

Recovering from conflict: an analysis of food production in Burundi

By

D'Haese, Marijke; Speelman, Stijn; Vandamme, Ellen; Nkunzimana, Tharcisse;
Ndimubandi, Jean; & D'Haese, Luc

*Poster presented at the Joint 3rd African Association of Agricultural
Economists (AAAE) and 48th Agricultural Economists Association of South Africa
(AEASA) Conference, Cape Town, South Africa, September 19-23, 2010*

**Paper submitted for the AAAE and AEASA Conference September 2010,
South Africa**

Recovering from conflict: an analysis of food production in Burundi

Marijke D'Haese^{a,b}, Stijn Speelman^a, Ellen Vandamme^a, Tharcisse Nkunzimana^c, Jean Ndimubandi^d & Luc D'Haese^{a,c}

^a Department of Agricultural Economics, Ghent University, Ghent, Belgium, Coupure links 653, 9000 Gent, Belgium.

^b Development Economics Group, Wageningen University, Wageningen, the Netherlands, Hollandseweg 1, 6706KN Wageningen, the Netherlands.

^c Department of Bio-science Engineering, Antwerp University, Antwerp, Belgium.

^d Faculty of Agricultural Sciences, University of Burundi, Bujumbura, Burundi, BP 1550, Bujumbura, Burundi.

Abstract

This paper deals with the devastating food insecurity in two densely populated provinces in the north of Burundi as a result of overpopulation and low production capacity in the aftermath of conflict. We compare data that was collected in the Ngozi and Muyinga Province in 2007 with data of households interviewed on the same hills in 1996. Households live from subsistence farming, erratic surplus sales, sales of coffee and banana and occasional off- and non-farm work. We find that not only did production levels decrease but also total factor productivity (Malmquist indices calculated with DEA approach) dropped in 83% of the hills between 1996 and 2007.

Key-words: food security, post-conflict, Central Africa, Burundi, subsistence farming, poverty trap

1. Introduction

In recent years civil wars have gained increasing attention of academics and policy makers leading to a growing body of research that highlights the mutual associations between economic conditions and civil conflicts (Miguel et al., 2004; Bundervoet et al., 2008).

Specifically, researchers are trying to understand the causes of war and its role in reducing growth and development (Collier and Hoeffler, 1998; Miguel et al., 2004; Guidolin & La Ferrara, 2007; Bundervoet et al., 2008). When studying the causes of conflicts most research suggests the existence of a positive correlation between economic under-performance and the likelihood of civil strife (Collier, 1999; White, 2005; Kondylis, 2007). Pinstруп-Andersen and Shimokawa (2008) explain how poverty, hunger and food insecurity together with an unequal distribution of income, land and other material goods generate anger, hopelessness, a sense of unfairness and lack of social justice, which provides a fertile ground for grievance and conflict. Furthermore it is generally accepted that conflicts have a significant and quantitatively important impact on investment decisions at the household level and on general economic diversification (Deininger, 2003; Pinstруп-Andersen and Shimokawa, 2008). Conflicts cause food insecurity and depress production and income from cash crops and livestock, reducing the coping capacity of those dependent on these sources for their livelihood (Messer and Cohen, 2004).

This paper deals with the interrelationships between conflict and food security in Burundi. Between the start of conflict in Burundi in the early 90s and 2002, per capita income fell from \$210 to \$110 leaving Burundi as the world's poorest country. The proportion of people living below the nationally defined poverty line increased during this period from 35 to 68 percent (IMF, 2007). In this paper we analyze the agricultural production of rural households in two densely populated provinces in the north of Burundi at two periods in time (mid-war 1996 and post-war 2007). For these households, agriculture is a way of living, and they primarily depend on subsistence consumption, surplus sales and irregular off- and non-farm work (Baghdadli et al., 2008). This paper sketches the situation of very impoverished rural communities. In 2007, 75% of the households in the sample rated themselves as highly food insecure. This dramatic situation may have been the result of high population pressure

with cyclic conflicts as Malthusian-checks; yet we analyze in this study if the comparison with 1996 shows a worsening long term effect of people being trapped in poverty. At this point, it is worthwhile clarifying that we will not deal with the source of the armed conflict i.e. test the Malthusian law, instead we analyze the possible effect of conflict on the long term food security basis. As indicated by Kondylis (2007) providing an economic assessment of a post-conflict situation appears particularly relevant information to estimate the likelihood of conflict resurgence.

The contribution we want to make with this study is an analysis of the sources of continued impoverishment of rural population of one of the poorest countries in the world in order to inform stakeholders on the dramatic situation these people are in. On a scientific level, the contribution to literature is to provide an agricultural economic study of an undocumented area of the world. We link the food security situation to the direct contributor of food availability, namely the own farm production capacity as well as the market access to food. We believe using panel-data on a ten-year post-conflict period is unique. Although the panel is not on individual but on hill (colline) level, the analyzes demonstrate some clear trends.

2. Background

2.1 Agriculture and malnutrition/food security in Burundi

The agricultural sector in Burundi consists of small-scale, subsistence-oriented family farms. Between 90 and 95 % of the country's households live in rural areas and produce most of the food they consume. An estimated 85% of the total cultivated surface is used for food crop production. Nearly all households grow a mix of food crops, sometimes associated with cash crops. They also own some animals (Baghdadli et al., 2008). Production of these animals is usually low, suggesting that they are more kept for manure, draught power, savings, security

and social status (Cochet, 2004; similar to the situation in Zambia explained by Moll, 2005). The described strategy of on-farm diversification and self-reliance seems to be rational in a context of constant shortage of agricultural land (Oketch and Polzer, 2002; Peters, 2004; Messer and Cohen, 2004; Baghdadli et al., 2008), unreliability of food markets (Messer and Cohen, 2004), and the lack of opportunities to earn income outside of agriculture (resulting from the underdeveloped nature of the non-farm rural economy) (Ngaruko and Nkurunziza 2000; Baghdadli et al., 2008).

The current performance of the agricultural sector is very poor. Clearly the conflict which resulted in displacement of farmers, destruction of infrastructure and loss of livestock is a major explanatory factor for this weak performance, but the situation is further aggravated by inefficient production systems, difficulties in accessing seeds and other inputs, limited access to credit and financial services and high land fragmentation (Oketch and Polzer, 2002; Baghdadli et al., 2008). Symptomatic for the poor access to inputs is the low fertilizer use, which in 1992 was marginal at 3.7kg /ha, much lower than the average of 14.9 kg/ha for sub-Saharan Africa (Ngaruko and Nkurunziza , 2000). Furthermore the intensive cultivation due to high population density (on average of 230/km²) led to a marked decline in productivity of the land with serious soil erosion and soil fertility problems (Oketch and Polzer, 2002).

