

Organization of agricultural production unit seen as a family business in mountainous South Kivu in the Democratic Republic of Congo

Abstract

Agricultural extension actors in mountainous South Kivu in eastern DRC have been supporting producer's increased efforts for decades. The adoption impact is still weak. This study determined and confirms the socio-economic factors for widespread adoption of the bean, cassava, maize and potato intensification technologies in this portion of the country. The qualitative and quantitative data from 360 file Managed were Households in Burhinyi Kabare Kaziba, Luhwinja, and Walungu Chiefdoms. The results of the discriminant factor analysis show that There are factors common to the wide-scale adoption of the use of improved varieties, the use of organic fertilization method, the use of the fertilizer, the fertilization method with GIFS, the use of the tractor thesis oven for crops in mountainous South Kivu.

Keywords: agricultural intensification, determinants, family farming production unit, mountainous South Kivu agricultural technologies

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Abbreviations: DRC, Democratic Republic of Congo; UPFA, unit of production family farming; ETD, decentralized territorial entity; NGOs, non-Governmental organizations; LDP, local development program

Introduction

In the Democratic Republic of Congo (DRC),¹ over 80% of the population is rural and a household economy based mainly on agriculture. Cassava continues to occupy first place in the diet of rural households that produce while subject to a devastating attack by the African cassava mosaic² and brown streak (Casinga, 2018). Beans, sorghum and bananas are among the basic food in mountainous South Kivu,³ (Franke and DeWolf, 2011) next to the sweet potato, potato⁴ and maize.⁵ These crops are grown in monoculture sometimes, sometimes in polyculture.⁶ The yields peasant cultures are low despite efforts by the actors of the platform Agricultural Extension. For example, the cassava is on average of the order of 8T/ha, but yields are variable depending on the environmental conditions of each country. For Bisimwa,² they can range from 6t/ha (high altitude) to 23t/ha (low altitude). The yield on the kidney bean station varies between 1780 and 3600kgs/ha,⁷ while in the middle peasant, this yield is between 250kgs to 350kgs/ha. The corn yield can reach 3098kgs/ha (Bolakonga, 2013) in crops intensified when in middle peasant rarely exceed 350kgs/ha. Low productivity is related to the low adoption of intensification technology (Sibiri and Hitimana nd) yet in extension

in the area for more than two decades. At this low adoption can be added to the failure of the weak implementation of public policies in agriculture yet defined in the Agricultural Act of 2009 and revised in 2011. This study aims to verify the factors that determine a large-scale adoption of intensification of cassava, beans, maize, and potatoes for the development of agribusiness in households mountainous South Kivu. These factors will be taken from the trio Newfoundland Capital Labor, the main factors of production supported by the physiocrats⁸ can be added the failure of the weak implementation of public policies in agriculture yet defined in the Agricultural Act of 2009 and revised in 2011. This study aims to verify the factors that determine a large-scale adoption of the intensification of cassava, beans, corn and potatoes for the development of agribusiness in households mountainous South Kivu. These factors will be taken from the trio Newfoundland Capital Labor, the main factors of production supported by the physiocrats⁸ can be added the failure of the weak implementation of public policies in agriculture yet defined in the Agricultural Act of 2009 and revised in 2011. This study aims to verify the factors that determine a large-scale adoption of the intensification of cassava, beans, corn, and potatoes for the development of agribusiness in households mountainous South Kivu. These factors will be taken from the trio Newfoundland Capital Labor, the main factors of production supported by the physiocrats.⁸

The study answers the questions below: What are the determinants of the adoption of the intensification? The level of production per unit of production Family Farming (UPFA) allows it to switch to

agriculture business? What is the level of economic profitability of the agribusiness family? It has highlighted the categorization of chiefdoms and classification variables identify technologies of intensification that are usual and their determinants, and the profitability of adoption.

Methodology specific

The study is part of the hypothesis that there are key factors to include in the dissemination of the intensification of technology and whose low adoption results in a crisis of agricultural production.

The approach to test this hypothesis was to make a state of the art on intensifying the adoption of agricultural technologies, environment production systems peasant farming family production units and agricultural policies. Deductions dependent variables are adopting the use of improved varieties, fertilization, agricultural mechanization, and plant disease treatment to the intensification of cassava, beans, corn and apples earthen. Twenty-five independent variables were selected whose civil status of head of household, labor used, the size of the farm, planting used, which decides whether the adoption of belonging to a development association, access to the road leading to urban markets, the exercise of a non-agricultural activity, access to seeds, access to training/information, access to agricultural credit, performance assessment of improved varieties, appreciation of cooking, the distance compared to the operated field, agricultural extension, the location of the field, the stronger taste of improved varieties, sex and allocation of production. The analysis model is an econometric equation of the kind $Y(v, f, m, p) = f(X1 + X2 + \dots Xn)$.

Harvesting of household data was made using a survey questionnaire sent to heads of households. The survey was preceded by a pre-investigation to confirm the data collection tool. The sample, the random remains proportional and was selected using the following formula: $n = p(1-p) * \frac{t^2}{d^2}$, where n=sample size; $t=2$, the approximate value corresponding to the value of the type of a confidence level of 95% ($\alpha=7\%$); p=estimated proportion of heads of households whose main activity agriculture; $d=0.05$; value type of a margin of error of 5%. Referring to the data of the context in mountainous South Kivu (2018), $p=66\%$; $t=2$; $d=0.05$. The calculated sample was 360 households who responded to the culture survey questionnaire in five chieftains South Mountain Kivu (Burhinyi Kabare Kaziba, Luhwinja, and Ngweshe). The cleaning of the field data has to finish there is not the same total by culture. Increased four crops namely beans, cassava, maize, and potato has been the subject of study. Thus, each respondent answered question about each culture is one of 360 households multiplied by 4. This number, he added 11 more renseignements contacted in focus groups. The study included two categories of farmers: small producers (0.1 to 1 ha) and medium producers (1.1 to 5 ha) (Table 1).

Households were selected in three administrative groups not contiguous in each chiefdom and randomly drawn. Actual other actors contacted by Chiefdom were not in line with forecasts. The questionnaire administered was not identical and is designed to be according to the theme and the necessary variables, or according to the categories of interlocutors. The collected data were entered in Excel before they were analyzed using STATA software, SPSS, and XLSTAT. Crosstabs made SPSS allowed to conclude the frequency and the adoption of different technologies within households. The independent variables were analyzed by bet binomial and multinomial regression ($p=0.05$ and $p=0, 1$) to identify those that are critical to the adoption of each dependent variable, which also is wagered. Factor

analysis to classify the variables of study in four independent groups and characterization of chiefdoms. A projective analysis was used to assess the life of the variables studied in the chiefdoms. The data on the adoption of intensification technologies have been complemented by a comparative analysis of several trading accounts made by the producers to conclude on the profitability of farming. The altitude was selected as a criterion to facilitate comparison relative to income per hectare.

