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Modernising agriculture through a 'new' Green Revolution: the limits of the Crop Intensification Programme in Rwanda

Giuseppe Davide Cioffo[a*], An Ansoms[a] and Jude Murison[b]

[a]*Centre for Development Studies, Université Catholique de Louvain, Louvain-la-Neuve, Belgium;* [b]*University of Antwerp, Research Centre for Longitudinal and Life Course Studies, Antwerp, Belgium*

Over the past decade, African agriculture sectors have been the object of numerous initiatives advancing a 'new' Green Revolution for the continent. The low productivity of African smallholders is attributed to the low use of modern, improved agricultural inputs. In short, African countries are expected to catch up with the Green Revolution in other parts of the world. This paper is a contribution to the debate on the new African Green Revolution. We analyse the Rwandan Crop Intensification Programme (CIP) as a case study of the application of the African Green Revolution model. The paper is based on research at the macro, meso and micro levels. We argue that the CIP fails to draw lessons from previous Green Revolution experiences in terms of its effects on social differentiation, on ecological sustainability, and on knowledge exchange and creation.

Keywords: agriculture; Green Revolution; Rwanda; modernisation; livelihoods; CIP

[Moderniser l'agriculture par une 'nouvelle' Révolution verte : les limites du « Crop intensification programme » au Rwanda.] Pendant les dernières dix années, les secteurs agricoles des pays africains ont connu un nombre important d'initiatives pour la promotion d'une 'nouvelle' Révolution verte pour le continent. A cause de la faible productivité de leurs activités agricoles, en fait, il est demandé aux petits producteurs africains de rattraper leur désavantage par rapport aux pays de la Révolution verte. Cet article est une contribution au débat sur la nouvelle Révolution verte en Afrique. L'article analyse le Programme d'intensification des cultures rwandais (Crop Intensification Programme, CIP) en tant qu'étude de cas de l'application du modèle de la Révolution verte. La discussion présentée dans cet article dérive d'un effort de recherche à trois niveaux : macro, meso et micro. L'analyse révèle que le CIP ne prend pas en considérations les résultats des expériences précédentes de Révolution verte, en particulier pour ce qui concerne des questions de différentiation sociale, de durabilité environnementale et de création et diffusion des connaissances.

Mots-clés : agriculture ; Révolution verte ; Rwanda ; modernisation ; moyens d'existence ; CIP

Introduction

Discourses on agriculture modernisation in sub-Saharan African over the last decade have focused on the necessity of increasing the productivity of land and labour in order for

*Email: giuseppe.cioffo@uclouvain.be

African countries to fill the African 'yield gap' (World Bank 2007; Lawrence 1988, Patel 2013). In the proposals of international donors and development agencies, the low productivity of African smallholders is attributed to low use of modern, improved agricultural inputs. In short, African countries must catch up with the Green Revolution in other parts of the world, in order to both boost their productivity and address their mainly rural type of poverty. Advocates of the new 'Green Revolution for Africa' argue that models of agricultural intensification based on off-farm industrial inputs such as improved seeds and chemical fertilisers may strengthen smallholders' ability to increase yields and participate in national and international agricultural markets (World Bank 2007).

Rwanda is one of the countries that embarked on a process of agricultural modernisation via a Green Revolution approach. Although internationally acclaimed for its success in terms of GDP growth, Rwanda remains a largely agricultural country, and agriculture remains the backbone of the Rwandan economy (MINAGRI 2011; GoR 2004). According to the third Integrated Household Living Conditions Survey (EICV III) (NISR 2012) and World Bank data (2012), between 75 and 78% of the country's active workforce is employed in the agricultural sector, either in wage labour or in independent farming activities. This mass participation in the agricultural economy occurs in the context of a small, landlocked country, with one of the highest population densities in the African continent – more than 430 people per square kilometre (World Bank 2012). As a result, Rwandan agriculture is mainly based on small-scale family farming units (with an average plot size of 0.75 ha), concentrating their activities on production for household consumption and local market exchange (Ansoms 2010). Moreover, with the rate of population growth among the highest on the continent, the Rwandan government is convinced that the agricultural sector has to do more, shifting 'from producing enough to producing surplus' (MINAGRI 2011).

This article proposes a critique of the modernisation process articulated through the Crop Intensification Programme (CIP), the main policy initiative adopted by the government of Rwanda to bring about agricultural intensification. In particular, we assess the extent to which the Green Revolution offers a viable model of agricultural production for Rwandan smallholder farmers. The article adopts a 'triangular' approach, combining an analysis of the discourse on agricultural modernisation in macro-level policy documents, with micro-level views from peasant communities, and with information collected at the level of district agronomists. We draw our data from three phases of field research carried out in 2011 (subsequently referred to as 'Research 2011'), 2012 ('Research 2012') and 2013 ('Research 2013').

In the first part of the paper, we examine how the ambitions of the CIP fit into a broader Green Revolution rationale as promoted by international donors and the World Bank, and we compare critical scholarship on previous Green Revolution experiences with the new Green Revolution model. The paper then focuses on three of the four specific aspects of the CIP in the Rwandan context: the implementation of land use consolidation, the distribution of fertilisers and improved seeds, and the provision of proximity extension services. We analyse the extent to which CIP policies address smallholder farmers' livelihood challenges.