Trends in aggregate food production during the conflict period are alarming. Bundervoet et al. (2008) estimated that production of cereals declined with 15% between 1993 and 1998, that of roots and tubers with 11%, and that of fruits and vegetables with 14%. Also the average number of tropical livestock units per household decreased dramatically from 2.37 before the crisis to 0.42 in 2001 (UNFPA, 2002). The negative trend has continued after the conflict. Expressed in terms of cereal-equivalents, food crop production in 2005 was only about 62% of the pre-conflict level. When considered on a per capita basis, the decrease

was even more dramatic: per capita food crop production in 2005 was only 45% of the 1993 level (Baghdadli et al., 2008).

In a country where the majority of the population is relying on subsistence agriculture, the negative trends in food production can be expected to have an immediate impact on food security. Indeed, Fournier et al. (1999) report that the conflict in Burundi led to widespread and severe food insecurity. Burundi ranks at the moment last of 119 developing countries in terms of the Global Hunger Indexⁱ. The index rose from 27.7 in 1981 to 32.3 in 1992 and to 42.7 in 2003. An estimated 56 % of the population has a caloric intake of less than 1,900 kcal (Baghdadli et al., 2008).

2.2 Food security and crisis

Borlaug (2004; cited by Pinstруп-Andersen and Shimokawa, 2008) argues that world peace can not be build on empty stomachs. Although no simple generalizations are plausible for explaining why armed conflicts occur, a growing number of case studies and econometric analyzes seems to confirm this and indicates that absolute and relative depreviations due to poor economic and health status are important underlying causes of armed conflicts (Kondylis, 2007; Pinstруп-Andersen and Shimokawa, 2008). Uvin (1996) for instance argues persuasively that food insecurity critically contributed to triggering the 1994 genocide in Rwanda. Such findings partly concur with the hypotheses made by Malthus in his 600-page counting essay first published in 1798. Malthus' point was that as humans 'reproduce' they continually put pressure on the resources for subsistence, which eventually is halted by checks to population growth such as war and epidemics (Leathers and Foster, 2009): 'land, unlike people, does not breed' (paraphrasing Malthus in Leathers and Foster (2009)); or in other words, if malnutrition or ill-health become too problematic due to a lack of subsistence means, the risk on a population correction such as war increases (Leathers and Foster, 2009).

Obviously, war or conflict negatively influences food security and overall wellbeing. Conflicts often cause loss of access to arable land and pastures, changing farming systems and herding strategies, they disrupt trade and access to markets and relief supplies. Furthermore resources are diverged to war efforts and problems associated with demobilization and reintegration arise (White, 2005). Conflicts also destroy productive assets, leading to production losses for subsistence farming households and reduced food availability at country level (Messer and Cohen, 2004). In this sense, the impact of conflicts on food security is comparable to that of environmental disasters, which in their turn can also lie at the origin of conflicts (Messer et al., 2001). White (2005) for instance highlighted a complex web of interactions between drought, food security and the direct and indirect effects of several conflicts in Ethiopia. Carter et al. (2007) explain that poor households may fall in poverty traps after being victim of shocks. In the case of droughts in Ethiopia during the 1990s and the 1998 Hurricane Mitch in Honduras, better endowed household are found to recover from shocks. Poorer households seem to be trapped in poverty (Carter et al., 2007).

Also in Burundi there seems to be a mutual link between the economic and food security situation at one hand and the recurring conflicts on the other. Ngaruko and Nkurunziza (2000) describe how the recent conflict was fueled by a combination of poverty, governance policies of exclusion and the fight for control of the country's limited resources, mainly land. Land scarcity and intense competition for land is also acknowledged as an influencing factor for the conflict in Burundi by Peters (2004). Messer and Cohen (2004) quote it as a contributing factor to the conflict in neighboring Rwanda, while Miguel et al. (2004) and Welsch (2008) more generally point at the negative influence of agricultural resource scarcity on probability of conflict. Moreover, in Burundi the economy seems to be particularly vulnerable and not robust to shocks because the production system is not diversified (Ndikumana, 2001). Some agricultural specialists suggest that a critical factor to

prevent environmental scarcities and food shortages to spark or incite violence is the ability of local people to intensify agricultural production or otherwise diversify livelihoods without degrading the environment (Messer et al., 2001; Deininger, 2003). For Burundi Oketch and Polzer (2002) claim that high population density already resulted in degradation of agricultural resources, limiting the scope for intensification, while Baghdadli et al. (2008) argue that alternative employment opportunities are practically non-existent. In this light, it is particularly striking that governmental development policy in Burundi has largely neglected the rural sector which constitutes the basis for the livelihood of the majority of the population (Ndikumana, 2001).

Unlike earlier episodes of ethnic violence in Burundi that caused temporary shocks to output, the recent conflict has caused a larger decline in production because it has lasted longer and therefore prevented economic recovery (Ndikumana, 2001). The crisis has reversed the slow but steady increase in food production experienced since the 1980s. Even after the conflict, food production was still declining in Burundi as a result of poor security conditions (Ndikumana, 2001; Fournier et al., 1999). This has resulted in a dramatic food security situation (Baghdadli et al., 2008; Fournier et al., 1999).

3. Methodology

3.1 Conceptual framework

Based on the above cited literature, we start by assuming that the rural Burundian households survive mainly from their own agricultural production. Markets for food crops and labor are not well developed; occasional surplus food sales and ill-paid off- and non-farm employment will contribute only little to the food security situation of the households. Basic input for agricultural production is access to land, which is limited due to an ever-increasing population. Successive inheritance have reduced farm sizes, and induced taking more

marginal plots in production. Hence, food security is under pressure, possibly triggering a Malthusian check. Armed conflict is cyclical, ethnically inspired, and devastating for the economy, production resources and wellbeing of the population.

Apart from the erosion in production resources due to conflict, the civil war in Burundi has displaced many households. Many had left their land behind to find refuge elsewhere, abandoned their farm, and/or abandoned the production of cash crops (including cutting of coffee trees by those who remained in the rural areas). As a result, export of coffee (country's most important income source) was undermined. Yet, what we find is that those who stay behind, or those households that have returned after some time, are left with very limited land and other production resources in a context of absent labor markets and massive market failures which would be crucial to cover food needs. The support to coffee production and other extension services is limited. As a result, we hypothesize that rural households are caught in a poverty trap.