Table 1 Sample taken to ensure the adoption of intensified

Chieftaincy	BEAN	CASSAVA	BUT	PDT	TOTAL
Burhinyi	88	95	46	26	255
KABARE	96	91	92	84	363
Kaziba	91	96	80	53	320
Luhwinja	82	89	61	73	305
Ngweshe	72	79	52	18	221
TOTAL	429	450	331	254	1464

The results have been returned from other scientists to gather the views and considerations that were used in the production and publication of the scientific paper.

Results

The technologies of agricultural intensification in mountainous South Kivu

Much of the land is cultivated together of cultures: 86% for beans; 85.3% for cassava and 92.7% for maize. Given the narrowness of the land in most households, the fallow barely exists. In this study, the use of organic fertilizer was estimated at 27.7% for beans; 24.2% corn; 23.1% cassava and less than 1% for the potato. The adoption of the use of the tractor and a cultivator has been estimated at 3% for the cultivation of cassava and beans; 4.2% for maize and 1.2% to the potato. The adoption of integrated soil fertility management (ANIMATED fertilization) was low: 0.2% for beans; 0.3% for corn, 19.4% for potato and 1.3% for cassava. The global adoption of erosion control is estimated at 13.3%. The techniques of anti erosive struggle used in the region are: ridging, fixing the fences on the ground contour, discontinuous ditches, clappers, mulching, and terracing. The adoption rate of agroforestry and crops corridor observed in the mountainous South Kivu was estimated at 4.4% for beans; 5.8% cassava; 3.9% for maize and 4.3% for potatoes. The adoption of improved seed rate is estimated at 19% for beans; 15.3% for cassava; 26.6% for corn and 27.7% for those who practice the potato. The rate of adoption of row planting in mountainous South Kivu was estimated at 9.8% for cassava; 8.5% for the bean; 6.3% for maize and 11.1% for the potato to practitioners. The pest control efforts in South Kivu Mountain by households are estimated at 1.4% for beans; 1.6% for cassava; less than 1% for maize and 3.6% for the potato. The adoption rate of agricultural credit in the mountainous South Kivu households is estimated at 6.3% for beans, 4% for cassava, 4.8% for maize and 5.1% for the apple Earth.

Characterization of the study area

The five chiefdoms that make up the study area do not always have the same advantages as described by the graphs below Figures 1–5:

Chiefdoms are favorable to the variables that affect the maximum and not favorable to the variables that affect not the maximum.

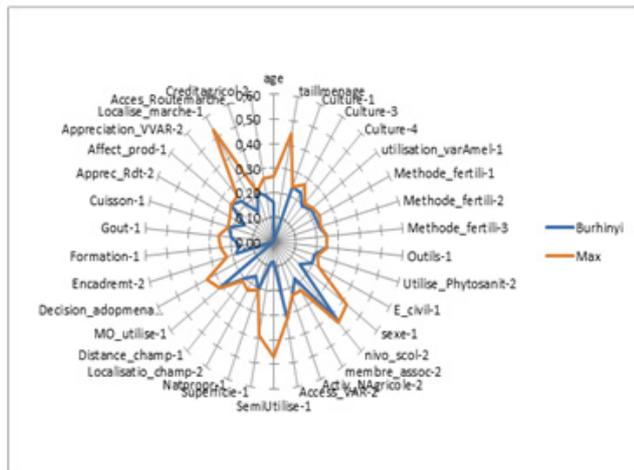


Figure 1 Characterization of the Chiefdom Burhinyi.

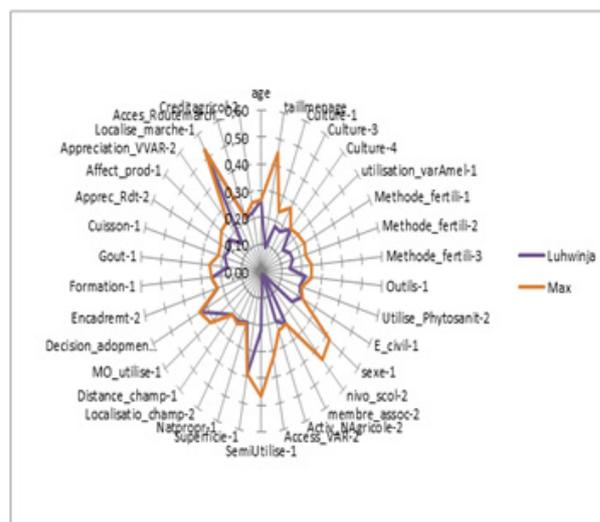


Figure 4 Characterization of the Chiefdom Luhwinja.

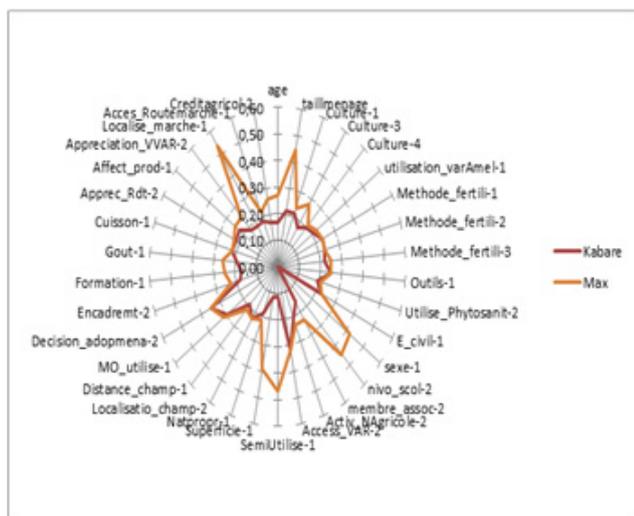


Figure 2 Characterization of the Chiefdom Kabare.

