact of CA on the agricultural sector in sub-Saharan Africa, where smallholder farms make up 80% of the total farmland (Wiggins and Keats 2013). Accordingly, FAO and other agencies advocating for CA consider the increase of CA adoption by smallholder farmers and the scaling-up of CA practices critical for food security and climate change adaptation and mitigation.

While the scale of farmland using CA is one indicator of the extent to which CA is being adopted by smallholder farmers, some studies point to the importance of the *quality* of CA adoption (Giller *et al.* 2015:2, Corbeels *et al*. 2014). Due to various resource and institutional constraints, smallholder farmers often adopt the CA principles only partially. Several studies have revealed that smallholder farmers often practice no or minimum tillage in the absence of organic soil cover and crop diversification. This can have serious negative effects, such as decreased crop yields (Mango, *et al*. 2017, Pittelkow *et al.* 2015 cited in Giller *et al.* 2015:4) and accelerated soil erosion (Baudron *et al.* 2012 cited in Giller *et al*.

2015:7).

3. Methodology

This study draws on a descriptive case study conducted in four different geographical areas in the eastern and southern provinces of Rwanda, namely, the Gahara and Mahama sectors of the Kirehe district, Juru sector of Bugesera district, and Mbuye sector of Ruhango district.[2] The case study included ten CA-practicing smallholder farmers (see Table 1) as well as focus groups with CA farmers in the four areas. The farmers in the Mahama and Gahara sectors are participants of a CA-focused food security project implemented by the Association des Eglise Baptistes au Rwanda (Association of Baptist Churches in Rwanda), while those in the Juru and Mbuye sectors are participants of a CA-focused food security project implemented by Friends Peace House (FPH) and MJCI-Shalom (Mission des Jeunes pour Christ Internationale-Shalom), respectively.

3.1. Selection of study areas

For our case study, we purposely chose four geographical areas that are considered severely or moderately drought-prone with very low or moderately low annual rainfall by Rwandan standards. The decision to select drought-prone areas was based on an understanding that CA is likely to have greater positive effects on agricultural productivity in drier and drought-prone regions than those with higher annual rainfall. The Mahama and Gahara sectors are located in Kirerhe district, with an average annual rainfall of 898 mm and a relatively low population density of 290 people per km^2. The Juru sector is located in Bugesera district, with an average annual rainfall of 900 mm and a relatively low population density of 282 people per km^2. The Mbuye sector is located in Ruhango district, with an average annual rainfall of 1,170 mm and a relatively higher population density of 510 people per km^2. We visited these areas in November 2019 and January-February 2020 to observe smallholder farmers' CA practices during Season A, one of the two major crop-producing seasons in Rwanda[3] that starts in September and ends in January of the following year.

3.2. Data collection

The data collection methods used in this study consisted of individual interviews with CA farmers, government officials in charge of agriculture, and NGO workers in charge of CA projects implemented in the four sectors. NGOs recommended these farmers as they were considered well experienced in CA.

Individual interviews with case study farmers were accompanied by field observations of their CA

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[2] Rwanda was divided into 4 provinces and Kigali City, which were further divided into 30 districts, 416 sectors, 2,148 cells and 14,837 villages at the lower levels of its territorial administration.

[3] Rwanda has two major crop-producing seasons: Season A from September to January of the following year and Season B from March to July of the same year.

practices during Season A of 2019–2020. Focus groups were conducted with groups of CA farmers in all four study areas to gain an understanding of their perspectives on constraints to adopting and scaling-up CA. Focus groups in each study area involved all the case study farmers from that particular sector as well as two to five additional CA farmers from that sector. Progress reports obtained from NGOs implementing CA projects were also reviewed.

3.3. Profiles of case study farmers

Table 1 shows the profiles of the farmers involved in this case study. As stated previously, they were all participants of existing CA-focused food security projects implemented by the three different NGOs in the four study areas (Mahama, Gahara, Juru, and Mbuye). In total, ten farmers participated in our case study, seven men and three women with ages ranging from 29 to 63 years. The time at which farmers started to implement CA ranged from September 2013 to February 2019. At the time of our fieldwork, eight of them had been practicing CA for less than three years, while farmers with the longest and the second-longest experience with CA had been practicing it for six and a half years and four years, respectively. All participants were smallholder farmers with household landholding ranging from 0.11 to 1.45 ha. One of the farmers, MA3, a farmer who held the largest landholding among the farmers, rented out one quarter of his farmland during Season A of 2019–2020. Two farmers, MA1 and JU2, grew crops on both their own land and land they rented. The main crops that these farmers grew during Season A of 2019–2020 were maize, cassava, and bananas. Two farmers in Mbuye were coffee farmers and one farmer in Gahara grew Irish potatoes intercropped with maize in the same field.