To check whether this hypothesis holds true, we argue that being trapped in poverty is not only a matter of limited resource access, but also one of limited returns levels. Barret (2005) argues that when caught in a poverty trap households 'sink' towards a low productivity subsistence equilibrium; poor households lack the productive asset levels necessary to generate (endogenous) growth. This is because income, or in our study agricultural production, depends on both the level of endowments of productive assets and the sorts of returns the household can reap from these assets, or mathematically this is described in the following equation (Barrett, 2005):

$$dY = dA'R + A'dr + A'd\varepsilon^R + d\varepsilon^T + d\varepsilon^M \quad (1)$$

with Y income, production; A asset levels, r returns to assets, ε^R is an exogenous shock to physical productivity (e.g., rainfall or pests), input, output prices, ε^T the transitory exogeneous

income, and ε^M the measurement errors. ε^R , ε^T and ε^M are stochastic elements; their mean is zero, with constant variance and they are serially independent.

The ex ante expected income change becomes (Barrett, 2005):

$$E[dY] = dA'r + A'dr \quad (2)$$

The expected income change is due to a change in asset levels and a change in expected returns to these productive assets. It is argued that the potential to improve expected returns in turn depends on the level of endowments. Households trapped in poverty with an endowment level below the so-called Micawber threshold, face entry barriers to enter more remunerative livelihood strategies (Barrett, 2005).

In this study, we focus on the impact of conflict on productivity levels due to possible endowment erosion all resulting in a poverty trap. In absence of panel data on an individual level, it is difficult to specify the Micawber threshold. Our attention therefore turns to the changes in productivity levels of the rural households over time and its determinants.

Using a Data Envelopment Analysis (DEA) methodology we calculate the Malmquist indices for changes productivity levels of subsistence production between 1996 and 2007. This enables us to check the impact of a 10 year period of conflict and post-conflict on the efficiency levels as well as levels of endowment at colline level.

3.2 Data analysis

3.2.1 Data

Data was collected among households in the Ngozi and Muyinga Provinces in the north of Burundi. Both provinces are densely populated and in particular Ngozi has been badly affected by the civil war (Bundervoet, 2009).

In 1996 the University of Burundi was asked to establish a base line survey of the agricultural production in five provinces in Burundi among which Ngozi and Muyinga

(Minagri, 1996). The survey covered all municipalities in the provinces, and in each municipality a set of hills/collines was selected. The term ‘collines’ is preferred to ‘hills’ because it refers to an institutional entity that coincides with a particular hill; it delineates a community headed by a chief ‘de colline’. In total 160 collines were selected of which 115 were visited in 1996. On each colline four households were randomly selected, yielding a total sample of 468 households, 204 in Muyinga and 264 in Ngozi. In 2007 the same collines were revisited with a similar questionnaire. On each of the 160 collines again four households were randomly chosen. It was not possible to retrieve the same households that were interviewed in 1996 because of the namelessness of the 1996 sample. In 2007, a total of 640 households were interviewed, 280 in Muyinga and 360 in Ngozi.

The interviews were held in Kirundi in collaboration with a team of the University of Burundi. The questionnaire inquired on household, farm and farming system characteristics. The farm input and output data covered one production year, namely seasons 1995C, 1996A and 1996B for the 1996 data, and seasons 2006C, 2007A and 2007B for the 2007 dataⁱⁱ. The questionnaire also included questions on expenditure on different farm inputs and on additional food stuffs bought on the market. For the 1996 data, the 2007 value of these expenditures were calculated using the inflation figures published by the National Bank of Burundi and reported in the PRSP of Burundi in 2006 (Republique du Burundi, 2006) and by the IMF (IMF, 2009).

3.2.2 Analysis of farm production

Farm production is taken as the sum of food production and cash crops. Cash crops are coffee and banana; food crops include beans, cassava, sweet potato, maize and to a lesser extent other vegetables. The production of bananas is taken separately because banana can be considered as a semi-cash crop as mentioned above. In order to enable summing up the

production volumes and to explore their contribution to food security, we convert food production volumes to their content in calories. The farm production is then related to inputs as illustrated in the following equation:

$$Y_{colline} = \sum_{i=1}^4 Y_i = \sum_{i=1}^4 (Q_{foodproduction} (kcal) + Q_{bananas} (kg) + Q_{coffee} (kg))_{colline} \quad (3)$$

$$= f_{colline} (labour, land, inputs)$$

Traditionally evolution in productivity has often been assessed in terms of a single input factor, such as labor or land productivity. However in reality, multiple inputs are simultaneously utilized in production and often there is more than a single output as well. When having multiple outputs and multiple inputs, it is preferable to measure total factor productivity (TFP) changes: the change in total output relative to changes in the use of all inputs. This measurement allows comparing units with non-identical production functions, because differences in outputs are explained in terms of differences in efficiency and technology (Caves et al. 1982). In this study a Malmquist index, based on DEA (Data Envelopment Analysis) was used to measure TFP change between 1996 and 2007. The Malmquist TFP index measures the change between two data points by calculating the ratio of distances at each data point relative to a common technology. In this study we use output oriented distance functions, which consider a maximum proportional expansion of the output vector, given an input vector.

The output-based MI, as defined by Färe et al. (1994), may be written as follows:

$$MI(y_s, x_s, y_t, x_t) = [MI_s, MI_t]^{1/2} = \left(\frac{d_t^t(y_t, x_t)}{d_s^s(y_s, x_s)} \right) \left[\frac{d_t^s(x_t, y_t)}{d_s^t(x_s, y_s)}, \frac{d_s^s(x_s, y_s)}{d_t^t(x_t, y_t)} \right]^{1/2} \quad (4)$$

The first term on the right-hand side measures the change in efficiency (EC) between period t and s . The second term represents the technical change (TC), measured by the geometric

mean of the frontier shift between t and s with respect to two input levels x_t and x_s . In this way the Malmquist index is decomposed into technical change and efficiency change. A TFP score greater than one indicates a gain in productivity; conversely, a value lower than one indicates deterioration. The same holds for interpreting the EC and TC components of the Malmquist index. Values greater than unity, indicate positive contributions to TFP growth, and values lower than one indicate negative contributions (Fulginiti & Perrin, 1997).

The returns to scale efficiency change is composed of pure efficiency change and scale efficiency change. Pure efficiency change is the change in technical efficiency under the assumption of a variable returns to scale technology. Scale efficiency change is the difference between the variable returns to scale and the constant returns to scale technology (Fulginiti & Perrin, 1997).