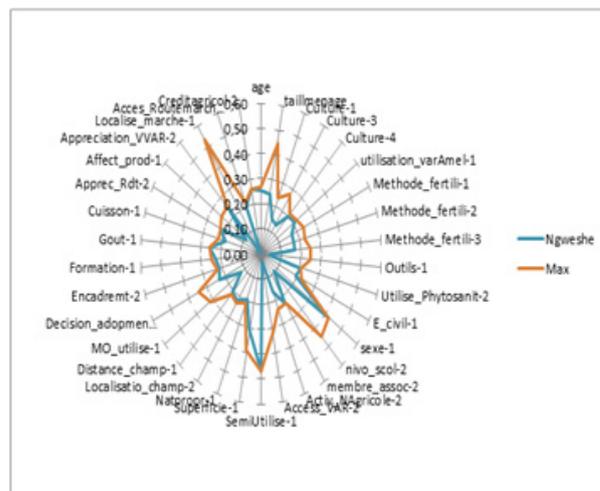


Figure 5 Characterization Chiefdom Ngweshe.

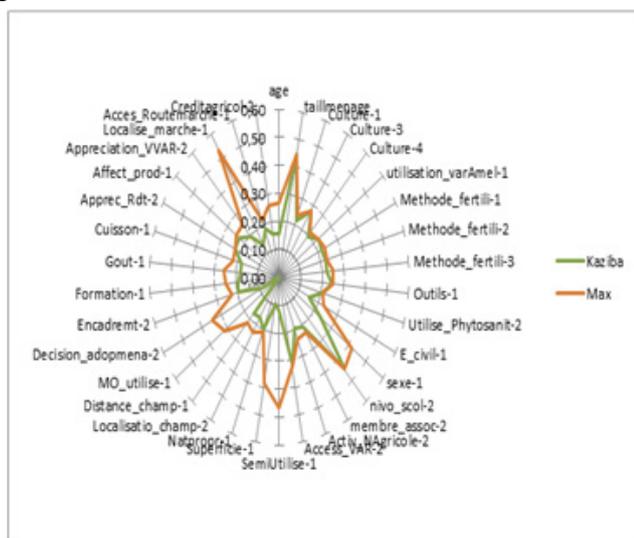


Figure 3 Characterization of the Chiefdom Kaziba.

Classification of variables' study

Factor analysis CAH ranked variables increased by four independent groups (Figure 6).

Determinants of technology adoption of agricultural intensification in the mountainous South Kivu

Bean growing

A. Adoption of improved varieties of beans

The results highlight that the adoption of improved varieties of beans is positively influenced by membership in a development association ($p=0.021$), easy access to seeds ($p=0.000$), the online seeding ($p=0.000$), training/information received on improved seeds ($p=0.001$), the performance assessment (high compared to local varieties; $p=0.020$), and if the market is open ($p=0.033$). By cons, it is negatively influenced and significantly by the location of the field to the swamp (especially if it is not well-drained, $p=0.055$), conditionality to use pesticides ($p=0.012$) and long cooking time ($p=0.042$).

B. Adoption of fertilization for beans

The adoption of the use of organic fertilizer technology that is positively influenced by the level of education (p=0.041), easy access to seeds (0.001), the nature of land ownership (0.092), the distance between home and the field (p=0.047), characters who decide to adopt within the household (p=0.032), taste (p=0.001), the cooking time (p=0.099) and easy access to agricultural credit (0,000). It is influenced negatively and significantly by the performance of the non-agricultural activity by the head of household (p=0.005), the

performance assessment (p=0.051) and the allocation of production (p=0.011).

C. Adoption of mechanization for beans

The results confirm that the adoption of this technology for beans is significantly influenced by marital status (p=0.009), the exercise of non-agricultural activity (p=0.025), the labor used (p=0.000), the location of the field (p=0.000), taste (p=0.000), cooking (p=0.007), market access (p=0.004) and obtaining an agricultural credit (p=0.004).

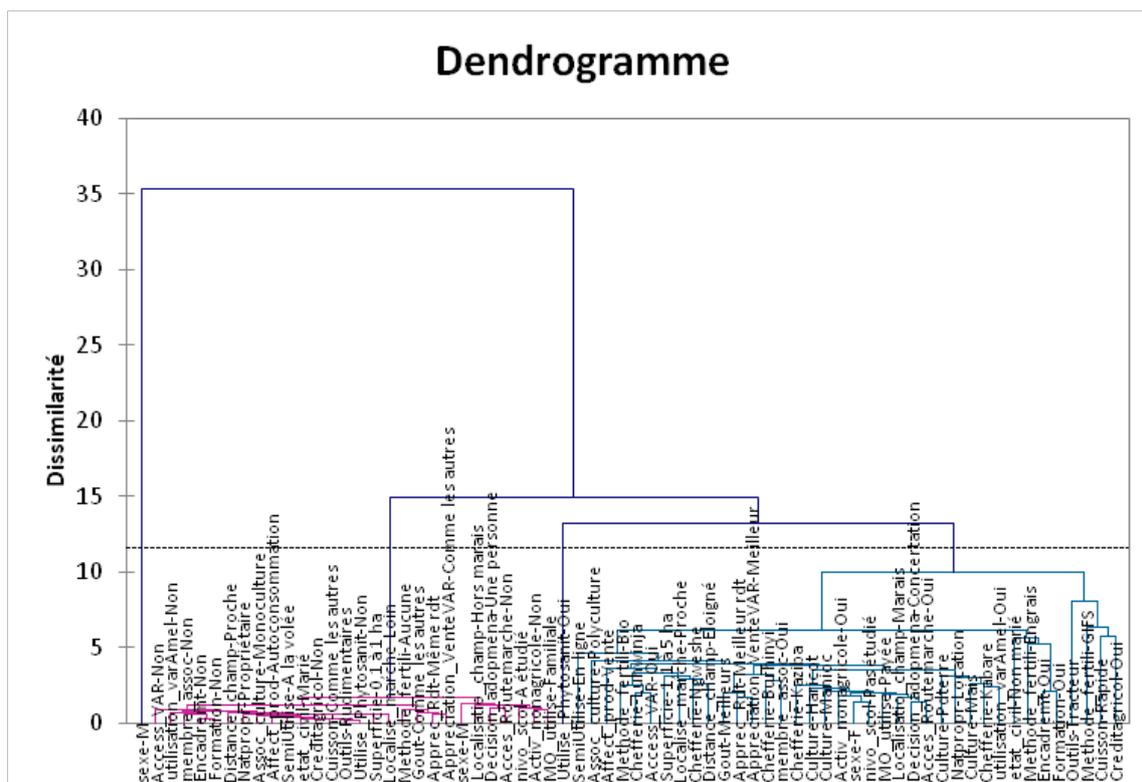


Figure 6 Dendrogram variables.