Table 1. Case study of CA farmers

Sector	CA project holder	Farmer code	Sex	Age	Time of CA adoption	Size of own household's farmland (ha)	Size of total farmland in season A of 2019–2020 (ha)	Main crops grown in season A of 2019–2020
Mahama	AEBR	MA1	M	53	Sep. 2017	0.45	0.75	maize, banana, cassava
		MA2	F	44	Sep. 2018	0.35	0.35	maize, cassava, banana
		MA3	M	63	Sep. 2013	1.45	1.07	maize, cassava
Gahara	AEBR	GA1	M	43	Feb. 2018	1.30	1.30	maize, cassava
		GA2	M	45	Feb. 2015	0.16	0.16	maize, Irish potatoes

Juru	FPH	JU1	M	29	Feb. 2017	0.24	0.24	banana, maize
		JU2	M	51	Feb. 2018	0.44	0.64	maize, banana, cassava
Mbuye	MJCI-Shalom	MB1	M	38	Feb. 2019	0.11	0.11	maize
		MB2	F	32	Feb. 2018	0.50	0.50	coffee, maize
		MB3	F	31	Feb. 2019	0.45	0.45	coffee, maize

4. Findings and discussion

In this section, we present and discuss key findings with regard to the two research questions presented in the introduction: 1) to what extent and in what particular form has CA been adopted by smallholder farmers in the study areas; and 2) what are, from the perspective of CA farmers, the major constraints to adopting and scaling-up CA, specifically in the context of smallholder farming in Rwanda?

4.1. CA adoption by smallholder farmers

With regard to the first question, our fieldwork yielded four major findings: 1) limitations in the extent to which the farmers in our case study had adopted CA; 2) their partial adoption of CA principles; 3) varied forms of CA practised on a continuum of agroecology; 4) contrasting attitudes among CA farmers towards the policy to boost the use of mineral fertilisers; and 5) contrasting attitudes among CA farmers towards the policy to enforce monoculture farming of priority crops.

4.1.1. Limited extent of CA adoption

Table 2 shows the CA adoption rate of the ten farmers during Season A of 2019–2020. The adoption rate of the farmers varied significantly, ranging between 20 and 100% of their total farmland area. Six out of the ten farmers practised CA on less than 30% of their farmland. Apart from GA2 in Gahara, all the farmers identified a severe shortage of mulching materials as the principal reason why they could not implement CA on all the farmland on which they had planted crops in Season A of 2019–2020.

Table 2. CA adoption rate of case study farmers (Season A of 2019–2020)

Sector	Farmer code	Total farmland area (ha)	Total farmland area under CA (ha)	Percentage of farmland area under CA (%)
Mahama	MA1	0.75	0.45	60.0

	MA2	0.35	0.08	22.8
	MA3	1.07	0.47	43.9
Gahara	GA1	1.30	0.30	23.1
	GA2	0.16	0.16	100.0
Juru	JU1	0.24	0.18	75.0
	JU2	0.64	0.16	25.0
Mbuye	MB1	0.11	0.03	27.3
	MB2	0.50	0.10	20.0
	MB3	0.45	0.09	20.0

4.1.2. Partial adoption of CA principles

Through direct observations and interviews, we attempted to determine the degree to which they had adopted each of the three CA principles on their CA fields: minimum-tillage, organic soil cover (mulching and/or cover crops), and crop diversification (crop rotation and intercropping or mixed cropping). Each CA farmer was assessed on the extent to which they practised individual CA principles for Season A of 2019–2020. Table 3 shows the assessment criteria of each principle.

Table 3. CA principle assessment criteria

Degree of adoption	CA principle
	Minimum tillage
Well	Less than 25% of the cropped area disturbed
Moderate	More than 25% but less than 80% of the cropped area disturbed
Poor	More than 80% of the cropped area disturbed
	Organic soil cover
Well	More than 30% of the cropped area covered
Moderate	More than 20% but less than 30% of the cropped area covered
Poor	Less than 20% of the cropped area covered
	Crop diversification
Well	Both crop rotation and crop association practised
Moderate	Either crop rotation or crop association practised
Poor	Neither crop rotation nor crop association practised

Table 4 shows the results of our assessment based on direct field observations and individual interviews. Minimum tillage was practised well by all CA farmers in the four study areas. Crop rotation was also commonly practised by CA farmers who planted maize or Irish potatoes in Season A of 2019–

2020 after harvesting legume crops, such as bush beans or ground nuts, that had been grown during Season B of 2018–2019 (March–July 2019). Crop association in the form of intercropping or mixed cropping was also practised by eight out of the ten case study farmers in all four study areas, while two farmers in Mbuye practised monocropping of maize or cassava on their CA fields.

Permanent organic soil cover through mulching or growing green manure cover crops (GMCCs) was found to be the least adopted CA principle, especially in the Mbuye and Gahara sectors. Difficulties in obtaining sufficient organic mulching materials such as crop residues or forest and marshland grasses was the biggest challenge they experienced in practising CA during Season A of 2019–2020. This is discussed in further detail in the section on the constraints on adopting and scaling-up CA below. All of the case study farmers paid significant amounts, ranging from 8,000 to 100,000 Rwandan francs (US $8.6 to $107.5) to buy various mulching materials. During Season A of 2019–2020, the amount spent on mulching materials was equivalent to the cost of employing agricultural labour for 10–125 days. This shows that farmers make a significant investment in their CA fields. In all four study areas, crop residues and grasses have become an increasingly valuable resource due to competition for livestock feed, soil mulching, and compost production. In particular, farmers in Mbuye faced a serious shortage of mulching materials caused by local coffee plantations that require large amounts of mulch.

Agroforestry was implemented by some of the case study farmers to mitigate the shortage of mulching materials in Mahama, Gahara, and Juru (MA1, MA2, MA3, GA1, GA2, and JU2). For example, branches and leaves of pigeon peas and Leucaena (*Leucaena leucocephala*) planted in or on the edges of their CA fields were used for mulching.