The four output oriented distance measures equation 4 can be obtained by solving four simple linear programming problems of the following form for each observation:

$$\left[d_s^t(x_s, y_s) \right]^{-1} = \max_{\theta, \lambda} \theta \quad (5)$$

$$\text{s.t.} \quad -\theta y_{is} + Y_t \lambda \geq 0, \quad (6)$$

$$x_{is} - X_t \lambda \geq 0, \quad (7)$$

$$\lambda \geq 0 \quad (8)$$

Once the Malmquist indices for total factor productivity change between 1996 and 2007 are calculated, we explore the determinants of this change. Following the theory of poverty traps explained above, we assume that households on collines that do relative well will have a higher probability to have improved efficiency levels. We check for the influence of availability of land and labor, financial capital, access to other livelihood options, and other farm and household characteristics at the starting point of the analysis namely 1996. Furthermore, we add in the relative efficiency scores for the farms in 1996 to the equation (9).

This is to check whether relative efficiency influences productivity changes. Finally we control for location.

$$Efficiencyscore = e(Y_{colline}) = g(H_i, L_i, F_i, A_i, E_i, VRS_{1996}, province) \quad (9)$$

with H_i representing household characteristics (household size, age and gender of head of household); L_i being livelihood options, namely whether the households undertake salary work and are involved in commercial activities; F_i are farm characteristics such as the total number of plots, farm intensity as measured by the share of plots under fallow over total number of plots, on-farm diversification measured by a herfindahl index and market orientation (share of the banana production sold as this is the only farm product except for coffee that is sold by reasonable share of households); A_i are farm size and farm size squared to check for a non-linear relations; and E_i are proxies for household endowments other than land, namely the number of cattle owned and total expenditure on farm inputs and food. We add the relative efficiency scores obtained for 1996 and a dummy for location in Ngozi or Muyinga.

4. Results

4.1 Poor subsistence farming

The situation of the Burundian households that we will describe is one of poor farmers, using very little inputs for a subsistence production. We first give an overview of the basic farm characteristics of the households interviewed in Ngozi and Muyinga in 2007; and in the following section we analyze if and how the conditions have changed between 1996 and 2007.

The respondents in 2007 were mainly men, of a relatively young age at the head of large households (Table 1). This reflects the typical situation of Burundi, where the average life expectancy at birth is 57.8 years and 57.8% of the population is younger than 14 years old (CIA Worldfactbook, 2010). About half of the household members were actively participating in farm activities, but most of the households in the survey (83%) also gained at least some part of their income outside their own farm. For 53% of the households the income received outside the farm contributed to less than a third of the total household income. In depth analysis of the data showed that in general the poorest groups had a higher likelihood to participate in off-farm activities suggesting the occurrence of push diversification (see Vandamme (2008) for more details).

>> insert Table 1 about here

The average farm size was 1.125ha; however when 30 outliers with more than 3.7 ha were excluded, the average farm size dropped to 0.834ha. Figure 2 illustrates the farm size distribution. About 45 % of the farms in the sample had less than 0.5ha. Farms were larger in Muyinga compared to the more densely populated Ngozi Provinceⁱⁱⁱ (Table 2). The farms were furthermore highly fragmented with on average more than eight plots on the collines (hill), and one to two plots in the swamps^{iv} (marsch). Of these plots, only a few were left fallow, which suggests an intensive use of the available land. Two cash crops were produced, namely coffee for export and bananas for consumption as vegetable and dessert, and for beer production (Rishirumuhirwa & Roose, 1988; Cochet, 2004). Compared to Muyinga, Ngozi counted more farmers with coffee; moreover the number of coffee trees and the production were higher. Banana production seemed equally important in both provinces. Traditionally livestock is considered as the main form of financial capital in Burundi (Bundervoet, 2009).

Yet in 2007, a minority of the farm households kept (a very limited number of) cattle. As for small ruminants, goats are more common than sheep. This could be caused by the fact that several communities in this study have benefited from a goat promoting project. More than half of the households kept at least one goat, and on average they had two to three animals.

>> insert Table 2 about here

>> insert Figure 1 about here

4.2 Comparison production capacity between 1996 and 2007

As explained above, we averaged the characteristics of the four households interviewed on each of the collines visited in 1996 and 2007 to evaluate the effect of post-conflict development. In total 113 collines sampled in 1996 were revisited in 2007.

A comparison of production and household characteristics of the collines is given in Table 3. Changes were noted in household size, and in age and gender of the head of the household. A positive evolution was the improvement of access to non-farm labor and trade. However, these jobs are often not well paid as illustrated by the very low expenditure levels of these households.

Overall production levels of food crops, banana and coffee decreased between 1996 and 2007. Food production per person per day decreased from over 4000 to a level of about 1500 kcal/person/day. The comparison of changes in levels of farm production factors shows that average farm sizes were not reduced, while the average number of plots decreased. Production became more concentrated and fewer plots were left fallow. Finally, no significant changes were noted in endowment levels as indicated by the number of cattle kept. Yet average expenditure levels on food and inputs increased.

>> insert Table 3 about here

4.3 Efficiency analysis

Using DEA, the efficiency levels of the average farms on each colline were calculated. Figure 2 shows the results for variable to scale (VRS) efficiency levels. It is not possible to compare the 1996 and 2007 VRS efficiency scores because these figures are calculated relatively to the efficiency frontier for 1996 and 2007 collines, respectively. In 2007 more collines were on the efficiency frontier compared to the 1996 situation. In 1996 more variability can be noticed. The average efficiency level in 1996 was 0.69 (standard deviation 0.245), while in 2007, this was 0.76 (standard deviation 0.224) (Table 4).

>> insert Figure 2 about here

In 2007, 32 collines were situated on the efficiency frontier, while 80 collines had efficiency levels below this frontier. The collines considered to be efficient were characterized by a younger head of household (38.4 years compared to 40.9 years of age on average for less efficient collines) and a relative smaller household (5.3 persons in the household compared to 5.8 on less efficient collines)^v. No difference was found for land size or level of fragmentation. In terms of production, efficient farms produced significantly more coffee (438.3kg on average, compared to 228.3kg produced on less efficient farms), and produced a higher crop output when considered per capita per day (1905kcal/person/day compared to 1296 kcal/person/day, banana production excluded, and 3753kcal/person/day compared to 2471 kcal/person/day when banana production is included). No significant differences were

found in expenditure on input use between efficient and less efficient farms. A comparison of the herfindahl index finally shows that production on efficient farms is less diversified.

4.4 Changes in total factor productivity

The DEA approach was also used to calculate the Malmquist index which measures changes in total factor productivity between 1996 and 2007 at colline level (Table 4). For most collines (86%), the Malmquist index of change in total factor productivity was smaller than unity, indicating a worsening of the farmer's productivity levels between 1996 and 2007. The indicators for technical change were particularly low, while average pure efficiency change and scale change were on average slightly larger than one. The Malmquist index was significantly larger in Ngozi than in Muyinga, but no significant differences were found for change in efficiency, pure efficiency or scale efficiency.