D. Adoption of the use of pesticides for beans

Determinants of the adoption of the use of pesticides for beans are: educational level (p=0.045), membership of a development association (0.030), labor used (p=0.000), the performance assessment (p=0.026) and obtaining an agricultural credit (p=0.006).

influenced by the level of the household head (p=0.058), the area harvested (p=0.035), the distance between the field and the home (p=0.055), access to training and information (p=0.080) and cooking (p=0.069). It is influenced negatively by belonging to a development association (p=0.004), the agricultural extension (p=0.038) and access to agricultural credit (p=0.001).

Maize cultivation

A. Adoption of improved varieties of maize

The adoption of improved varieties of culture of the mountainous South Kivu corn is positively influenced by membership in a development association (p=0.024), access to improved seeds (p=0.000), used sowing (p=0.017), the tools used (p=0.008) and the allocation of production (p=0.026). It is negatively influenced significantly by market access (p=0.035) and the location of the field relative to the home (p=0.001).

C. Adoption of mechanization for maize

The adoption of mechanization for maize cultivation is significantly influenced by sowing used (p=0.000), labor used (p=0.000), marital status (p=0.000), characters who decide family adoption (p=0.024), the exercise of non-agricultural activity (p=0.001), access to cuttings (p=0.000), the location of the field (p=0.002), the production allocation (p=0.028), taste (p=0.000) and access to the road leading to the market (p=0.000).

B. Adoption of fertilizer for maize cultivation

The adoption of organic fertilizer for maize cultivation is positively

D. Adoption of the use of pesticides for corn

For field, data analyzes with SPSS and STATA not confirmed any of the independent variables as a determining factor (the threshold

p-value = 0.05) of the adoption of the use of pesticides for corn. 100% harvested opinion denies use this technology for this crop.

Culture of cassava

a) Adoption of improved varieties of cassava

The results confirm that the adoption of improved varieties of mountainous South Kivu cassava is significantly influenced by membership in a development association (p=0.000), the exercise by the head of household activity non-agricultural (p=0.000), the seedlings used (p=0.001) and agricultural training by non-state (p=0.000). It is influenced negatively by marital status of household head (p=0.011), gender (p=0.020), the location of the field (p=0.003) and training/information received (p=0.058).

b) Adoption of fertilization of cassava

The results confirm that the adoption of organic fertilization mountainous South Kivu cassava is positively influenced by the level of education (p=0.011), the area under cultivation (p=0.009), the location of the control (p=0.049), the distance between the field and the home (p=0.023), the hand used to work (p=0.021), characters who decide to adopt or not in the household (0.073), the duration of cooking (p=0.006) and access to agricultural credit (p=0.002). By cons, it is negatively influenced by marital status of household head (p=0.011), the exercise of non-agricultural activity (p=0.000), the seedlings used (p=0.003) and membership a development association (p=0.099).

The analysis of the determinants of the adoption of the mineral fertilization in mountainous South Kivu for cassava confirms that it is positively influenced by the nature of land ownership (p=0.009), the location of the field (p=0.034), the cooking time (p=0.021) and market access (p=0.004). This adoption is negatively influenced by marital status of household head (p=0.060), the exercise of non-agricultural activity (p=0.000), access to cassava cuttings (p=0.078), seeding used (p=0.018), the work used to hand (p=0.005) and access to agricultural credit (p=0.038).

c) Adoption of the mechanization of cassava

The adoption of mechanization for cassava is significantly influenced by sowing used (p=0.010), labor used (p=0.000), marital status (0.011), characters who decide to adopt in the household (p=0.034), access to healthy cuttings (p=0.000), the area (p=0.000), the location of the control (p=0.000), taste (p=0.000), the production allocation (p=0.000), the location of the market (p=0.000) and obtaining an agricultural credit (p=0.034).

d) Adoption of the use of pesticides for cassava

Three independent variables are confirmed as critical (at the 5% level) adopting the use of pesticides for cassava: sowing used (p=0.003), the agricultural extension (p=0.015) and access to training/information (p=0.029).

Culture of the potato

i. Adoption of improved varieties of potato

The results confirm that the adoption of improved varieties of potato is positively influenced by membership in a development association (especially cooperative, p=0.030), the agricultural extension (p=0.002), appreciation performance (p=0.064) and access to agricultural credit (p=0.066). Factors which influence negatively are operated area (p=0.001) and the location of the control (p=0.014).

ii. Adoption of fertilization to the potato

Only the combined fertilization fertilizer “organic and inorganic” generated determining factors with a p-value of 0.05. The adoption of the technology for ANIMATED fertilization potato is positively influenced by the level of education (p= 0.055), the labor used (p=0.063), market access (p=0.028) and access to agricultural credit (p=0.001). It is negatively influenced by marital status (p=0.030), the location of the field (p=0.016), the distance between the field and the home (p=0.007), the characters who choose adoption (p=0.004), the allocation of production (p=0.061), access to the road leading to the market (p=0.024).

iii. Adoption of the mechanization of potato

The adoption of mechanization for potato is significantly influenced by sowing used (p=0.002) and access to training/information (p=0.013).

iv. Adoption of the use of phytosanitary products for potato

Two independent variables are critical to the adoption of the use of phytosanitary products for potato: the hand labor used (p=0.03) and the characters who decide to adopt a family (p=0, 05).

Adoption of the intensification of technology and profitability of crops

This study analyzed, using a simplified operating account, which earns a household decides to do one or the other culture understudy in monoculture and identified the following findings (Table 2):

Table 2 Operating Account compared with 4 main crops in mountainous South Kivu (altitude higher than 1,500m)

No.	Wording	Costs in US dollars for 1 ha in monoculture situation			
		Bean	But	Cassava	Pdterre
Exploitation charges					
1	Hire Plot	(100) 0	(100) 0	(100) 0	0
2	Soil preparation	130	150	65	230.8
3	seedling	164	55	72.5	2039.7
4	Fertilizer purchase cost	150	300	(75) 0	121.8
5	Transport of inputs (Home-field)	5	4	4	19.2
6	Spreading fertilizer	21	30	22.5	66.7

Table Continued

No.	Wording	Costs in US dollars for 1 ha in monoculture situation			
		Bean	But	Cassava	Pdterre
Exploitation charges					
7	Crop maintenance	188	259.5	354	329.5
8	Harvesting and Storage	111	917.5	52.5	200
9	Marketing cost	30	60	5	0
	S / T variable loads	(899) 799	(1876) 1776	(750.5) 525.5	3007.7
10	Opportunity cost = S / T variable expenses X Interest Rate	17.98	93.8	0	0
	TOTAL EXPENSES VARIABLE	(916.98) 817	(1969.8) 1869.8	(750.5) 650.5	3007.7
11	total amortization	-	-	-	-
12	TOTAL PRODUCT	1190	2790	1730	4518.2
13	EXCESS CRUDE	(273.02) 373.02	(820.2) 920.2	(979.5) 1079.5	1510.5
14	INCOME FARMER	(273.02) 373.02	(820.2) 920.2	(979.5) 1079.5	1510.5
15	INCOME PER HECTARE	(273.02) 373.02	(820.2) 920.2	(979.5) 1079.5	1510.5
	Report Cost - Value (C / V)	(1.3) 1.46	(1.4) 1.5	(2.3) 2.66	1.5