Table 4. Level to which individual CA principles were practised

Sector	Farmer code	Minimum-tillage	Organic soil cover	Crop diversification
Mahama	MA1	Well	Well	Well
	MA2	Well	Moderate	Well
	MA3	Well	Well	Well
Gahara	GA1	Well	Moderate	Well
	GA2	Well	Moderate	Well
Juru	JU1	Well	Well	Well
	JU2	Well	Well	Well
Mbuye	MB1	Well	Poor	Moderate
	MB2	Well	Poor	Moderate
	MB3	Well	Moderate	Well

Eight of the ten case study farmers used GMCCs such as Mucuna, cowpeas, and Lablab as one solution to the scarcity of mulching materials. However, during our field visits, only two of the ten case study farmers had adequate levels of soil cover by GMCCs in their CA fields (MA1 planting cowpeas in a maize plot and JU2 planted Mucuna in a banana plantation). Five other farmers (MA2, MA3, GA1, MB2, and MB3) planted cowpeas in or on the edge of their maize fields, but these GMCCs provided only scant cover for the soil.

4.1.3. Varied forms of CA on a continuum of agroecology

Interviews with the ten farmers to obtain detailed information about their farming practices and direct field observations allowed us to locate them on what we call an agroecological continuum. The agroecological continuum refers to the degree to which various agroecological management practices are adopted. Table 5 shows a summary of the data concerning the degree to which six agroecological practices—mulching, GMCC, compost, intercropping or mixed cropping, agroforestry, and natural pest control—were adopted by the case study farmers. All of these practices are well recognised in the literature of the agroecological approach to agriculture (Wezl *et al*. 2014, Rosset and Artieri 2017). We did not include minimum tillage and crop rotation in the table since, as discussed above, both of them were agroecological practices commonly adopted by all case study farmers. The purpose of this table is to illustrate that the CA farmers in Mahama and Gahara are at the higher end of an agroecological continuum, with higher total scores, whereas those in Mbuye and Juru are at the lower end, with lower total scores.

The use of compost and agroforestry is the most prominent factor that separates the farmers of Mahama and Gahara at the higher end of the continuum and those of Juru and Mbuye at the lower end of the continuum. The difference in the adoption of compost seems to be attributable, to some extent, to the fact that AEBR, the organisation implementing the CA project in Mahama and Gahara, had distributed pigs or goats to its project participants. This significantly increased participant farmers' access to manure, whereas FPH and MJCI-Shalom, the organisations implementing the CA projects in Juru and Mbuye, did not provide such livestock to their project participants. The difference in the adoption of agroforestry seems to also be attributed to a stronger emphasis AEBR had placed on agroforestry, as compared to FPH and MJCI-Shalom.

The relative absence of intercropping, mixed cropping, and mulching are the key factors that push farmers in Mbuye towards the lower end of the agroecological continuum. We confirmed, in both individual interviews and the focus group we conducted in Mbuye, that they preferred a monoculture farming system over a polyculture system. This preference was based first on their belief that the former is a more productive system, and second, on their limited understanding of the various advantages of crop association. As noted above, the fact that two farmers in Mubuye had poor mulching practices in their CA fields is attributable to the serious shortage of mulching materials in the local area due to the competition for organic materials that are mostly directed to existing coffee plantations. In addition, the absence of agroforestry practices contributed to the relative absence of mulching in Mbuye. Most CA farmers in other areas (MA1, MA2, MA3, GA1, GA2, and JU2) used branches and leaves from agroforestry species for both fodder and mulch.

Notably, natural pest control was found to be the least adopted agroecological management practice across the four study areas. The practice was only confirmed on the CA field of one farmer in Gahara (GA2). In 2018, he planted *Desmodiu*a (a perennial fodder crop that can be used as a repellent against moths that lay armyworm eggs) in strips surrounding his maize field to protect the maize plants during Season A of 2019–2020. During our field visit in January 2020, he testified that in the field surrounded by *Desmodiu*a, the maize plants had not been attacked by any armyworm.

Table 5. Adoption of agroecological management practices by the case study farmers

Agroecological Continuum			Farmer code	Gender	Age	Mulching	GMCC	Compost	Intercropping or mixed cropping	Agro-forestry	Natural pest control	Total Score /12
Agroecological Continuum	Higher	Mahama	MA1	M	53	Well	Mod	Well	Well	Well	Poor	9
		Mahama	MA2	F	44	Mod	Mod	Well	Well	Well	Poor	8
		Mahama	MA3	M	63	Well	Well	Well	Well	Well	Poor	10
		Gahara	GA1	M	43	Mod	Mod	Well	Well	Mod	Poor	7
		Gahara	GA2	M	45	Mod	Poor	Well	Well	Well	Mod	8
		Juru	JU1	M	29	Well	Poor	Poor	Well	Poor	Poor	4
		Juru	JU2	M	51	Well	Well	Poor	Well	Mod	Poor	7
		Mbuye	MB1	M	38	Poor	Poor	Poor	Poor	Poor	Poor	0
		Mbuye	MB2	F	32	Poor	Mod	Poor	Mod	Poor	Poor	2
	Lower	Mbuye	MB3	F	31	Mod	Mod	Poor	Well	Poor	Poor	4

Scoring system:

Well = 2 points Mod (moderate) = 1 point Poor = 0 point Maximum score = 12 / Minimum score = 0

4.1.4. Contrasting CA farmers' attitudes towards the policy to boost the use of mineral fertilisers

The focus groups and individual interviews we conducted in the four study areas yielded noteworthy observations about the contrasting attitudes towards the policy to boost the use of mineral fertilisers under the CIP. Remarkably, even though all the case study farmers self-identified as farmers practicing CA, they had significantly different attitudes towards the use of mineral fertilisers for their crop production. We identified the following three types of attitudes, which largely correspond to CA farmers' position on the agroecological continuum discussed above.