>> insert Table 4 about here

The collines were categorized according to the quartiles of the Malmquist indices they scored. The determinants of the probability of belonging to a specific quartile were analyzed in an ordered logit model. The estimates are reported in Table 5, and they should check the hypothesis that less endowed collines showed lower rates of recovery. Yet, the model results were not conclusive. They mainly show that the collines with a higher probability to belong to the first quartile with the lowest Malmquist indices were characterized by, on average, large households, less female headed households, less access to paid jobs, higher on-farm diversification, larger farm sizes along an U shape, being situated in Muyinga and relative higher efficiency scores in 1996.

>> Insert Table 5 about here

The non linear relationship with land is remarkable. The probability of being in a higher TFP quartile decreases with land size, but this trend is reversed for larger farm groups. The relationship follows a U shape. It means that mainly the middle-sized farms were more likely to experience a decrease in TFP. With regards to the relative efficiency levels of 1996, the negation coefficient confirms the findings of Figure 3 namely that the differences in efficiency levels between the farms were smaller in 1996 compared to 2007. Farms with relatively high efficiency levels in 1996 seemed to have dropped in TFP towards 2007.

Finally, the effect of location can be explained by the better overall situation of the Ngozi province. It has a larger trading center, namely the city of Ngozi, and it is renowned for its coffee production.

5. Discussion and conclusion

The main conclusion from this paper is that the resilience of the farms in the Muyinga and Ngozi Provinces of Burundi to recover from conflict is very low. Farms did not succeed in recovering; they are still trapped in poverty, even farms of middle to large size.

The situation outlined throughout this paper is one of a continually impoverishing farming community. Households are poor and severely food insecure due to a limited availability and accessibility of food. Households seem to fail to cover their own needs by home production, due to limited access to production factors, including land and necessary additional inputs. In comparison with the situation at mid-conflict time (1996), deterioration is mostly pronounced in terms of production, but less in average land and cattle ownership. Furthermore, the results from the Malmquist analysis show that households failed to improve efficiency levels, and instead average productivity decreased on most farms.

Overall, the study shows that households did not yet recover from conflict as they are still sliding further into poverty. We would have expected to find a group of households who had succeeded to escape the poverty trap, but instead we find a general trend of households sliding deeper into poverty. Inequality in land ownership remains high, but the level of efficiency with which this land is being used has evened towards a lower steady state. All farms are doing equally well, or bad(?). Due to conflict and the bad economic situation of the country, households seem to suffer severely from the lack of support systems, bad infrastructure, underdeveloped local markets and limited access to national markets, missing input markets and absence of a well paid labor market.

Some issues need more research in order to be clarified. Due to a lack of detailed income data we were not able to analyze the contribution of off-farm and non-farm income to farm productivity and food security. While we assume that this contribution is limited, it has shown to be significant in the ordered logit analysis. This is matter of further research. Another question for future research is the importance of cropping patterns. Due to the common practice of intercropping, the calculation of production levels of separate crops is not straightforward. It would be interesting to analyse the importance of crop choice on efficiency levels. Finally, the efficiency levels in this paper are calculated with a DEA approach. DEA has the advantage to allow a multiple input multiple output model, but it is reported to be sensitive to noise. Future research could benefit from the comparison with other estimation models using parametric approaches.

6. References

Baghdadli, I., Harborne, B. & Rajadel, T. (2008). Breaking the Cycle. A Strategy for Conflict Sensitive Rural Growth in Burudni. World Development Working Paper No 147. The World Bank, Washington D.C.

- Barrett, C.B. (2005). Rural poverty dynamics: development policy implications. *Agricultural Economics*, 32(s1), 45-60.
- Bundervoet, T. (2009). Livestock, Land and Political Power: The 1993 Killings in Burundi. *Journal of Peace Research*, 46(3), 357-376.
- Bundervoet, T., Verwimp, Ph. & Akresh, R. (2008). Health and Civil War in Rural Burundi. *The Journal of Human Resources*, 44(2), 536-563.
- Carter, M.R., Little, P.D., Mogue, T. & Negatu, W. (2007). Poverty Traps and Natural Disasters in Ethiopia and Honduras. *World Development*, 35(5), 835-856.
- Caves, D.W., Christensen, L.R. & Diewert, W.E. (1982). The economic theory of index numbers and the measurement of input, output, and productivity. *Econometrica* 5, 1393–1414.
- CIA Worldfactbook (2010). Burundi. The World Factbook <https://www.cia.gov/library/publications/the-world-factbook/> accessed March 2010.
- Cochet, H. (2003). A Half Century of Agrarian Crisis in Burundi (1890-1945): The Incapacity of the Colonial Administration in Managing the Agrarian Crisis of the Late Eighteen-Hundreds. *African Economic History*, No. 31, 19-42
- Cochet, H. (2004). Agrarian dynamics, population growth and resource management: The case of Burundi. *GeoJournal*, 60, 111-122.
- Collier, P., (1999). On the Economic Consequences of Civil War. *Oxford Economic Papers*, 51, 168-183.
- Collier, P. & Hoeffler, A. (1998). On economic causes of civil war. *Oxford Economic Papers* 50, 563–573.
- Deininger, K., 2003. Causes and Consequences of Civil Strife: Micro-Level Evidence from Uganda. World Bank, Policy Research Working Paper 3045,

- FAO (Food and Agriculture Organisation). (2009). Food insecurity in the world, economic crises impacts and lessons learned. Food and Agricultural Organisation. Rome, Italy.
- Färe, R., S. Grosskopf, S., Norris, M. & Zhang, Z.. (1994). Productivity Growth, Technical Progress, and Efficiency Change in Industrialized Countries. *American Economic Review* 84(1), 66–83.
- Fournier, A., Mason, F., Peacocke, B. & Prudhon, C. (1999). The Management of Severe Malnutrition in Burundi: An NGO's Perspective of the Practical Constraints to Effective Emergency and Medium-term Programmes. *Disasters*, 23(4), 343-349.
- Fulginiti, L. E. & Perrin, R.K. (1997). LDC agriculture: Nonparametric Malmquist productivity indexes. *Journal of Development Economics*, 53, 373-390.
- GIEWS (Global information and early warning system). (2010). Crop prospects and Food situation, February 2010. ROME
- Guidolin, M. & La Ferrara E. (2007). Diamonds are Forever, Wars Are Not: Is Conflict Bad for Private Firms? *American Economic Review*, 97(5), 1978-1993
- IMF (2009). World Economic Outlook. Sustaining the Recovery. IMF, Washington DC.
- Kondylis, F. (2008). Agricultural Outputs and Conflict Displacement: Evidence from a Policy Intervention in Rwanda. *Economic Development and Cultural Change*, 57, 31–66.
- Leathers, H.D. & Foster, P. (2009). The World Food Problem. Toward Ending Undernutrition in the Third World. Fourth Edition. Lynne Rienner Publishers. Boulder, Colorado.
- Messer, E. & Cohen, M.J. (2004). Africa. Breaking the Links Between Conflict and Hunger in Africa. 2020 Africa Conference Brief 10, IFPRI, Washington DC.
- Messer, E., Cohen, M.J. & Marchione, T. (2001). Conflict: A Cause and Effect of Hunger. Environmental Change Security Program Report. Issue 7. Woodrow Wilson International Center for Scholars, Smithsonian Institution, Washington DC.