NB Figures in brackets would be achieved if we include the rental of the operated field

Discussion of results

The technologies of agricultural intensification

The use of organic fertilizers resorted to the use of manure, compost or enriched compost. This study found that organic fertilization is experiencing low adoption in households for the following reasons: inputs to use have become scarce, women prefer to bring waste directly to the field in their baskets to store and arrange composters to hot or cold; there is a problem with labor as the fieldwork is most often left to women alone. “The fertilizer is expensive and animals that provide manure are disappearing; this technology requires a lot of money we do not have, etc. “There are some arguments that agricultural producers argue to justify their low or non-adoption.

The low adoption rate of erosion control techniques has always been justified by the narrowness of the field. This study found the following adoption rate for crops in Study: Use of ridging: 1.1% for beans and 3.3% potato; use of mulching: 11.1% bean, 12.2% for maize and 7.8% potato; furnishings ditches clappers and 14.4% for beans, 12% corn and 11% potato; terracing 5.6% for beans and 8.9% for maize.

The agroforestry technology straddles between fertilization and anti-erosive struggle. All of the species used in agroforestry are exotic. This is mainly calliandra, the grevillea, the Markham, the Maesopsis, the cedrella and Podocarpus. There is too little research/efforts for the enhancement of native species in this technology. Producers timidly observe those that incorporate agroforestry species in their fields without too be convinced that these devices can not damage crops.

Agriculture mountainous South Kivu is mechanized in the lowland part of Kamanyola in Chiefdom Ngweshe and sites having a planar configuration. The relief is not appropriate for this technology. Some households use a tractor or tiller but the cost is almost the same compared to the farmer who used the plowing by hand paid labor (\$80/ha). The income of small producers does not allow the majority

of households to use this technology. This agriculture is the most extensively used rudimentary tool: hoes, machetes, the trident.... Hardware that requires farmers to provide more physical strength to get substantial agricultural yields. The central government after the democratic elections in 2006 was distributed to the Decentralized Territorial Entity (ETD) tractors to support mechanized farming but it should be remembered that no business case could proceed. Needs were unclear for some circles if we take into consideration the terrain within the ETD.

Integrated soil fertility management is a technology introduced on an experimental basis in mountainous South Kivu by CIALCA and CATALYST. It is now popular in the region by several local and international NGOs. This technology is to combine the use of organic and chemical fertilizers with other technologies such as intensifying the use of improved varieties, row planting, agroforestry, the EIA, the development of hill slopes, etc. Despite the repetition of experiences with the “farmer field school” approach and results in how often convincing, the adoption of this technology remains low.

The technology of using improved varieties is extension by research institutions, Non-Governmental Organizations (NGOs) for sustainable and humanitarian involving sometimes the state services such as the National Seed Service (SENASA) and provincial agriculture inspection, fisheries and livestock (IPAPEL).

Row planting requires time and abundant labor. This is the main reason for its partial rejection. In cassava, the population has not completely broken with the mounds densely despite animations made by development organizations. Those who have adopted uses a 1mx1m spacing for cassava, 25 cm for cuttings; 1mx0,8m for corn, 3-4 seeds per hole; 25cmx25cm for beans, 2 seeds per hill.

The use of pesticides is not too inked in the farming practices of producers. Cassava is attacked for more than a decade of African mosaic, streak, whitefly, etc. Corn is regularly attacked by the caterpillar of the corn. Producers helplessly to the gradual

disappearance of cassava fields. Those boxes receive some cuttings that can withstand the mosaic. Other crops (mainly potato, corn, and beans) are regularly attacked.

Agricultural credit date of fewer than 2 decades in the middle. It was introduced by NGOs agricultural extension in a context where the Congolese State subsidies are not available to producers. The banks are reluctant to grant agricultural loans. They have not convinced guarantees, plans business and reimbursement. Those who dared to victims of offenders credits (low profitability, industry risks, bad faith, etc.). Producers who have benefited trial court while the context of climate disruptions caused more failures than successes. Others are forced to sell their fields or parcels (those who) to repay agricultural loans. So that, For growing beans in Burhinyi among adopters of intensification technologies, 24% use improved varieties and organic fertilization against 9% in Kabare, Kaziba 6%, 3% and 42% to Luhwinja Ngweshe. Only 3% use improved varieties and chemical fertilizers Kaziba against 9% Ngweshe. The ANIMATED fertilization and use of improved varieties account for 3% of which are adopting Ngweshe.

For the cultivation of cassava Burhinyi, adopters of the use of improved varieties represent 37% of which 11% use improved varieties and organic fertilization against 26% who use improved varieties and ANIMATED fertilization.

At Kaziba, adopters of this combination are estimated at 19% with 12% for the use of improved varieties and fertilization bio against 7% using improved varieties and ANIMATED fertilization. Ngweshe adoption is estimated at 44% of adopters of which 40% use improved varieties and organic fertilization against 4% who use improved varieties and ANIMATED fertilization.

Compared to maize, to Burhinyi adopters of the use of improved varieties and fertilization are estimated at 28% of which use organic fertilization. Kabare producers using these technologies are estimated at 17% of which 11% use improved varieties and fertilization Bion against 6% that combine improved varieties and fertilizers. This passage is from 11% to Kaziba including 6% use improved varieties and ANIMATED fertilization against 5% using improved varieties and fertilizers. Luhwinja, adoption is estimated at 17% and all use of improved varieties and organic fertilization. Ngweshe by cons, for the cultivation of the potato, the adoption of the combination of the use of improved varieties and fertilization is estimated at 0% Burhinyi adopters against 25% in Kabare, 12.5% and 62.5% Luhwinja to Ngweshe. All combine improved varieties with ANIMATED fertilization.

It is worth noting that the supply of improved seeds in mountainous South Kivu (26.8% for beans, cassava 23.8%; 33.5% for maize and 29.6% for the apple land) is far below demand and the population has been badly accustomed to the legendary free seeds. "We seek what we have not the neighbor and pays hardly healthy cuttings of cassava," said an executive of a local NGO.⁹ The support provided by organizations and support institutions in improved seeds is insufficient: 13.3% of service for beans, 12% for cassava cuttings; 11.2% for maize and 7.1% for potato and constitutes a kind of dusting.