The 'old' and 'new' Green Revolutions: criticism and challenges

The CIP assumes that the 'Green Revolution in Asia and elsewhere was mediated by the facilitation of modern inputs such as improved seeds, fertilisers and pesticides'. This allowed the latter to 'increase their crop production levels' (MINAGRI 2011, 8). The

'upgrading' of the Rwandan agricultural sector, therefore, would require the 'replication of such adoption of modern inputs by the smallholder farmers' (*Ibid*.). This discourse is in line with the emerging rhetoric of a 'new Green Revolution for Africa'. It is the World Bank's opinion, in fact, that ensuring food security and the profitability of agriculture for African farmers will require a 'revolution in smallholder farming' (World Bank 2007, 1) based on the introduction of professionalised inputs such as improved seeds and chemical fertilisers and pesticides, distributed through private-friendly state interventions in input markets (*Ibid*. 135, 150–151).

The claim for a new African Green Revolution was welcomed by significant private actors, namely the Rockefeller Foundation and the Bill & Melinda Gates Foundation. Both foundations joined in a partnership in 2006 to fund the Alliance for a Green Revolution in Africa (AGRA), with the aim of making African farming systems more productive and competitive. The ambitions of such 'new' Green Revolutions are largely inspired by the 'old' Green Revolution wave that took place in the 1960s and 1970s. The term refers to 'the rapid growth in Third World grain output associated with the introduction of a new package of tropical agricultural inputs' consisting of 'a combination of improved grain varieties [. . .], heavy fertiliser usage and carefully controlled irrigation' (Cleaver 1972, 177).

As Patel points out:

> the 'New Green Revolution for Africa' rhetoric suggests that investments in improved agricultural methods had somehow and until now 'bypassed' sub-Saharan African, while '[T]here has been sustained investment in agricultural technology in Africa. Yet narratives of African agricultural development [. . .] consistently represent Africa as the continent passed over by the Green Revolution. (Patel 2013, 33)

While in sub-Saharan Africa most of colonial agricultural investments were destined to large-scale settler agriculture (Bernstein 2010), the post-colonial state focused on the development of nationwide systems of agricultural production based on the assumption that '[T]he hand-hoe will not bring us the things we need today . . . We have got to begin using the plough and the tractor instead' (Nyerere 1966, 183–4, cited in Coulson 1981, 71). The idea that market-oriented capital-intensive agriculture would foster economic development nourished the implementation of state-led programmes of investments in agricultural villages (ujamaa) in Tanzania (Coulson 1981, Scott 1985) and of agricultural intensification in countries like Niger (Roberts 1981) and Ghana (Beckman 1981).

The guiding principle of such intervention was the idea that 'traditional' African farming is irresponsive to change, low-yielding and would not bear the technology needed to increase the productivity of land and labour (see Heyer, Roberts and Williams 1981; Williams 1981). Such assumptions were also the basis of interventions in the agricultural sector during the 1970s and 1980s, the age of Structural Adjustment Programmes and of market liberalisation (see Havnevik et al. 2007, Ponte 2002). While dismantling state support for agricultural modernisation and pushing for the full commodification of inputs and output, both the state-led and the liberal models failed to improve the livelihoods of African smallholders, while often increasing inequality and having adverse effects on smallholders' production basis (Havnevik et al. 2007).

The classical criticism of the Green Revolution approach can be summarised in three main points. The first criticism calls into question the validity of the relationship between input use, increased agricultural output, and improved living conditions for smallholders. Advocates in favour of the 1960s and 1970s Green Revolution claim that a positive relationship exists between increased input use on the one hand, and higher income for rural

actors – including smallholder farmers – on the other. Lipton (1989) even frames it as a 'necessary' relationship. The author points to the intrinsically higher productive potential of improved inputs, which should in turn raise income through two mechanisms: the marketing of the increased output and the larger amount of labour required to handle the increased output during the harvesting process. Moreover, it is also assumed that higher food production will push down food prices, thus increasing real wages (*Ibid*.) and improve overall food security (World Bank 2007).

However, as Das (2000) points out, this 'necessary' relationship is not straightforward. First, the use of improved inputs tends to be expensive, which reduces access for resource-poor farmers. State subsidies might mitigate this problem, but such subsidy schemes tend to be temporary. This is problematic, given that research on input use trends in sub-Saharan Africa shows that subsidies are crucial to sustain high input use in the long term (Crawford et al. 2003, 279–280; Dorward and Chirwa 2011). Second, the application of Green Revolution technologies does not necessarily enhance labour demand. On the contrary, large-scale production often requires mechanical harvesting through the use of tractors and other machineries, which tend to reduce the need for rural labour force (Das 2000; see also Freebarin 1995 and Ladejinsky 1969). The resulting surplus of labour would also 'depress the increase in real wages brought about by low food prices'. (*Ibid.* 63). The relation between smallholder farming and rural labour poses the crucial issue of rural class relations at the core of the social impact of Green Revolution programmes (Cliffe and Moorsom 1979; see also Republic of Rwanda 2013; Gökgür 2012), posing questions for the role of the state in the effective integration of newly dispossessed workers in capitalist agriculture (Lawrence 1988).

The second criticism questions the environmental sustainability of Green Revolution technologies, in terms of both the conservation of natural ecosystems and biodiversity, and the long-term productive potential of such farming models. The debate on the environmental effects of intensive input use is still ongoing. There is strong evidence that the intensive adoption of monoculture arrangements raises pressure on water and soil resources (Singh 2000, Tilman 1998, Wilson 2000, Tilman et al. 2001, Patel 2013). As a result, fertiliser use becomes indispensable, given that without it the important nutrient losses in the soil would make it impossible to achieve the spectacular Green Revolution yields. However, the intensive use of chemical fertilisers aggravates soil and water salinisation, a process that also risks spreading to neighbouring 'traditionally' farmed plots (Patel 2013).