- Miguel, E., Satyanath, S. & Sergenti, E. (2004). Economic Shocks and Civil Conflict: An Instrumental Variables Approach. *Journal of Political Economy*, 112(4), 725-753.
- MINAGRI, Ministère de l'Agriculture et de l'Élevage (1996). Reformulation et mise en place d'un système de suivi-évaluation. Unpublished Project document. Bujumbura, Burundi.
- Moll, H. A. J. 2005. Costs and benefits of livestock systems and the role of market and nonmarket relationships. *Agricultural Economics*, 32, 181–193
- Ndikumana L. (2001). Fiscal Policy, Conflict and Reconstruction in Burundi and Rwanda. Wider Discussion Paper No. 2001/62. The United Nations University.
- Ngaruko, F. & Nkurunziza, J.D. (2000). An economic interpretation of conflict in Burundi. *Journal of African Economics*, 9(3), 370-409.
- Nzigamasabo, A. & Nimpagaritsen A. (2009). Traditional fermented foods and beverages in Burundi. *Food Research International*, 42, 588-594.
- Nzigamasabo, A. & Zhou Hui Ming (2006). Traditional Cassava Foods in Burundi – A Review. *Food Reviews International*, 22, 1-7.
- Oketch, J.S., & Polzer, T. (2002). Conflict and Coffee in Burundi. In: Lind, J. & Sturman, K. (eds), Scarcity and Surfeit, The Ecology of Africa's Conflicts. Institute for Security Studies, South Africa.
- Peters, P.E. (2004). Inequality and Social Conflict Over Land in Africa. *Journal of Agrarian Change*, 4(3), 269-314.
- Pinstrup-Andersen, P. & Shimokawa, S. (2008). Do poverty and poor health and nutrition increase the risk of armed conflict onset? *Food Policy* 33, 512-520.
- République du Burundi (2006). Poverty Reduction Strategy Paper. Republic of Burundi.
- Rishirumuhirwa, Th. & Roose, E. (1998). The Contribution of Banana Farming Systems to Sustainable Land Use in Burundi. *Advances in GeoEcology*, 31, 1197-1204.

- United Nations Population Fund (UNFPA). (2002). Situation Démographique et Sociale au Burundi. Résultats de l'Enquête Sociodémographique et de Santé de la reproduction. Burundi: Département de la Population.
- Uvin, P. (1996). Tragedy in Rwanda: The political ecology of conflict. *Environment*, 33(3), 6-15.
- Vandamme, E. (2008). Diversificatie binnen en buiten de landbouw in Ngozi, Burundi. (Diversification inside and outside agriculture in Ngozi, Burundi). Unpublished Msc thesis. In Dutch. Faculty of Bioscience Engineering, Ghent University, Belgium.
- Verwimp, Ph., Justino, P. & Brück, T. (2009). The Analysis of Conflict: A Micro-Level Perspective. *Journal of Peace Research*, 46(3), 307-314.
- Welsch, H. (2008). Resource abundance and internal armed conflict: Types of natural resources and the incidence of 'new wars'. *Ecological Economics* 67, 503–513
- White, P. (2005). War and food security in Eritrea and Ethiopia, 1998-2000. *Disasters*, 29(1), 92-113.

TABLES

Table 1. Basic household characteristics (means, share and standard deviation in parentheses)

	Mean (n=640)	Ngozi (n=360)	Muyinga (n=280)	Test ^a
	Mean/share	Mean/ share	Mean/share	
Age head of household (years)	40.8 (12.7)	41.5 (12.5)	40.0 (12.9)	1.453
Household size (nb)	5.2 (2.4)	5.8 (2.3)	5.6 (2.5)	0.952
Gender of head of household (% man)	93.3	93.9	92.4	0.528
Household members working on farm (nb)	2.7 (1.2)	2.8 (1.3)	2.5(1.1)	2.516**
Family farm work intensity (family labor/household size)	0.508 (0.207)	0.509 (0.197)	0.506 (0.220)	0.193
Share of income off and non-farm (%)	37.8 (32.4)	36.8 (32.6)	39.2 (32.1)	-0.925

^a t-statistics are reported for the comparison of means of continuous variables and chi-squared statistics for the relationship between a categorical variable and the province.

Table 2. Overview of land use, cash crops and livestock (means, share and standard deviation in parentheses)

	Mean (n=640)	Ngozi (n= 360)	Muyinga (n=280)	Test
	Mean/share	Mean/share	Mean/share	
Farm size (m ²)	11248.5 (16462.8)	9919.3 (14173.1)	12952.6 (18889.7)	-2.240**
Farm size excluding outliers with more than 3.7 ha (m ²)	8346.1 (8013.4)	7639.7 (6576.4)	9269.2 (7458.9)	-2.858***
Total number of plots on hill (nb)	8.47 (4.67)	8.18 (4.5)	8.84 (4.9)	-1.766*
Total number of plots in swamp (nb) (march?)	1.54 (2.12)	1.89 (2.2)	1.09 (1.9)	4.861***
Share of farmsurface used for food production (%)	75.9	72.8	80.0	-4.589***
Share of plots fallow (%)	0.010 (0.033)	0.013 (0.038)	0.007 (0.026)	2.107**
Share of farmsurface under fallow (%)	7.0 (13.0)	7.1 (12.2)	6.6 (13.9)	0.504
Households having produced coffee in 2007 (%)	58.2	60.9	54.5	
Average number coffee trees (nb) ^a	191.09 (242.2)	250.1 (261.7)	221.9 (214.2)	1.281
Coffee production (kg/year) ^a	471.6 (800.4)	518.7 (895.8)	280.8 (385.9)	3.413***
Production of coffee (kg/m ²)	0.050 (0.071)	0.067 (0.087)	0.030 (0.031)	5.600***
Production of bananas (kg/year)	3913.2 (6078.3)	3865.5 (5551.4)	3583.2 (6532.9)	0.591
Households having produced banana in 2007 (%)	95.4	94.5	96.6	
Households with cattle (%)	12.3	18.3	4.5	
Number of cattle (nb) ^a	1.93 (1.63)	1.63 (0.92)	1.83 (0.83)	-0.693
Households with goats (%)	41.5	46.8	67.7	
Number of goats (nb) ^a	2.83 (3.39)	2.90 (4.42)	2.55 (1.85)	0.823

^aNote: these variables were calculated for households having coffee trees, cattle, and goats respectively.