In general, the adoption of these core technologies of agricultural intensification is confirmed low. It shows a slight increase for some over the years and too little change for others. The results obtained in this regard are: 15.3% of adopters to use improved varieties of cassava compared to 1.5% reported by Mastaki:¹⁰ 40% (Cirimwami, 2014)

and 15% reported by Serge¹¹ in CIALCA sites where the extension was more active; 18.9% of adopters for the use of improved varieties of beans compared to 29% recorded by Masirika A¹² in CIALCA sites and 43.3% in Walungu (Cirimwami, 2014). 26.6% of adopters for the use of improved varieties of maize from 43.3% found in Walungu by Cirimwami K. (2014); 27.7% of households who practice the culture of the potato using improved varieties of potato against 28.9% found by Cirimwami K (2014).

Search results¹³ concluded that the overall adoption of organic fertilization in South Kivu Province is 82.8% among adopters of this technology against 7.4% using mineral fertilizers and 9.8% have adopted the GIFS. This study has identified in detail the adoption of ANIMATED fertilization technology is low in the study area: 0.2% for beans; 3.3% for corn, 19.4% for potato and 1.3% for cassava. Farmers use more organic fertilizers and inorganic;^{13,14} Similarly, Bossissi,¹⁵ showed that farmers cannot pay the cost of fertilizer at the rate recommended in the study area.

The use of organic fertilizer was estimated at 27.7% for beans; 24.2% corn; 23.1% cassava and less than 1% for the potato. Burundi and Mihigo,¹⁶ estimated the rate of adoption of this technology in Kabare north as follows: Use of manure: 20% of households; use of compost 57% of households; use of household waste: 13% of households. It is also a problem of land applied quantities. The recommended doses per square meter are not met because of ignorance and lack of available organic matter. In this regard, Tete (pers. Comm., 2019) claims that overall agricultural intensification in the mountainous South Kivu is handicapped by under-use of fertilizers and soil amendments.

Food production in South Kivu is essentially carried out in association crops. The product range is very wide and made up 50% of the cultivated area of cassava, 19% of beans, 17% of bananas, 5% corn.⁶ The polyculture outweighs monoculture for main crops:¹⁷ 61% for beans; 73.1% for cassava; 59% for maize. Except for potato (34% of adopters practice polyculture). The soil is exhausted to the point of no longer support several cultures at once. Too few farmers who practice crop rotation; several times gives the same culture. Phenomenon explained by the small size of land and the number of fields owned by the household. The adoption of the use of the tractor and a cultivator has been estimated at 3% for the cultivation of cassava and beans; 4.2% for maize and 1.2% to the potato. This action by the Government in 2011 has not been evaluated by many scientists (idem, 2011).

Characterization of chiefdoms

The average class size in the Chiefdom Burhinyi are better for the adoption of the culture of beans and corn, the use of improved maize varieties, those that use chemical fertilizers, producers who have not studied, those who do have not nonagricultural activities as a secondary activity, poor access to improved varieties, those who sow the fly, those who exploit the fields of an area less than 1 ha, landowners, those who operate out fields marsh, those with near fields of their houses, those who use family labor, those who consult with family for adoption, those who enjoy cooking that improved varieties have the same duration as other varieties those who felt that the yield of improved varieties is high compared to other varieties, those that affect production for self-consumption, those who have not benefited from agricultural credit.

The average class size in the chiefdom Kabare are better for the adoption of the potato, those who do not fertilize their fields, who

use rudimentary tools, those using plant protection product, producers who are married, those who have studied, who have poor access to improved varieties, those who praise the exploited fields, those that do not consult each family for adoption, those who do not benefit from the training, those who think that the improved varieties have the same taste than other varieties, those who think that the improved varieties have the same yield as the others, those who are close to markets, those without access to the road leading to the market.

The average class size in the Chiefdom Kaziba are better for the adoption of cassava, using the ANIMATED fertilization, producers female, those who have difficulty accessing improved varieties of crops, owners of exploited fields, those who exploit distant fields of residential houses, those using paid labor, non-member producers association, those who have no agricultural training, those who enjoy cooking improved varieties as fast, those who think that the improved varieties are selling like the others, those who benefit from agricultural credit.

The average class size in the Chiefdom Luhwinja is high for the number of people per farm household, those who use fertilizer bio, those who use rudimentary tools, those who claim easy access to improved varieties, producer's sex masculine, those who believe that the sale of improved varieties is better than other varieties.

The average class size in the Chiefdom Ngweshe are best for those who have adopted the bean crop, those using improved varieties, those who use the tractor, those who do not use pesticides, unmarried producers, producers who have studied, who have easy access to improved varieties, those that are members of associations, those who practice non-agricultural activities, those who exploit an area larger than 1 ha, those who exploit fields in the marshes, those that receive agricultural training, those who have benefited from training, those who have adopted the online seeding, those who appreciate the improved varieties have better taste than other varieties, those that affect production for sale, remote market producers those who have easy access to the road leading to the market.

Classification of variables' study

The four crops (beans, maize, cassava, and potato) are provided in the five Chefferies. Four classes whose variables act together emerged:

The first group includes bean cultivation, the cultivation of maize, cassava culture, the culture of potato, Chefferie Burhinyi Chefferie Kabare Chefferie Kaziba, Chefferie Luhwinja, Chefferie Ngweshe, use improved varieties, the use of organic fertilization method, the use of the fertilization method with fertilizers, fertilizing method with GIFS, the use of the tractor, female gender, not having studied, membership association, exercise of non agricultural activities, access to improved varieties, the use of mixed farming, the use of online seeding an area of 5 ha 1.1, use land for rent, operate a gently sloping field, far field, a hand of paid work, consultation with the adoption, benefit from agricultural extension, get training, find that the taste is better, fast cooking, better performance, assignment of production to sales, appreciate that the sale of improved varieties is better, the market is close easy access to the road leading to the market and easy access to agricultural credit.

The second includes non-use of improved varieties, not using any method of fertilization, using rudimentary tools, does not use pesticides, male sex, studied, is not a member of an association, no nonfarm business, No access to improved varieties, practicing monoculture, broadcast sowing, area 0.1 to 1 ha, owns the operated

field, sloping field, near field, use family labor, a one-person decides to adopt, no agricultural training, no training, taste appreciated as the other varieties popular cooking as other varieties, even yield than other varieties, affect production for self-consumption, appreciate that improved varieties are selling like the other varieties, live far from the market, no access to the road leading to the market, no access to agricultural credit.