Environmental sustainability is also important in terms of assuring long-term farming systems' productivity. According to Weis (2010, 2007), environmental externalities not only represent the 'hidden costs' of capitalist industrial farming, but they also undermine the 'operative logic' of these farming models as they

> mask the deterioration of the very biophysical foundations of agriculture. These include the undervaluation of the damage associated with: soil erosion and salinization, the overdraft of water and the threats to its long-term supply; the loss of biodiversity and crucial 'ecosystem services' [. . .] and [greenhouse gas] emissions. (Weis 2010, 316)

Biodiversity represents a major concern for Thompson (2012), who sees the development and distribution of hybrid seeds in Africa under initiatives such as AGRA as theft of African genetic biodiversity, 'without benefit-sharing nor recognition back to those who developed the cultivars for centuries' (*Ibid*., 345). Moreover, Cliffe and Moorsom (1979) have shown how in Botswana changing rural class relations entailed changes in producers' environmental stewardship, which can negatively affect agricultural productivity – a line of

criticism which has also been taken up by classical political ecology (see also Blaikie and Brookfield 1987).

The third criticism points to the fact that the Green Revolution approach is often treated as the only possible body of agricultural knowledge at the expense of traditional knowledge and practices. From their original proponents to their contemporary counterparts, the Green Revolution discourse is framed in the language of modernisation and seen as antithetical to 'tradition', which is associated with farmers' knowledge and practices. Morgan and Murdoch (2000) highlight how Green Revolution debates represent a battlefield between, on the one hand, the bureaucratic standardised knowledge produced and administrated by scientific and rational institutions, and on the other hand 'tacit knowledge'[1] seen as a context-specific, experience-engendered corpus of knowledge accumulated by farmers on the ground. According to these authors, Green Revolution environments push farmers to 'trade local knowledge for increased output' (*Ibid*., 165). In fact, the exclusive attention of policy makers and of public and private institutions towards 'scientific' agricultural practices results in the neglect of relevant corpuses of indigenous or alternative knowledge (Schneider and McMichael 2010; Scott 1985; Williams 1981, 28–36). While regarded as backward and somehow static, local-level knowledge can actually be rich in context-specific know-how on how to deal with cyclical adverse agro-ecological conditions.

Overall, these three points of criticism call into question the productive potential of Green Revolution technologies in the medium to long run, and their poverty-reducing potential. By situating the Rwandan experience against these three strands of criticisms, this paper aims at contributing to the debate on the viability of the African Green Revolution.

The Rwandan effort in agricultural modernisation: the Crop Intensification Programme

The CIP is the main policy adopted by the Rwandan government to bring about agricultural modernisation. The CIP aims for the prioritisation of six food crops (maize, wheat, cassava, beans, Irish potatoes, and rice), and at a uniformity in farming practices across the country. The programme focuses on four axes: (1) land use consolidation; (2) the distribution of fertilisers (namely DAP – diammonium phosphate – and urea) and improved seeds; (3) the provision of proximity extension services; and (4) the improvement of post-harvesting handling and storage.

Since its implementation, the CIP has led to encouraging results in terms of productivity. Production of maize, wheat and cassava tripled between 2007 and 2010, bean production doubled, and rice and Irish potato production increased by 30% over the same time span (MINAGRI 2011). However, there is a consensus that the implementation of Green Revolution policies will leave certain categories of farmers behind. According to the Ministry of Agriculture and Animal Resources, since the implementation of the CIP 'some farmers were able to adopt Green Revolution more radically than others' (MINAGRI 2011, 9). In the following sections, we will focus on the experiences of those farmers who have not been able to 'radically' adopt Green Revolution practices. We will do so by analysing their participation in three of the CIP axes: land use consolidation, the distribution of improved inputs, and the promotion of proximity extension services.

Land use consolidation

The first pillar of the CIP strategy is 'land use consolidation', a policy that aims at the rationalisation of land use for profit maximisation and ecological sustainability.[2] Farmers

keep their land rights, but they must use their land in such a way that 'farmers in a given area' grow 'specific food crops in a synchronised fashion that will improve the productivity and environmental sustainability' (MINAGRI 2011, 15). By the end of 2010, 254,000 hectares of land had been consolidated, mainly for the production of beans and maize. At that time this represented about 18% of the total land in the country. The process is expected to continue, as the government aims to consolidate 70% of the national agricultural land by 2017 (*Ibid*.).

The ambition to consolidate the use of land seems to fit within the rationale of previous Green Revolutions. As a strategy, it was crucial during the 'second agricultural revolution' in Europe, in order to increase productivity and yields (Bairoch 1989). Also in India and South-East Asia, achieving increased output was considered to be possible only through the consolidation of large land holdings. This led to a reconfiguration in land ownership and use, favouring large landowners by pushing smallholders to lease or sell their plots (Das 2000). Others, however, have found an inverse relationship between farm size and productivity, even after a Green Revolution has taken place. On the basis of post-Green Revolution data from India, for example, Carter (1984, 144) concluded that 'these results suggest that small-scale agriculture warrants attention as a base for agriculture development in a land-scarce economy.'

In the case of Rwanda, it is indeed questionable whether the consolidation of hill land use is leading to higher productivity rates. Blarel et al. (1992), for example, identified that in pre-1994 Rwanda, land fragmentation was advantageous to farmers' risk management and productivity. For the post-genocide context (2001 dataset), Ansoms, Verdoodt and Van Ranst (2008) found a strong inverse relationship between farm size and productivity, and a slight positive impact of plot fragmentation on productivity rates at farm level. The question is whether these findings will hold if land consolidation is accompanied by the other CIP policy measures. And, even if this were the case, overall productivity is not the only concern.