Showing antipathy towards mineral fertilisers

The views of the farmers in Mahama, the farmers located at the highest end of the agroecological continuum represent an antipathetic attitude towards the use of mineral fertilisers in their CA practice. All of them expressed a strong preference for organic soil fertilisation methods through the use of compost, manure from livestock, green manure from agroforestry species, or GMCCs. They also expressed a preference for the integration of legume crops in their farming systems through intercropping, mixed cropping, and crop rotation.

The Mahama farmers' antipathetic attitude towards mineral fertilisers was grounded in specific negative experiences that local farmers had with mineral fertilisers in the past. They shared three types of negative experiences. First, they testified that the harmful effects mineral fertilisers had on soil structure and fertility by killing what Rwandan farmers call *inshuti y'umuhinzi*, literally meaning 'friends of a farmer', or soil organisms that play a vital role in maintaining soil fertility. Farmlands in many parts of Mahama are characterised by sandy soil with very low nutrient and organic matter content. Farmers believe that the application of mineral fertilisers on such soil for consecutive years may make it barren unless a large amount of organic fertiliser is used at once.

Second, another negative experience with the use of mineral fertilisers is associated with Striga (*Striga hermonthica* and *Striga asiantica*), a parasitic weed that is abhorred by local farmers for its devastating effects on crop production. This highly destructive pest sucks out nutrients from the roots of the host cereal crops such as maize, sorghum, and millet, thereby seriously hampering their growth.[4] One male participant in the focus group told us that DAP (diammonium phosphate) used on his maize field attracted Striga, which destroyed all his maize plants in Season A of 2018–2019. Emphatically dismissing any possibility of ever using DAP again in his field, he said, 'Even if the agronomist leaves a sack of DAP on my doorstep, I would not use but sell it at the market' (focus group with CA farmers at Mahama, 22 January 2020).

Third, many farmers in Mahama and adjacent areas have experienced difficulties in repaying the loan

[4] Rwanda Environment Management Authority (REMA) (2009:48) identifies it as 'a major pest of agricultural intensification, associated with increased cropping intensity and declining soil fertility'.

they took to buy agricultural inputs, especially mineral fertilisers. During the focus group, MA2, a female CA farmer and her husband, told us that in 2017, they received a loan of 52,000 Rwandan francs (approximately US $ 56) for mineral fertilisers, but they could not pay it back because their maize crops failed due to a drought that hit the whole region. They only managed to pay back 25,000 Rwandan francs. The government then cancelled the remaining amount due to drought, which affected many people in the region that year. According to the participants of the focus group, many farmers failed to pay back their loans. Consequently, their land titles are still kept by the supplier of inputs called TUBURA programme, which is run by One Acre Fund, a US-based NGO that imports and supplies subsidised mineral fertilisers to local farmers as a part of the CIP framework.

The CA farmers in Mahama openly shared their negative feelings about the government's vigorous campaign for mineral fertilisers, which they considered an unwelcome imposition of government policy. Fully convinced that his organic way of producing crops is more productive than with mineral fertilisers, MA3, a 63-year old male farmer with more than six years of CA experience declared his determination not to use any mineral fertiliser on their farmland: 'If the government forces us to use it, I will refuse it' (focus group at Mahama, 22 January 2020).

Accepting a mixture of mineral fertilisers with organic ones

Compared to the attitude of the farmers in Mahama, a more moderate attitude was identified among the farmers in Gahara and Juru who participated in separate focus groups. They generally supported the use of mineral fertilisers in combination with organic fertilisers. However, they specified that they would not need to use mineral fertilisers if they had enough organic fertiliser. They were also aware of the harmful effects mineral fertilisers may have on soil structure and fertility, as their counterparts in Mahama described. However, unlike the farmers in Mahama, they did not show antipathy towards the use of mineral fertilisers.

Supporting the increased use of mineral fertilisers

On the other hand, farmers who took part in a focus group in Mbuye, who were also at the lowest end of the agroecological continuum, emphasised the importance of the increased use of mineral fertilisers for optimal soil fertilisation management. In their view, while they understand the importance of mixing organic fertilisers with mineral fertilisers, they believe that the use of mineral fertilisers is necessary for more productive farming. When we shared our observation that the CA farmers in Mahama were very productive organic farmers, they insisted that the Mahama farmers should be taught the importance of mineral fertilisers so that they could become more productive. The farmers in Mbuye were not overly concerned about the harmful effects of agro-chemicals on the soil, plants, and humans.

4.1.5. Contrasting CA farmers' attitudes towards the policy to enforce monoculture farming

As discussed above, since the introduction of CIP in 2007, monoculture farming of market-oriented priority crops determined by the government has been vigorously promoted as a productive farming system. This system is especially encouraged in government-owned marshlands and privately owned lands that are under the Land Use Consolidation (LUC) programme. However, in all the areas we conducted our fieldwork, different forms of crop association were widely practised by smallholder farmers on their privately owned lands, both inside and outside the LUC area. We identified the following three types of attitudes, which largely correspond to CA farmers' positions on the agroecological continuum.