The third isolate the use of pesticides and the fourth isolates the male.

The determining factors of intensification

The study, which focused on technology adoption intensification of beans, maize, cassava, and potato mountainous South Kivu, ranked the independent variables as follows:

- 1) Marital status:** Is a common determining factor for the adoption of the use of improved varieties of cassava as confirmed by Masirika (2013), Dontsop et al.;¹⁸ organic fertilization cassava, cassava chemical fertilization, the adoption of GIFS of the potato; mechanization of beans, maize, and cassava.
- 2) The gender of the household head:** It is a determining factor for the adoption of healthy cassava cuttings. Ntsama et al.¹⁹ retained by cons it is a determining factor for the adoption of improved varieties of corn.
- 3) The level of education:** Is a determining factor for organic fertilization bean, corn, and cassava. Mastaki;⁶ Masirika A. (2013) and Ntsama et al.¹⁹ have confirmed on the adoption of improved varieties of beans, and cassava in contrast to findings from a Cirimwami (2014) in Walungu.
- 4) The nature of the property:** This is a determining factor for the adoption of organic fertilization bean, chemical fertilization cassava. Those who practice "direct claims to" adopt more than those who rent farmland.
- 5) The area harvested:** This is a factor determining the adoption of improved varieties of potato; organic fertilization of corn and that of cassava (as noted by Buchekuderhwa,¹³) and mechanization of cassava. The area consists of a multitude of traditional farms and family-type valued at more than 60% of the population of the province. These farms have an average size of less than 1ha (Ouma and Birachi, 2011)
- 6) The work used a hand:** Is a factor determining the adoption of fertilization cassava; the use of chemical fertilizers for cassava; the adoption of ISFM for potatoes; mechanization of beans, corn, and cassava; the use of pesticides for beans and potato. The use of hired labor could express in some ways the transition from traditional agriculture to modern agriculture considering the farm as a business.¹²
- 7) Belonging to a producers' association:** It is a factor determining the adoption of improved varieties of beans as affirmed by Mastaki N⁶ for the bean variety Acc714; corn as affirmed by Ntsama et al.,¹⁹ cassava and potato; fertilization of maize and cassava and use of pesticides for beans.
- 8) Access to urban markets:** It is a determining factor for the adoption of improved varieties of beans as affirmed by Mastaki N⁶ and corn; the use of chemical fertilizers for cassava; ISFM for potatoes; mechanization of beans, maize, and cassava.

- 9) **The practice of a non-agricultural activity by the head of household:** Is a factor determining the adoption of fertilization bean and cassava; of mineral fertilization cassava; mechanization of beans and corn; improved varieties of cassava (Cirimwami (2014), $p=0.04$). It is not for the adoption of improved varieties of beans as found in Masirika A.¹²
- 10) **Access to seeds/cuttings healthy:** It is a determining factor for the adoption of improved varieties of beans, maize, and cassava; of organic fertilization bean; of mineral fertilization cassava and maize; mechanization of corn and cassava. Exchanges in the Focus also retained as a determinant of the adoption of improved varieties of potato. (COOPABU, pers. Comm. Sept. 2018)
- 11) **Access to training/information:** Is a determining factor for the adoption of improved varieties of beans and cassava as affirmed by Masirika A.;¹² organic fertilization of corn and mechanization of the potato. The exchanges made focus group retained this factor as important for adopters of technology intensification of potato. (Mushambarhwa to Buhanga, pers. Comm. 2017).
- 12) **Access to agricultural credit:** it is a determinant of adoption of improved varieties of potatoes; fertilization of beans, corn, and cassava; of mineral fertilization of the potato; the GIF for potatoes; mechanization beans, manioc and corn; the use of pesticides for beans. Those who have access to agricultural credit easily adopt the technology intensification.
- 13) **The agricultural extension:** It is a determining factor for the adoption of improved varieties of cassava and potato and fertilization of corn. This is coaching services by state and non-state actors. This factor influenced positively or negatively by that producer's benefit or not.
- 14) **The performance appraisal:** Is a factor determining the adoption of improved varieties of beans and potato; of organic fertilization bean and maize; the use of pesticides for beans.
- 15) **The production assignment:** It is a determining factor for the adoption of improved seeds of maize; of organic fertilization bean; ANIMATED fertilization for potatoes; mechanization of corn and cassava.
- 16) **The appreciation of the cooking time:** It is a determining factor for the adoption of improved varieties of beans; fertilization of beans, corn and cassava; of mineral fertilization cassava and mechanization beans.
- 17) **The distance between the field and the home:** This is a factor determining the adoption of organic fertilization bean, corn and cassava, and ANIMATED fertilization for potato.
- 18) **The location of the field:** there is Is a factor determining the adoption of improved varieties of beans, corn, cassava, and potato; of organic fertilization cassava; of mineral fertilization; ANIMATED fertilization for potatoes; mechanization of beans, maize and cassava. Those who operate out swamp fields adopt more than those who exploit the marshes since most of these soils are not well-drained.
- 19) **The seedlings used:** Is a determinant of the adoption of improved varieties of beans, corn, and cassava, cassava fertilization; of mineral fertilization cassava; mechanization corn, cassava and potato. Those who adopt row planting, although a minority, adopt more technologies intensification.
- 20) **The decision on adoption in the household:** This is a factor determining the adoption of organic fertilization bean and cassava; ISFM for potato. Households where farming activities are shared more adopt the intensification technologies.
- 21) **Taste:** It is a determinant of organic fertilization bean; mechanization of beans, maize, and cassava. However, it should be noted that the majority of farmers attach more importance to quality than quantity to happen when it comes to the adoption of fertility. For this cause, adopters bean biofortified in the study area began to reject the taste because and in spite of its performance (D. Bikaba. Comm staff, January 2019).

Determinants and adoption rates of fertilization vary from one type of fertilizer to another,¹³ from one culture to another; from one country to another. Among other factors identified as determinants of adoption of ANIMATED fertilization, he retained sex, educational level, the area owned by the household, access to credit and the distance between the field and the home. Despite the efforts of development partners to promote agricultural intensification through the implementation of technical conservation and fertilization ground; the level of use of organic fertilizers and inorganic remains very low, or even zero in some parts of the province. However it is seen progress considerable in the use of organic materials for the fertilization of the field which is in the middle residue (Masirika, 2015).