In fact, another major issue is how land use consolidation is impacting on local food security. The implementation of the CIP implies that local agrarian systems will shift from auto-subsistence-based to being dependent upon market exchange, and that crops usually destined to enhance food security are to be replaced by market-oriented crops. The assumption is that the effects of market integration and economies of scale will increase profitability and households' well-being.

Our own in-depth field research material, however, suggests that this is not straightforward. In 2013, Cioffo gathered data on food security (on the basis of the HFIAS questionnaire[3]) and on land use for 150 households[4] in two settings (henceforward referred to as Settings A and B) in the Northern Province of Rwanda. The consolidation programme had been initiated in 2006–07 in Setting A, and in 2008–10 in Setting B. Households that participated in the study were identified on the basis of their socio-economic category, derived from the *ubudehe* lists,[5] dividing the population in six ascending socio-economic categories. The sample was intentionally biased to include farmers who are poor and cultivate on small plots (between Categories 2 and 3), and who may engage in agricultural wage labour for other farmers or occasionally employ agricultural labour.[6] Farmers in Category 1 (extremely poor) and in Categories 4 and 5 (better-off farmers) are under-represented in the sample.

Table 1 and Figures 1 and 2 present the relationship between land consolidation and food (in)security. The rate of consolidation (rC)[7] is ratio of the number of consolidated plots (cP) on the total number of plots (nP)[8] cultivated by the participating household. With a consolidation rate equal to zero, the household has no consolidated plots. When

Table 1. Consolidation rate for the four HFIAS-category-based subsamples.

HFIAS class	N	rC (average)	St. dev.	rC (median)
1	27	0.43	0.647	0.45
2	18	0.31	0.070	0.26
3	32	0.39	0.536	0.33
4	73	0.60	0.493	0.71
Total sample	150	0.49		0.48

Notes: N=150; rC is rate of consolidation; St. dev. is standard deviation. HFIAS equal to 1 = food-secure household; equal to 2 = mildly food-insecure household; equal to 3 = moderately food-insecure household; equal to 4 = severely food-insecure household.
Source: authors' own data.

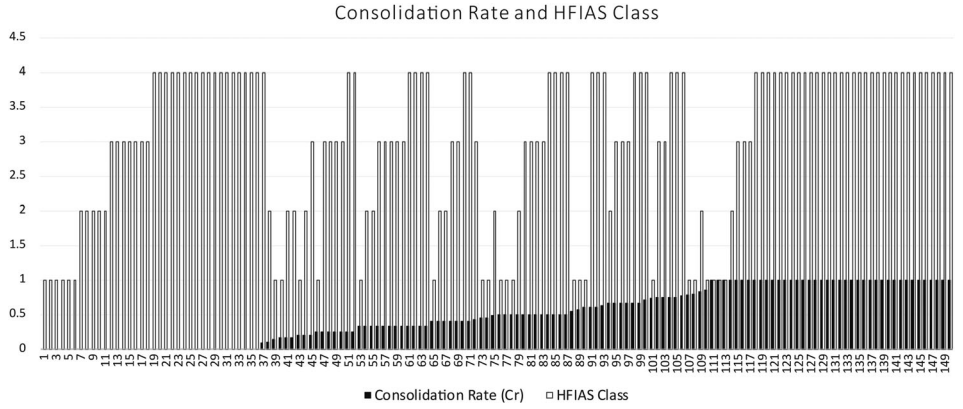

Figure 1. Histogram of Household Consolidation Rate and HFIAS class.
Note: N=150; HFIAS equal to 1 = food-secure household; equal to 2 = mildly food-insecure household; equal to 3 = moderately food-insecure household; equal to 4 = severely food-insecure household;
Source: authors' own data.

the consolidation rate is equal to one, all plots cultivated by the household are consolidated. The HFIAS category (Household Food Insecurity Access Scale indicator) is a measure for household food insecurity over the four weeks prior to the questionnaire. The data allow households to be divided into four classes: 1 – food-secure households; 2 – mildly food-insecure households; 3 – moderately food-insecure households; 4 – severely food-insecure households. Figure 1 presents a histogram, while Figure 2 offers a whisker diagram for each HFIAS class in the sample, representing the distribution within each subsample as regards the consolidation rate.

On the basis of these figures, we see that there is no straightforward linear relationship between land consolidation on the one hand, and household food security on the other. The histogram of Figure 1 indicates a high prevalence of severely food-insecure households (HFIAS=4) among those who have consolidated all their plots (rC=1). The second highest concentration of severely food-insecure households is to be found among the households who have consolidated none of their plots (rC=0).[9] The comparison of the whisker plots (Figure 2) and Table 1 adds further complexity to the analysis. Food-secure households (HFIAS=1) have a somewhat higher mean and median consolidation rate, whereas mildly and moderately food-insecure households (HFIAS = 2 or 3) have the