Crop diversification as a right for smallholder farmers

The CA farmers in Mahama, whom we located at the highest end of the agroecological continuum, expressed that crop diversification through different methods of crop association, such as intercropping, mixed cropping, and planting fruit and fodder trees on and around fields, is their right as well as being essential for their subsistence. They are aware that the government has been urging them to practice monoculture farming by planting a single crop of high commercial value in their fields, especially if a given field falls within the area designated for the LUC programme. However, they firmly believe that practicing various methods of crop association in their fields is necessary to reduce the risk of total crop failure due to adverse climatic conditions or pests and diseases. By doing this, they believe they will achieve higher net production.

Participants of the focus group in Mahama, including all three CA farmers in our case study, were of the view that implementing a monocropping system on all their farmland would be too risky, especially because their region is very dry and highly susceptible to droughts. They also expressed the view that their risk-averting strategies through various crop diversification methods are becoming more important than before due to increasing climate variability in recent years. Accordingly, they said they would continue to practice polyculture farming even in fields that are within the LUC area.

Accommodating the government's instructions around monoculture farming

The CA farmers in Gahara and Juru showed a rather accommodating attitude toward the subject of the monoculture farming system promoted by the government. All of the CA farmers interviewed, and others involved in the focus groups in the two study areas acknowledged the need for planting multiple kinds of crops in their small fields as a strategy of risk aversion and maximising productivity per unit area; however, they chose to avoid confrontation with government authorities. This led them to accept the government instruction of monocropping in the area under the LUC programme. However, they still continued to plant multiple crops in their fields near their homesteads or on fields in locations not easily viewed. They chose not to speak out openly about their preference for polyculture, but they stated that they would continue practicing various methods of crop diversification so long as they are tolerated by government authorities.

Accepting monoculture farming as the way forward

The CA farmers in Mbuye, whom we observed as the least agroecological in this study, showed a remarkably different attitude towards the monoculture vs. polyculture debate. All of the three CA farmers we individually interviewed and those involved in the focus group in Mbuye unambiguously indicated their belief that monoculture farming is more productive than polyculture farming. When we asked GA2, one of the female CA farmers we interviewed, why she did not practice any form of crop association, she said firmly, 'The government is telling people not to mix crops in the same field, so as a lead farmer, I cannot do that as I have to tell others not to do that' (interview on 5 February 2020 Mbuye). She then stated that she and her fellow farmers' practices must be in line with the government's instructions, including the adoption of monoculture farming. We also asked another female CA farmer, GA3, for her view of polyculture farming after visiting her remarkably biodiverse CA field on which pineapples, bananas, and cowpeas were intercropped with well-grown maize plants. Contrary to our expectation, she did not feel proud of the way multiple crops were planted in her field. She told us that she would transform it into a monoculture farm in the future because she was convinced that a monoculture would yield higher productivity than a polyculture. In her view, planting multiple kinds of crops in the same field may have advantages only for those who are farming very small plots of land. Participants of the focus group in Mahama unanimously confirmed that monoculture is the way forward for Rwandan farmers.

4.2. Constraints to adopting and scaling-up CA by smallholder farmers

In seeking answers to the second research question, 'What are, from the perspective of CA farmers, the major constraints to adopting and scaling-up CA, specifically in the context of smallholder farming in Rwanda?', eight themes emerged from the fieldwork. These themes are discussed in this section. Some of the themes relate to challenges faced by smallholder farmers, specifically in relation to their CA practice. Other themes relate to the key challenges smallholder farmers in Rwanda face more generally. These more general challenges may also hamper CA farmers' attempts to scale up their CA practices. The first six themes are linked to smallholder farmers' limited access to agricultural resources and services necessary for productive CA, whereas the last two themes are linked to government policies for agricultural intensification and commercialisation under the CIP. These policies considerably limit farmers' choice regarding the farming system and methods they may adopt.

4.2.1. Shortage of mulching materials

The CA farmers across all four study areas identified the shortage of organic mulching materials as the most severe constraint to their current CA practice as well as to the possible expansion of CA fields. Organic materials such as crop residues and grasses from various sources are becoming increasingly scarce, and therefore more valuable because of competition for organic material used as livestock feed, compost production, and soil mulching for food crops and coffee plantations.

A large majority of the case study farmers we visited considered the shortage of mulching materials to be a major factor limiting the extent to which organic soil coverage was practised. In addition to the general scarcity of organic materials for mulching, some of them also testified that they had faced other problems during Season A in 2019–2020, such as theft of mulches from their fields and serious damage to mulches caused by termites. As reported in section 4.1.2, most of them spent a significant amount of money buying mulching materials, despite the fact that the amount they could afford was far less than the amount required to cover the soil adequately.

All CA farmers considered GMCCs as a potential solution to the shortage of mulching materials. As indicated in section 4.1.2, however, only two of them were found to have established adequate levels of soil coverage by GMCCs at the time of the field visit.

4.2.2. Shortage of manure for organic soil fertilisation

Case study farmers across all four study areas expressed concern over the limited availability of manure and identified it as a major constraint to adopting and scaling-up their CA practice. For the large majority of farming households that engage in mixed farming in Rwanda (NISR 2018),[5] it is common knowledge that the application of manure from livestock is essential for maintaining soil health and productivity. As the depletion of soil nutrients due to over-cultivation is pervasive across Rwanda, the demand for manure has been increasing. Despite this, the supply of manure has not matched the demand due to a combination of factors, including a lack of purchasing power, limited access to fodder and water, and unavailability of affordable animal healthcare services.