Table 3. Comparison of production characteristics of average households on collines of the Muyinga and Ngozi Provinces between 1996 and 2007

	1996-data	2007-data	T-Test
	(n=116)	(n=160)	
	Mean (std.dev.)	Mean (std.dev.)	
Household size (nb)	6.32 (1.42)	5.71 (1.26)	-3.750***
Age of household head (year)	43.84 (7.27)	40.82 (6.72)	-3.555***
Gender of household head (0 to 1:man)	1.967 (0.096)	1.936 (0.119)	-2.437**
Involvement in regular paid jobs (0 to 1:yes)	0.126 (0.176)	0.375 (0.252)	9.634***
Involvement in trade activities (0 to 1:yes)	0.197 (1.218)	0.339 (0.259)	4.923***
Number of coffee trees (nb)	365.40 (165.83)	233.27 (148.40)	-6.911***
Production food crops (kcal/day)	23075.52 (17677.21)	7895.11 (4478.93)	-9.041***
Production food crops per person (kcal/day/person)	4341.73 (4288.98)	1494.12 (786.36)	-7.065***
Production bananas (kg/year)	6041.59 (3453.30)	3882.24 (3121.20)	-5.337***
Coffee production (kg/year)	597.93 (470.89)	441.19 (518.27)	-2.482**
Number of plots (nb)	13.31 (5.01)	10.01 (3.22)	-6.218***
Herfindahl index on-farm diversity	0.319 (0.086)	0.381 (0.070)	6.329***
Farm intensity (share)	0.017 (0.028)	0.011 (0.018)	-2.145**
Share banana production sold (share)	0.07 (0.05)	0.11 (0.03)	8.532***
Farm size (m ²)	11235.46 (1630.66)	11054.89 (9264.13)	-0.204
Cattle (nb)	0.76 (1.42)	0.73 (1.41)	-0.214
Total expenditure (US\$ value 2007)	121.9 (70.9)	180.9 (123.3)	5.014***
Total expenditure per m ² land (US\$ value 2007 /m ²)	0.011 (0.006)	0.022 (0.019)	7.089***

Table 4. Average rates of productivity change of agricultural production on colline level between 1996 and 2007 in Muyinga and Ngozi Provinces (means and standard deviation in parentheses)

	Mean (n=113)	Muyinga (n=49)	Ngozi (n=64)	t-test stats
Malmquist index	0.655 (0.427)	0.544 (0.315)	0.737 (0.481)	-2.557**
Efficiency change	1.341 (1.039)	1.271 (1.228)	1.396 (0.874)	-0.632
Technical change	0.519 (0.154)	0.492 (0.108)	0.541 (0.178)	-1.788*
Pure efficiency change	1.328 (1.012)	1.249 (1.192)	1.389 (0.855)	-0.728
Scale change	1.028 (0.274)	1.040 (0.347)	1.019 (0.204)	0.409
Efficiency score VRS 1996	0.689 (0.245)	0.680 (0.227)	0.696 (0.258)	-0.358
Efficiency score VRS 2007	0.757 (0.224)	0.691 (0.245)	0.806 (0.204)	-2.762***

Table 5. Estimates and marginal effects ordered logit model for Malmquist index (1996-2007) quartiles (collines in the Ngozi and Muyinga Provinces) (n=113)

Determinants from the 1996 dataset	Coefficient ordered logit model (std. error)	dy/dx (quartile1) (std. error)	dy/dx (quartile 2) (std. error)	dy/dx (quartile 3) (std. error)	dy/dx (quartile 4) (std. error)
Household size (nb)	-0.344 (0.179)*	0.041 (0.023)*	0.045 (0.024)*	-0.039 (0.026)	-0.045 (0.023)**
Age of household head (year)	-0.209 (0.311)	0.025 (0.036)	0.027 (0.042)	-0.024 (0.037)	-0.027 (0.041)
Age squared (years ²)	0.002 (0.004)	-0.000 (0.000)	-0.000 (0.000)	0.000 (0.000)	0.000 (0.000)
Gender of household head (0 to 1: man)	-5.872 (1.882)***	0.692 (0.252)***	0.764 (0.285)***	-0.680 (0.307)**	-0.776 (0.267)***
Involvement in regular paid jobs (0 to 1: yes)	2.533 (1.098)**	-0.298 (0.142)**	-0.327 (0.154)**	0.293 (0.159)*	0.335 (0.149)**
Involvement in trade activities (0 to 1: yes)	0.204 (1.005)	-0.024 (0.118)	-0.026 (0.131)	0.024 (0.118)	0.027 (0.131)
Number of plots (nb)	-0.048 (0.038)	0.006 (0.005)	0.006 (0.005)	-0.005 (0.005)	-0.006 (0.005)
Herfindahl index on-farm diversity	4.726 (2.759)*	-0.556 (0.328)*	-0.415 (0.386)	0.547 (0.367)	0.624 (0.365)*
Farm intensity (share)	-0.828 (7.922)	0.097 (0.931)	0.107 (1.033)	-0.096 (0.918)	-0.109 (1.047)
Share banana production sold (share)	-0.945 (3.623)	0.111 (0.429)	0.123 (0.475)	-0.109 (0.417)	0.125 (0.489)
Farm size (m ²)	-0.004 (0.002)***	0.001 (0.000)**	0.001 (0.000)**	-0.000 (0.000)**	-0.001 (0.000)***
Farm size squared (m ² *m ²)	0.000 (0.000)***	-0.000 (0.000)**	-0.000 (0.000)**	0.000 (0.000)**	0.000 (0.000)***
Cattle (nb)	0.026 (0.590)	-0.003 (0.069)	-0.003 (0.077)	0.003 (0.068)	0.003 (0.078)
Total expenditure per m ² land (FBU/m ²)	0.023 (0.041)	-0.003 (0.005)	-0.003 (0.005)	0.003 (0.005)	0.003 (0.006)
Efficiency VRS 1996	-6.678 (1.187)***	0.787 (0.179)***	0.869 (0.240)***	-0.773 (0.286)***	-0.883 (0.183)***
Province (1: Ngozi)	1.585 (0.700)**	-0.206 (0.100)**	-0.170 (0.066)**	0.177 (0.088)**	0.199 (0.079)**
Cut 1	-38.371 (12.383)				
Cut 2	-36.708 (12.283)				
Cut 3	-34.843 (12.249)				
Wald ch2(16)=75.35***					
Log pseudolikelihood= -117.14					
Pseudo R ² = 0.2522					