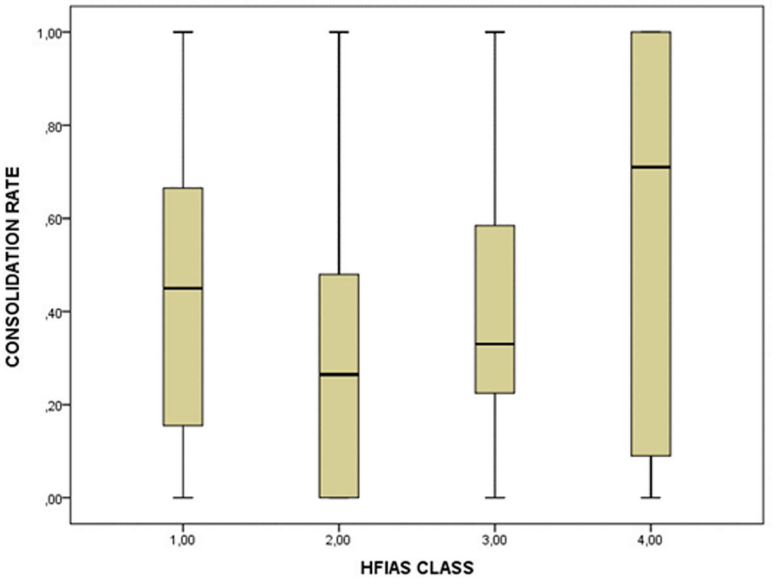

Figure 2. Distribution of consolidation rate for each HFIAS class.
Note: N=150; HFIAS equal to 1 = food-secure household; equal to 2 = mildly food-insecure household; equal to 3 = moderately food-insecure household; equal to 4 = severely food-insecure household.
Source: authors' own data.

lowest consolidation rates. However, the subsample of severely food-insecure households (HFIAS=4) has the highest mean and median consolidation rates.

Why are households with high consolidation rates so often severely food insecure? This is all the more intriguing given that consolidation schemes are generally set on fertile, better soils. As two respondents put it:

> If you have good land, land which is productive, they will make you consolidate, and you will get poor. If you have land on which nothing grows (which is unproductive), they will not ask you to consolidate. (Farmer 109, Setting A, 2013, rc=1, HFIAS= 4)
>
> If you are poor and you consolidate, it is not good for you. But if you are poor and you do not consolidate, it probably means your land is worth nothing. [. . .] If you have a plot down there on the mountains [referring to less fertile area], who is coming to ask you to consolidate? No one! (Farmer 96, Setting B, 2013, rc=0.86, HFIAS=1).

When cross-checking these quantitative data with qualitative data collected during the same field research (Research 2013), three points emerge. First, the imposition of a particular crop type for the consolidated area reduces farmers' ability to spread risk over a variety of plots and crops (see Ansoms 2010; Musahara and Huggins 2005). This is particularly relevant for poorer farmers with limited land holdings, who may prefer intercropping as a risk management strategy. This was all the more relevant during the agricultural seasons of 2013, when a particularly long dry season followed very intense but particularly unpredictable rains (Focus groups with aged farmers, Settings A and B). As two respondents put it:

> [Consolidation] can be good. If the climate is good everything is good. [. . .] But I don't want to consolidate more than this, because then they would force me to do only one crop. They

> don't allow you to mix crops, which is really bad, it is good to have a variety. (Farmer 108, Setting B, 2013, rC=1, HFIAS=4).
>
> This season was very bad, the sun destroyed everything [. . .]. Then there was too much rain, which destroyed all the beans. Before we were mixing everything, sorghum, beans, potatoes . . . now we can't do it any more. So if the rain destroys all the beans, what do you eat? (Farmer 55, Setting A, 2013, rC=0,33, HFIAS=4)

Second, land consolidation may entail a drastic reduction of available organic fertilising matter. The homogenisation of land use may curtail the availability of weeds, banana plants and other matters used for compost (we further explore this in the next section). Particularly households with small and few plots, or with irregular or little access to cash, may find it hard to find fertilising matter, which curtails productivity and food security. As one respondent put it: 'If you can afford fertiliser, and you cultivate, and you have a lot of plots, you will have a lot. But if you don't have anything, you won't have anything' (Farmer 110, Setting A, 2013, rC=0,5, HFIAS=3).

Third, food security is also affected by the crop choice in the consolidation programme, a decision taken by bureaucrats at the national or district level. Farmers often do not recognise these crops as suitable for the local setting's agro-climatic conditions (an issue we will return to in the next section). Moreover, a focus on market-oriented crop types is a risky undertaking for poorer farmers, as they lack access to insurance mechanisms or to storage facilities (Barrett 2008). This was the case for an overwhelming majority of the households in our 2013 sample in the two settings in the Northern Province: the government agency which should have purchased the harvest arrived three months late, forcing farmers to sell at prices 40–50% lower than subsidised prices.

Issues of choice emphasise the top-down nature of the CIP. Land use consolidation is supposedly voluntary and consensual. However, from our interviews with district agronomists and rural communities, participation seemed to be a mere procedural concern. In our 2012 research with district agronomists, we asked whether opting out of land consolidation was possible. Agronomists claimed that there is no obligation to consolidate. However, farmers owning plots in the consolidated area have no choice but to consolidate. Moreover, farmers can only choose among the crops prioritised by the Ministry of Agriculture (Research 2012). This was confirmed during several focus group discussions we had with farmers in 2013. In our own 2013 sample, several farmers only agreed after having been threatened with fines. Two farmers had spent a few nights at the local sector office for having cultivated non-consolidated crops.

The imposition of participation in land consolidation fits with the top-down decentralised structure of the Rwandan administration. Chemouni (2014) showed how the strict implementation of policy objectives through the performance contracts (*imihigo*) at every level of the administration provides a strong incentive for local authorities to achieve policy goals. In one focus group, farmers who were forced to grow cassava argued 'This is because of imihigo contracts. They have to say that a certain amount of people are cultivating cassava, so they made us. This is what they do.' (Focus group with cassava producers, Southern Province, 2013).

The cross-check between quantitative and qualitative data presented in this section indicates that households with high consolidation rates are often severely food insecure due to a combination of bureaucratic commitment to policy implementation, crop choice and management, and non-policy factors. These effects unfold along lines of social inequality: they are less important for medium farmers who may combine production for the household and for the market.

Input distribution – improved seeds and fertilisers

In line with the Green Revolution approach, the use of improved seed varieties and of insecticides and fertilisers is seen by Rwandan policy makers as a main driver for increased agricultural production and poverty reduction (MINAGRI 2011, 8).