Even though the shortage of manure was unanimously identified as a major limiting factor to productive CA practice, its impact varied among the case study farmers we visited. On one hand, all the case study farmers in Mbuye and Juru spent a significant amount of money buying manure during Season A of 2019–2020. These farmers either owned no animals or too few to produce enough manure. On the other hand, the case study farmers in Mahama and Gahara were found to be less reliant on

[5] In this paper mixed farming refers to a farming system which involves the growing of crops as well as the raising of livestock. According to the Agricultural Household Survey conducted by National Institute of Statistics Rwanda (NISR) in 2017, the percentage of households raising different types of livestock during the 2017 agricultural year was 61%, 53.6%, 33.7%, 30.6% and 18.1% respectively for cattle, goats, hens, pigs, and sheep (NISR 2018).

purchased manure partly because of the pigs and goats provided by AEBR's food security project, as reported in section 4.1.3. Using manure produced by these animals, these farmers were able to produce compost that helped them increase crop yield in their CA fields. However, they also clearly expressed that they would face a shortage of manure if they increase the size of their CA fields in the future.

4.2.3. Lack of means to transport organic fertilisers and mulching materials

Lack of means to transport manure or compost and organic mulching materials was identified as a potential constraint to adopting and scaling-up CA in the context of smallholder farmers in two study areas, Juru and Mahama. As noted earlier, according to the majority of case study farmers, manure or compost and organic mulching materials, such as crop residues and grasses, are two critically important inputs for CA, without which good crop production cannot be expected.

For Season A of 2019–2020, all CA case study farmers had different ways of making organic materials available for their fields. First, to transport manure or compost, many of them carried it by themselves or had their temporary workers carry it from their homestead, where they kept livestock, to their field. Second, those who bought a fairly large amount of manure arranged a truck to transport it to a location near their fields. Third, some CA farmers set up compost piles near the fields to minimise the labour required for transport. To supply mulching materials to their fields, the first option was to maintain crop residues in the field after harvest. They also carried crop residues manually from nearby places themselves, and temporary workers carried purchased grasses from the forest or marshland.

Since the size of their CA fields was fairly small, CA farmers in the study areas were able to supply manure and/or compost and mulching materials to their fields by these means. They said that it would be difficult for them to practice CA in larger fields unless tools for carrying the materials, such as a wheelbarrow and a hay cart, were made available.

4.2.4. High labour requirements

A high level of labour required for mulching and organic fertility management through manure or compost was identified as another critical factor that may hamper the scaling-up of CA in the future. This issue was raised during focus groups and interviews only by CA farmers in Mahama, Gahara, and Juru, who considered mulching materials and organic fertilisers as the two essential inputs for practicing CA in a productive way. It is not surprising that the CA farmers in Mbuye did not identity this issue as a constraint because they adopted the CA principle of organic soil cover only to a very limited extent (see Table 4). Moreover, they did not use much manure or compost, as they relied on mineral fertilisers more than CA farmers in other study areas (see section 4.1.4).

CA has been portrayed by its advocates as a labour-saving form of agriculture (Montt and Luu 2018: 3). FAO (2011) maintains that, compared to conventional farming based on extensive tillage, CA significantly reduces labour requirements for land preparation and weeding primarily due to its practices of minimum tillage and permanent soil coverage. At the same time, it acknowledges the need for extra labour for manure application, weeding, and other early tasks required until the CA system has established itself. However, additional labour requirements due to increased weed growth induced by the elimination or reduction of tillage as a weed control method have also been reported, especially when permanent soil cover is not adequately practised and/or herbicides[6] are not used (Lee and Thierfelder 2017). A recent study analysing data from five Sub-Saharan African countries suggests that CA can result in increased labour requirements. This is if the effects of various CA aspects (not only minimum tillage and permanent soil cover) on labour requirements at different production stages (e.g. land preparation, weeding, harvesting, and threshing) are taken into consideration (Montt and Luu 2018).

According to most of the case study farmers who applied mulching and organic soil fertilisation, the labour-saving effects of minimum tillage, and prevention of weeds by mulching cannot offset the extra labour requirements incurred through the introduction of the CA system. Therefore, it is likely that labour shortages will be a serious constraint to the scaling-up of CA in the future, unless certain labour-saving technologies and practices are effectively incorporated in the CA system.

4.2.5. Small landholding

Small landholding was also identified as a significant constraint to adopting and scaling-up CA. In Rwanda, landholdings are small and fragmented. The average landholding of 0.6 ha is often divided into even smaller three to four sub-plots; approximately 50% of farming households produce crops on less than 0.35 ha of land (NSIR 2016). As indicated in Table 1, the landholding of eight out of ten case study farmers, ranging from 0.11 to 0.50 ha, was much less than the national average landholding, whereas the landholdings of the remaining two case study farmers were 1.45 and 1.3 ha.

During Season A of 2019–2020, two case study farmers, MA1 and JU2, rented land for farming. They grew maize on the rented land using conventional methods: extensive tillage, no soil cover with mulches, and reliance on mineral fertilisers. These farmers pointed out that CA cannot be practised on rented land. This is due to the concern that the considerable investment in mulches and organic fertilisers required for CA would be wasted once the landowner asks them to return the land.