In his study in peripheral environments, INERA⁶ concluded that access to urban markets, the age of the operator, membership of a development association, are factors determining the adoption of the bean variety Acc714. Serge¹¹ concluded that marital status, level of education, the exercise by the head of a household of non-agricultural activities, access to *information* on improved varieties are the factors determining the adoption of improved variety of cassava and beans. Sex, educational level and marital status of head of household and tenure are not determining factors. For Ntsama and Kamgnia,¹⁹ belonging to a peasant organization and the level of education positively affect the adoption of the variety of CMS maize 8704. By cons, sex, age and the area down n 'no effect on the adoption of improved varieties of corn. Dontsop,¹² argues that knowledge and access to new varieties are determining factors of improving the adoption rate of those - ones.

There are production areas among the chiefs concerned over these four cultures that we can consider as production pools. The development of value chains is possible there. Kamanyola in Chiefdom Ngweshe, by its configuration and soil fertility, is one area bean, corn, and cassava. Kabare north (administrative groups Mudaka, Miti, Bugorhe, Katana, Lugendo, Luhihi, Ishungu and Bushumba) is an area legume (beans and soy), corn, cassava, sweet potato, and potato. The highlands Kaziba, Luhwinja, and Burhinyi are area cassava, and potatoes. Land Ngweshe produce, in addition to vegetables, cassava and beans. Kabare South (Mudusa and Mumosho group favor the beans and corn in marshes) A Kabare center, The results of this study confirmed that those who adopt improved varieties of maize are also adopting mechanization ($p=0.008$); those using improved varieties of cassava have not adopted the ANIMATED fertilization ($p=0.065$); those who adopt improved varieties of cassava also adopt mechanization ($p=0.009$) mainly Kamanyola in the Ruzizi plain; those who have adopted improved varieties of potato have not adopted organic fertilization ($p=0.000$).²⁰⁻²⁶

The profitability of crops

Most farmers do not rent the cultivated land (83.2% of households). They are owners. The average price of renting a hectare cost \$100. In the current context, the average income per hectare for a farmer who sowed beans (altitude above 1500 m) is estimated at \$273 for a campaign (3 months) it operated leases the land and \$373 if he owns the operating field. The C/V is respectively equal to 1.3 or 1.46. One who sowed maize monoculture was estimated at \$820 (a companion to 4 months) if he has leased 1 ha and \$920 if he owns it. The C/V is respectively equal to 1.4 or 1.5. Whoever planted cassava (annual crop) can earn \$979.5 if rents 1 ha and \$1079.5 if he owns it and has not fertilized. The C/V ratio is respectively equal to 2.3 or 2.66. The product value to cassava also includes the sale of cuttings. The farmer who sowed potato can win at the end of the campaign \$1510.5 if not operated leases the land and has not used the tractor. The C/V is respectively equal to 1.5. At altitude, the cost-value ratio of these crops is not encouraging for small producers, unlike medium and large producers. The correction is possible if we act on the amount of fertilizer, efficient processing, and high-yielding varieties. In this regard, Tete (pers. Comm. 2018)¹ says that only agricultural intensification within ANIMATED (Integrated Management of Soil Fertility) will help reverse the trend in the perspective of a sustainable increase in agricultural production. For Mrs Da Vumilia (pers. Comm. 2018).² For medium producers Kamanyola (Ruzizi plain) that do not use fertilizers, the report “values-costs” cassava (5.16 if one includes the sale of cuttings, if not 4.13) is most encouraging corn (2,4) and bean (1,4). Although cassava is an annual crop in Kamanyola (between 8 and 12 months of growth cycle), it is the top choice of producers engaged in agribusiness. Corn comes last.

All producers contacted have not integrated cost amortization. The interest rate was calculated for maize and beans for those who received a cash credit from the Micro Finance Institutions (MFIs). For Masirika (2015), the efforts made artwork by the actors involved in the development of agriculture were almost exclusively oriented the multiplication and/or the popularization of the seeds/cuttings and efficient fertilizer and improved farming techniques. These efforts have been devoted to increasing the yield per hectare to improve food security and incomes household. A weakness still apparent in the majority of producers: transactions are not regularly documented and accounted for. Lead households to be considered units agricultural production is seen as a family business could not be possible if other efforts are made to develop supply systems inputs, storage facilities, processing and marketing a performance sustainably. Masirika, (2015) concluded that profitability Cassava varied according to the links of the value chain. The stage production is more profitable (\$0.25 per kg) but the cycle length of production plays against him. Marketing follows with a profit of \$0.18 per kg and end transformation with \$0.14 per kg. In terms of value added, production contributes 44% to the added-value.²⁷⁻³⁴

Conclusion

The economy of mountainous South Kivu is mainly oriented

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²Madame Da Vumilia is a producing Kamanyola in the plain part of the Cheffery Ngweshu. She lives agribusiness based on maize and cassava for a decade.

towards agriculture. The objective of this study was to Chiefdoms out categorization and classification variables identify technologies of intensification that are usual and their determinants, and the profitability of adoption. Statistical analyses of the data collected from households have found that most of the land is cultivated in intercropping. Agriculture is practiced by farm households not sufficiently supervised, over large and area less than 0.9 hectares. The adoption of intensification technologies remains low and differs between chiefdoms. Less than 50% of households of agribusiness. The order of importance of the cost ratio values of four cultures studied is cassava, corn, potato, and beans. The results of this study confirmed that there are key factors to include in the dissemination of the intensification of technology and whose low adoption results in a crisis of agricultural production. Producers who adopt improved varieties of maize also adopt improved varieties of beans and mechanization ($p=0,008$); those using improved varieties of cassava have not adopted the ANIMATED fertilization ($p=0.065$); those who adopt improved varieties of cassava also adopt mechanization ($p=0.009$) mainly Kamanyola in the Ruzizi plain; those who have adopted improved varieties of potato have not adopted organic fertilization ($p=0.000$).

The opportunities available to improve the adoption rate of technologies mountainous intensified in South Kivu are many. The DRC has a DCSRDP since 2006 and the PAP. She has in 2009 and 2011 of an agricultural code. Efforts for a revisitation of national instruments in property matters are ongoing by the regulatory agencies. Efforts have been made to equip the chiefdoms of LDP (Local Development Program) with UNDP support. The suggestions made are founded on these opportunities.

The findings of this study coupled contextual realities mountainous South Kivu grow 4 to formulate recommendations in form of strategy to adopt: to strengthen agricultural extension within households, facilitate household access to agricultural credit and inputs, reform land by land consolidation and/or dismemberment and development of value chains.

These efforts must be accompanied by public policies to stimulate investments. This is only possible if there are substantial subsidy level efforts ETD.

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Conflicts of interest

The authors declare that they have no conflict of interest.

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