Consequently, in 2011 Rwanda imported and distributed about 6000 tonnes of fertilisers through the CIP programme (MINAGRI 2011, 13). This further increased the use of fertilisers in the country, following an already spectacular rise from an average use of 8 kg/ha in 2006 to 23 kg/ha in 2010 (IFDC, quoted in MINAGRI 2011, 14). Moreover, about 5477 tonnes of improved seeds for maize and wheat were distributed between 2008 and 2011, generating an increase in the use of improved seeds of about 37% compared to 2008 levels (MINAGRI 2011, 13–14). Over the same period, about 138,000 tonnes of improved cassava roots and 400 tonnes of improved sweet potato were distributed (MINAGRI 2011).

The problems with the massive distribution of improved agricultural inputs are multiple. First, there is the issue of their accessibility. Chemical fertilisers, for example are distributed to farmers through a voucher systems that subsidises 50% of the price of DAP, urea and more recently also NPK (nitrogen, phosphorus and potassium-combination fertilisers). However, this voucher system is only accessible to farmers that cultivate at least one hectare of land, an entry barrier that is well above the average farm size in the country. (Farmers who do not cultivate enough land may group with others and collectively access seeds and fertiliser – but this is not straightforward.) Moreover, farmers interviewed in 2013 reported that the price of fertilisers rose from about 18,000 Rwandan francs in 2009 up to 26,625 RWF in 2013, an increase of 48% (Research 2013).

Chemical fertiliser was often perceived by our 2013 interviewees as biased towards farmers who hold larger extensions and sufficient capital. As one farmer put it:

> People who have a good harvest, that's because they use fertiliser, while others do not. Chemical fertiliser, for example, if you have a job and you earn some little salary, you can go and buy it. This consolidation, it is good for the rich. (Farmer 116, Setting B, 2013, rC=1, HFIAS=3)

However, this does not mean that farmers who do not have any access to chemical fertilisers remain untouched by modernisation policies. These policies, in fact, have a profound impact upon households' organic fertilisation strategies.

Limited access to fertilisers and improved seeds

In our 2013 research in the Northern Province, 69% of the responding households found their access to organic fertiliser insufficient. In our qualitative interviews, respondents often linked the diminished availability of organic fertilisers to adverse weather conditions, but also to some of the CIP policy measures. Before detailing how these two factors may affect the availability of organic fertiliser, it is worth describing how such fertilisers were provisioned in the two settings before the start of the CIP. There were three ways through which households would produce organic fertiliser. First, household waste (comprising food waste and ashes from cooking) could be used to fertilise the cultivated plots while left fallow. Second, the remains of weeding work on the plots could be used to create 'green manure' (*engrais vert*). Third, animal manure would be used (often in combination with green manure) in order to produce on-farm organic fertiliser. While our 2013 interviewees often referred to the first of these three strategies as not very effective, while the second and the third strategies were seen as viable options.

The CIP policy affected the farmers' ability to fertilise their plots in various ways. In fact, the policy of land use consolidation imposed the homogenisation of vegetal life on consolidated plots of land. Homogenisation naturally causes a decrease in the variety of plants available on the plots. Combined with a particularly long dry season (as experienced in 2013), this meant that less waste was available for producing green manure and for feeding manure-producing animals. Particularly in Setting B, the large extension of consolidated land also meant that a significant number of banana trees, one of the main sources of animal feed, had been cut down. Moreover, the banana tree is 'an important factory in terms of biomass production', and the residue from banana beer production can be used in soil fertilisation (Van Damme, Ansoms and Baret 2014, 124, see also Van Damme 2013). As one farmer put it:

> It's becoming hard to get [organic fertiliser], and that is essentially because people cannot use bananas anymore . . . the government has cut all the banana trees, because they say it is not productive and it is not modern, it is not development . . . . (Farmer 73, Setting B, 2013, rC=0, HFIAS=0)

This dynamic translated to less access to organic *and* industrial fertilisers for the poorest farmers in our 2013 sample. It is unclear whether this is similar for better-off farmers. On the one hand, they do have access to industrial fertilisers. On the other hand, they are subject to the same homogenisation of vegetal life and climate conditions. Especially if the long-term effects of industrial fertilisers on soil structure are taken into account, it is difficult to speculate whether these farmers will be capable of maintaining current levels of soil productivity. In short, when social differences and ecological constraints are taken into account, it is likely that overall the CIP has curtailed farmers' ability to fertilise.

Furthermore, it is also debatable whether the 29% of crop-producing households currently using industrial fertilisers will be able to afford them once government subsidies are withdrawn. As Patel puts it (2013, 16), Green Revolutions 'would not have succeeded without subsidies'. Unsubsidised input markets risk compromising the economic viability of the smallest, resource-poor farmers (Feder and O'Mara 1981). The Rwandan CIP policy seems to acknowledge this risk: 'poor farmers bear the brunt of subsidy withdrawal leading [to] sharp declines in adoption rate, profitability and drops in agricultural productivity in smallholder farms' (MINAGRI 2011, 28). However, in our interviews with district agronomists (Research 2012), there was much less awareness about this problem. Overall, the agronomists interviewed expressed optimism about the capacity of Rwandans smallholders to afford improved inputs, even if the government was to withdraw the subsidies. While this was recognised as a major problem for the long-term profitability of the programme, local agronomists seem blind to the structural challenges preventing smallholders from purchasing fertilisers. The problem of farmers' reticence in input adoption is rather seen as an issue of 'mindset'.