While the CA farmers in this case study identified it as a serious constraint, small landholding generally does not seem to be the most important factor preventing CA farmers in the study areas from expanding the size of their CA fields. This is corroborated by the fact that six out of ten farmers in this

[6] While herbicide use could greatly reduce labour requirements for weed control as shown in some studies conducted in Sub-Saharan Africa (Umar *et al.* 2011, Muoni *et al.* 2013), none of the CA farmers we interacted with during the fieldwork pointed to herbicides as a potential solution to address the challenge of CA's high labour requirements. This was probably because herbicides are not well known to smallholder farmers and their availability at the markets is very limited.

case study adopted CA on less than 30% of their total farmland (see Table 2). As discussed above, the shortage of mulching materials seems to be the most important factor determining smallholder farmers' ability to practise CA on their land.

4.2.6. Lack of effective pest and disease control

The lack of effective pest and disease control was another constraint to scaling-up CA and was frequently raised in the interviews and focus groups. As reported in section 4.1.3, all but one of the case study farmers relied entirely on chemical pesticides during Season A of 2019–2020, despite the fact that they did not achieve satisfactory results. While the farmers we visited in Mbuye did not hesitate to use chemical pesticides, the farmers we visited in other sectors were all aware of their adverse effects on beneficial organisms and human health. To our surprise, however, there was an apparent lack of knowledge regarding organic pest and disease control methods among the case study farmers. There was an exception for the farmer in Gahara, who intercropped *Desmodium* plants over two crop-producing seasons on his maize plot as an effective biological pest management method (see section 4.1.3).

4.2.7. Conflict with the government policy to boost the use of mineral fertilisers

The fieldwork led us to discern tension between government efforts under the CIP to transform traditional subsistence farming into a modern, market-oriented farming, and CA farmers' efforts to enhance food security and resilience through agroecological farming practices. As discussed earlier, the type of farming system promoted by the CIP has two major features: 1) increased use of purchased inputs such as mineral fertilisers and improved seeds; and 2) a monoculture of a market-oriented priority crop in the area under LUC. Even though PSTA 4, the most recent strategic plan for agricultural transformation in Rwanda, shows a new policy direction and associated measures, in line with agroecological, sustainable farming practices, the government's vigorous pursuit of the CIP objectives remained apparent at the time of our fieldwork. We confirmed that specific quantified CIP-related targets, such as the number of hectares consolidated for growing priority crops and the quantity (kg) of subsidised fertilisers bought by farmers, featured at the top of annual targets set by the local government authorities from the district down to sector and cell levels.

The first theme that emerged as a potential constraint to scaling-up CA relates to the government's vigorous campaign to increase the use of mineral fertilisers. As reported in section 4.1.4, the CA farmers in Mahama, who were found to be at the highest end of the agroecological continuum (Table 5), opposed the use of mineral fertilisers. Their reasoning was that using mineral fertilisers was incongruous with their sustainable soil fertility management through the use of compost, mulching, and organic inputs from agroforestry trees. In the years during which the monocropping of maize was introduced to their district, the government authorities, according to the farmers' perspectives, forcibly imposed the use of chemical fertilisers on local farmers. With this past experience, they expressed fear that the government could increase its pressure on them to use mineral fertilisers in the future in order to achieve its annual target. This annual target is specified in a performance contract (locally known as *imihigo*) signed by the mayor of every district across Rwanda.[7] Thus, in their view, considerable scaling-up of CA (CA with a strong emphasis on agroecological principles) might not be tolerated by the government because it is seemingly in conflict with the policy objective of increasing the use of mineral fertilisers.

In sharp contrast to the CA farmers in Mahama, the farmers in Mbuye, who were found to be at the lowest end of the agroecological continuum (Table 5), did not see the government's push to use mineral fertilisers as a constraint because they considered the increased use of mineral fertiliser necessary for enhancing their CA productivity. Farmers in Gahara and Juru, who were located in the middle of the agroecological continuum (Table 5), indicated their view that mineral fertilisers can be mixed with organic fertilisers if a sufficient amount of organic fertilisers is not available.

There were varied attitudes towards the use of mineral fertilisers among CA farmers in the different study areas. This suggests that the constraining factor on scaling-up CA caused by the policy to boost the use of mineral fertilisers depends largely on which version of CA will be promoted in Rwanda in years to come, either one that is inclined towards agroecology or one that is not.

4.2.8. Imposition of monoculture against smallholder farmers' preference of polyculture

The second theme that emerged as a potential constraint to scaling-up CA concerns the other aim of CIP: promoting monocultures of market-oriented crops through the combination of regional crop specialisation and land use consolidation (LUC). One of the key CA principles is diversifying crops in time and space through various forms of crop rotation and association. This has been widely practised by smallholder farmers in Rwanda to reduce the risk of crop failures, manage soil fertility, and maximise agricultural productivity per unit area on their small fragmented fields (Isaacs *et al.* 2016).

As reported earlier, various forms of crop diversification, namely crop rotation, mixed cropping, intercropping, and planting fruit and fodder trees on and around the field, were seen in the fields of the CA farmers in this case study (see sections 4.1.2 and 4.1.3). The particular forms of crop diversification that are seemingly in conflict with the government's vigorous promotion of monoculture farming under the CIP are intercropping and mixed cropping.