FIGURES

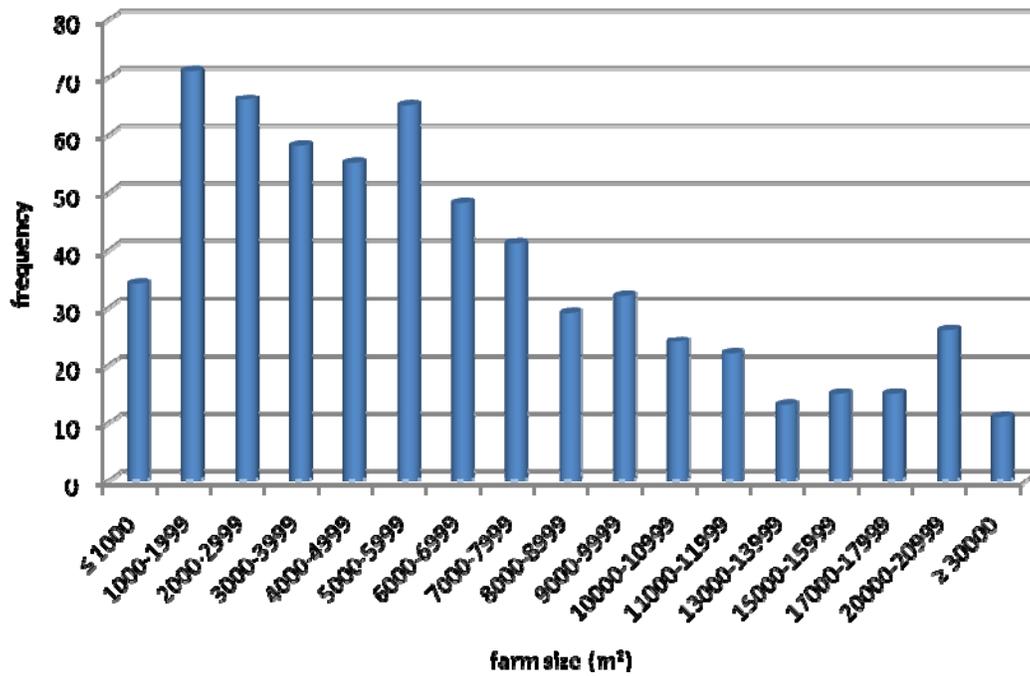


Figure 1: Distribution households over total farm size in Ngozi and Muyinga Province; farms with more than 3.7 ha excluded

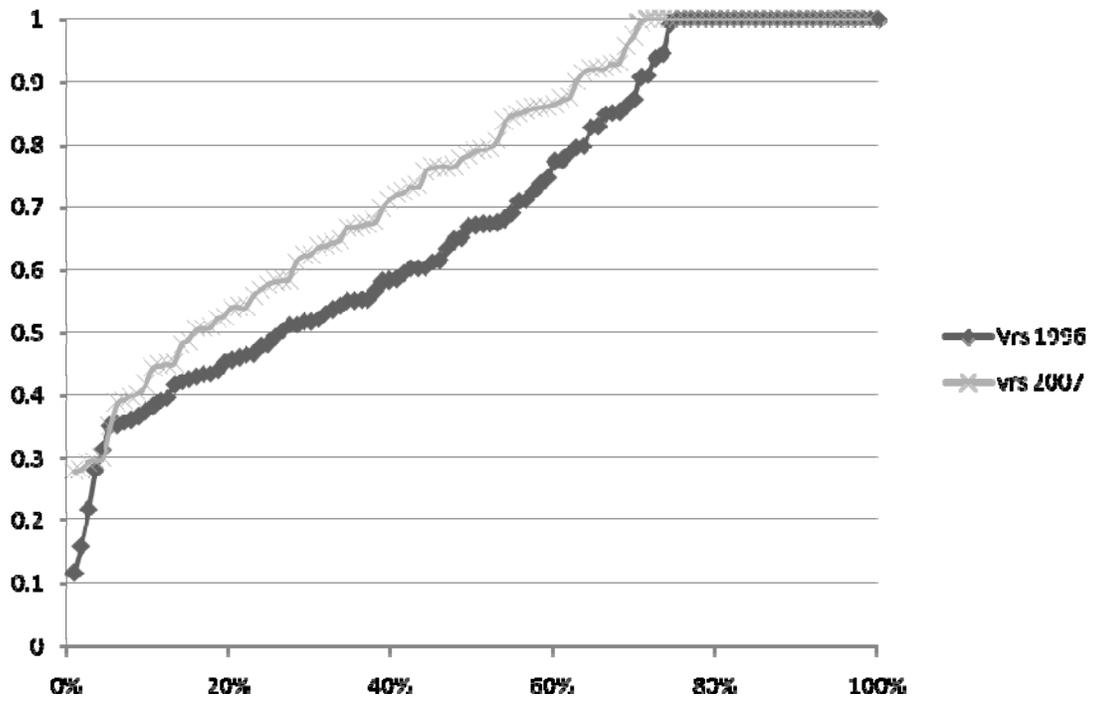


Figure 2. VRS efficiency levels for collines of Muyinga and Ngozi in 1996 and 2007

ENDNOTES

ⁱ The Global Hunger Index (GHI) is the arithmetic mean of three indicators: (1) The proportion of the population undernourished (the population that does not have the minimum caloric intake required for good health); (2) The percentage of children under five-years-old who are underweight and (3) the rate of infant mortality.

ⁱⁱ Season A runs from October to January and it is the cropping season of cassava, maize, sorghum, potato, sweet potato, rice, taro and beans; in season B from February to May beans, maize, peas, potatoes, sweet potato and peanuts are grown; in season C from June to September beans, maize, and potatoes are produced on the hills and vegetables in the swamps.

ⁱⁱⁱ The population density is 475 and 322 inhabitants per km² in Ngozi and Muyinga, respectively (Ministry of Planification of Development and National Construction, 2006).

^{iv} It is interesting to note that the plots in the swamps are allocated differently and used for different crops than the plots on the hills. The plots in the swamps are drained by government programmes and allocated by the chiefs of each colline to the households. The swamps are used for vegetable production.

^v Comparison of means with t-tests, and statistically significant for age of the head of the household and household size.