Seeds are, together with chemical fertilisers, part of the Green Revolution package. According to the 2010/11 EICV data, about 19% of all crop-producing households used improved seeds within their farming systems (NISR 2012). Our 2011 and 2013 research highlighted three main problems with the improved seed distribution systems. First, the conditions for access to and use of improved seeds are often set by cooperatives' management, certainly in the case of marshland production. Our 2011 research in the Southern Province suggested that while in some cases the results were encouraging (see for example Cooperative B in Ansoms and Murison 2012), in others, they were far from positive. In several settings, interviewees reported that cooperatives 'had chosen the wrong seed

several times in a row' with extremely adverse consequences for overall output. In addition, many farmers pointed to the problem of not being allowed to regenerate seeds for the next season and resented being entirely dependent on cooperatives to decide 'what to produce next' (Research 2011).

Second, our 2013 research indicates that the price for improved seeds remains a constraint for the poorest smallholder farmers. Indeed, it was true that farmers who managed to purchase the fertiliser pack received free (hybrid or open-pollinated) maize and wheat seeds. However, seeds for other consolidated crops such as Irish potato often remained unaffordable for most farmers. Moreover, increased pressure on seed prices was also reinforced through the consolidation programme itself, as seed prices for traditional crops tended to rise. During our 2013 research, for example, in an area where Irish potato and maize were recommended crops, the price of sweet potato plants and sorghum seeds had skyrocketed (2013, Setting B).

Moreover, non-traditional crops may perform important social functions (see also Cioffo 2014). In the case of Setting B (Research 2013), sorghum represented an important part of the food basket consumed in that region, and sorghum beer brewing had always been an important source of income. Moreover, sorghum requires less work and capital to be transformed into flour, while maize flour production requires a mill. Farmers reported increased stress as a consequence of changes in their food consumption habits.

Inputs versus agro-climatic diversity and ecological sustainability

As mentioned in the previous section, ecological concerns are not only linked to environmental issues, they are also crucial for ensuring long-term productivity gains (Moore 2010, Weis 2007, Woodhouse 2010). The regeneration of soil fertility has always been a major problem for Rwanda, a country with hilly, high-altitude cultivated land and high population pressure (Lewis and Nyamulinda 1995). 'In 1991', in fact, 'farmers estimated that approximately half their land exhibited declining soil fertility. By 2000A (agricultural season) the estimate was at 61% with 72% of farmers reporting a decline in soil fertility' (Kelly et al. 2001). Such degraded land is spread over an important variety of agro-ecological conditions, requiring a case-by-case approach (Steiner 1998). Although a small country, in fact, Rwanda is ecologically rich, and presents a variety of different soils, at different altitudes, that require a diverse approach in order to preserve soil productivity (*Ibid*.). As we have shown in above, the CIP approach tends to reduce rather than enhance diversity when dealing with soil management.

The massive introduction of improved seeds also imposes risks as regards agronomic and ecological sustainability in the medium to long run (see also Yapa 1993). The homogenisation of agricultural practices is often unsuitable for local-level agro-climatic and ecological conditions. Rwandan local seed variety is reducing, while it is an important factor for ecosystem biodiversity, and provides a safety mechanism in case of pests and diseases (Van Damme, Ansoms and Baret 2014). Moreover, whereas relevant personnel from the Ministry of Agriculture and the Rwanda Agriculture Board interviewed in 2012 and 2013 claimed the opposite, farmers in both settings included in the 2013 research reported that hybrid seeds were difficult or impossible to replicate, forcing them to acquire seeds on the market

Proximity extension services

In the case of Rwanda, extension services exist at different levels, with the district and sector agronomists being the most important providers. These agronomists are responsible

for connecting national policy makers with farmers on the ground. However, they lack budgetary and decisional autonomy. Because of this, the inputs they provide to farmers comes from a top-down logic in policy implementation (see Ansoms 2010; Ingelaere 2010), with little concern for realities on the ground.

However, even more problematic is the way in which agronomists themselves envisage peasants' practices on the ground. In several of our 2012 interviews with district agronomists, peasants were regarded as 'rétrograde' (backward), in some way irrational and continuously trying to reject 'modern ways'. Agronomists saw resistance as the result of a lack of understanding or intelligence, which training and sensitisation would help to overcome, regardless of social differences or ecological specificities. One agronomist, for example, told us: 'With their archaic [peasant] practices, there was resistance at the beginning of the CIP. But with time and awareness-raising [. . .], we have overcome them.'

This dissociation between modern practices espoused by agronomists and other service providers, and a backward rural past that the peasant farmers are locked into, is truly problematic. It disregards a priori all forms of context-specific know-how engendered by the accumulation of peasant farmers' experiences from their farming environments. Morgan and Murdoch (2000) find that such pools of 'tacit' knowledge (Polanyi 1966) – which could compete in terms of sustainability with their 'modern' counterpart – tend to be lost as farmers give 'way to the standardised, codified knowledge accompanying chemical sprays' (Morgan and Murdoch 2000, 165). Polanyi's tacit knowledge is a concept akin to that of 'vernacular' knowledge introduced by anthropologist James Scott (1985).

Scott (1985) notices that the replacement of vernacular knowledge with codified, scientific knowledge is essential for states to govern populations and space, and to extract economic surplus. While the link between state consolidation and land consolidation is not the object of this paper, it is worth noticing such double aim of codified knowledge. Des Forges (2006) had already noticed how the RPF-led post-genocide Rwandan government identified traditional Rwandan farming practices as one of the main obstacles to making the country governable, and to trigger economic accumulation. Thus, the diffusion of scientific knowledge on soil fertility and agricultural production continues to consolidate the presence of the Rwandan state in the countryside. Local agronomists appear as dispensers of agricultural modernity. Their role is threefold: to diffuse codified knowledge, to annihilate local repositories of tacit or vernacular knowledge, and to enact state presence. The obvious result of this process is the loss of specific practices and relations that, in the past, made Rwandan smallholder farming viable.