Since the introduction of the CIP, the policy of monoculture farming has been enforced across the country, especially if a given land falls in the area designated for LUC programme (Huggins 2017). Well aware of the potential disadvantages of monoculture farming, many of the CA farmers in this case study

[7] For this management system exercised by the Rwandan government based on a performance contract locally known as *imihigo*, see Gatwa and Uwimbabazi (2019).

showed a preference for polyculture farming, especially on small, fragmented plots of land. Only CA farmers in Mbuye, who possessed limited knowledge about agroecological farming, expressed their preference for monoculture farming.

In focus groups, we sought to capture their views about the potential future escalation of tension between the monoculture farming policy under the CIP and their preference for polyculture farming practices in their CA fields. We asked them whether they think that polyculture farming in CA fields would still be tolerated by government authorities even after scaling-up CA in the area. We expected an affirmative answer to this question from many of the CA farmers we talked with, especially those of Mahama who clearly demonstrated their critical view of monoculture farming (and a strong preference for polyculture farming). Contrary to our expectations, none of the CA farmers expressed much worry about a possible situation in which the promotion of monoculture farming by the government constrains polyculture farming practices in their CA fields.

The fact that the CA farmers did not see their polyculture farming in conflict with the promotion of monoculture farming by the government can possibly be attributed to a welcome change in policy direction and measures set out in PSTA 4 in response to 'the need for increased climate resilience and vulnerability management' (MINAGRI 2018:44). As already noted, intercropping and the use of cover crops are, in fact, among the climate-smart practices stipulated in PSTA 4 (ibid.45–46). During the fieldwork, we confirmed that the government agronomist working for the Mahama sector recognised the advantages of intercropping or mixed cropping for smallholder farmers. The advantages recognised included the maximisation of productivity per unit area and enhanced resilience to climate variability, particularly in food-insecure, drought-prone regions including Mahama. However, in his view, the practice of intercropping or mixed cropping should be limited to small-scale farms that are unirrigated and located in dry, drought-prone areas. We therefore suggest that the tension highlighted in this section can be considered a potential constraint to the scaling-up of CA by smallholder farmers.

5. Conclusion

We have discussed key findings from a case study of smallholder farmers practising CA in four different geographical areas in the eastern and southern provinces of Rwanda during Season A of 2019–2020 (September 2019 to January 2020). The first set of findings emerged from an analysis of the specific ways in which the ten case study farmers practised CA. First, many of the case study farmers adopted CA on a small portion of their total farmland; six out of ten farmers practised CA on less than 30% of their farmland for Season A of 2019–2020. This implies that conventional farming with extensive tillage remains a dominant farming method. Second, many of the case study farmers adopted the CA principles only partially. While minimum-tillage was commonly adopted, organic soil cover was found to be the least adopted CA principle due to a serious shortage of organic mulching materials as well as unsuccessful attempts to use GMCCs as an alternative to mulches of crop residues and grasses. The degree to which crop diversification was adopted varied significantly. Third, a detailed examination of their farming practices revealed that even though they use the same name *bunga bunga ubutaka* ('care for the soil') for CA practice, their approach to agriculture varied significantly in their application of agroecological principles. This realisation led us to place CA farmers at different positions on what we call the agroecological continuum. Fourth, these case study farmers held contrasting views towards the use of mineral fertilisers as well as the monoculture farming system promoted by the government. These approaches largely corresponded to their position on the agroecological continuum. Farmers at the higher end of the continuum showed negative feelings towards the use of mineral fertilisers and monoculture farming, whereas those at the lower end of the continuum supported them.

The second set of findings emerged from focus groups and individual interviews with CA farmers in the four study areas. These interviews focused on various factors that farmers perceived as constraints to adopting and scaling-up CA. Most of the constraints identified in this study, for example, a shortage of mulching materials, shortage of manure for organic soil fertilisation, lack of means to transport organic fertilisers and mulching materials, high labour requirements, small landholding, and lack of effective pest and disease control, stem from smallholder farmers' limited access to agricultural resources and services necessary for productive CA. Other themes emerged as potential constraints. Conflict with the policy to boost mineral fertiliser use and the imposition of monoculture farming under the CIP stem from tensions between government policies around agricultural intensification and commercialisation, and smallholder farmers' strategies for enhancing household food security and resilience in the face of increasing climate variability. These potential constraints were especially identified by CA farmers who believe that the application of agroecological principles should be the hallmark of CA.

Currently, efforts to promote CA in Rwanda seem to be gaining momentum due to the official recognition it is given as a form of climate smart agriculture (CSA) in PSTA 4. This plan proposes a new policy direction and associated measures in response to the need for 'increased climate resilience and vulnerability management'. The findings we present in this paper point to the need to address constraints stemming from smallholder farmers' limited access to various resources and services necessary for productive CA. This requires considerable allocations of resources from the government, international agencies, and NGOs. The findings concerning the tensions between government policies for agricultural transformation under the CIP and smallholder farmers' agroecological practices that are geared toward household food security and resilience should draw attention from policymakers and other stakeholders in the efforts to build sustainable, climate resilient agriculture in Rwanda. These policy-related constraints must be acknowledged and discussed so that continuous efforts can be made in policymaking and implementation to give smallholder farmers more space and increased support for experimenting, adopting, and expanding a farming system with greater productivity and climate resilience in the future.

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