Conclusion: fundamental flaws in Rwanda's Green Revolution approach

While drawing on the international discourse on a 'new' Green Revolution for Africa, the Rwandan CIP presents little that is new. Moreover, contrary to policy discourse, it seems to offer little opportunity to smallholder farmers. The data in this paper illustrate three areas in which the CIP fails to deliver its gains to smallholder farmers, the majority of the Rwandan population.

First, the increase in production seems to provide an advantage to medium and large farmers who are capable of engaging in capital-intensive agricultural techniques, while curtailing economic choice for the poorest producers. This is made evident by failures of food security in the Northern Province, and by the inability of the poorest farmers to access improved, modern inputs. Second, the top-down, bureaucratic approach towards soil management and ecological diversity risks undermining biodiversity and farmers' capacity to maintain the productivity of land and labour. Third, the same top-down approach has led

to the forceful introduction of modern forms of knowledge, consolidating state reach and its capacity to appropriate value from farmers' production while annihilating pre-existing forms of ecological stewardship and agricultural production.

The criticisms of Green Revolutions presented in this paper together with field observations suggest that these three factors are already polarising social differences in the countryside. While the government and more capital-intensive farmers are placed in the space of modernity and capitalist production, the poorest producers are left with feeble access to both industrial and on-farm productive inputs. Increasing inequality in access to agricultural inputs, when combined with the lack of off-farm jobs in the country (Republic of Rwanda 2013; Gökgür 2012), reveals the persistent class bias of the Rwandan CIP and of the African Green Revolution. Such a trend is worrying for the future of those farmers who will inevitably be pushed out of the agricultural sector while lacking wage opportunities in the secondary and tertiary sectors.

Notes on contributors

Giuseppe Cioffo is a PhD student at the *Université Catholique de Louvain* (Belgium) where he studies processes of agrarian modernisation in Rwanda. He is interested in the social and environmental dynamics linked to Green Revolution models as well as in small family farming and agrarian change in developing countries.

An Ansoms is assistant professor in Development Studies at the *Université Catholique de Louvain*. She is involved in research on rural development in land-scarce (post-)conflict environments, and particularly focuses on the Great Lakes Region in Africa. She has co-edited two books, *Natural resources and local livelihoods in the Great Lakes Region: a political economy perspective* (Palgrave, 2011) and *Emotional and ethical challenges for field research in Africa: the story behind the findings* (Palgrave, 2013).

Jude Murison is a graduate of the Universities of York and Edinburgh, and holds a doctorate in Politics and International Studies from the University of Warwick. Jude previously taught in Belgium and at the University of Warwick, UK, and has held Visiting Fellowships at Makerere University, Uganda and Sciences-Po, Paris. Jude has conducted field research in Rwanda, Uganda, Burundi and the Democratic Republic of Congo. Her research focuses on human rights, transitional justice, forced migration, health, rural development and agricultural production.

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Notes

1. Morgan and Murdoch (2000) use this concept in the same way that it was introduced by Polanyi in 1966.
2. The 2005 organic land law also follows this rationale (see Polanyi 1966).
3. The Household Food Insecurity Access Scale (HFIAS) is a measure of food insecurity developed by USAID (2007). The HFIAS measures the food insecurity positions of households at a given point in time, and therefore does not provide an indication of variation over time (linked for example to seasonal variations, change in input availability, etc.): this should be kept in mind

during discussion of the data. However, when triangulated with qualitative data, it may provide a strong indication of the food security trends for the households concerned.

4. The initial sample included 154 households. However, one household did not consent to participate in the HFIAS assessment, while the other three only provided incomplete answers to the HFIAS questionnaire.
5. *Ubudehe* lists divide the population in six ascending socio-economic categories. The average ubudehe category of the selected household is 2.75. The use of ubudehe lists is problematic in itself, as our own fieldwork experience suggests that being placed in one ubudehe category rather than another is often dependent on local politics rather than on household wealth. In our 2013 study, in fact, relatively wealthy households with good connections would often be placed in lower categories by local authorities. Similarly, poor households would often be placed in higher ubudehe classes, in order to meet poverty reduction goals. Therefore, the sample was adjusted during the research through snowball sampling in order to correct these biases.
6. Households belonging to the first category are defined as 'the most vulnerable' (*abatindi nyajujya*), and own no land to cultivate. Farmers in the second, third and fourth ubudehe classes are respectively identified as: vulnerable (*abatindi*), owning very small plots and combining agriculture with agricultural wage work; poor (*abakene*), owning small plots from which they manage to feed their household and, more rarely, engage in agricultural work; non-poor (*abakene bifashije*), working on their own plots and accumulating a small surplus. Farmers in the fifth and sixth categories are respectively defined as: wealthy (*abakungu*), owning fertile land, cattle, savings and often employing agricultural work; and very wealthy (*abakire*), who mostly employ agricultural workers, have access to savings and may live in urban centres (see Ansoms 2010, 100).
7. Ideally, we would have calculated the consolidation rate on the basis of the percentage of cultivated and consolidated area out of the total area the household cultivates. Although this would be a more accurate measure, data on the exact household cultivated areas were only available for less than a half of the sample.
8. rC= cP/nP.
9. This could be explained as a result of the fact that households with only one plot of land are generally poorer and more food insecure. These households either have a consolidation rate of 0 (if their plot is not consolidated) or 1 (if their plot is consolidated).

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