THE HAMMER AND/OR THE HOE? ANALYSING THE LINKAGES BETWEEN ARTISANAL MINING AND SMALL-SCALE AGRICULTURE IN SOUTH KIVU/EASTERN DRC

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Dedication

To my late uncle MUNYALI BAHIGE Salvador, I am sure you would have been proud!

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AM	Artisanal Mining
ANAPI	Agence Nationale pour la Promotion des Investissements (National Agency for Investment Promotion)
APED	Aides aux Personnes Démunies (Aid to the Disadvantaged)
asl	Above Sea Level
ASM	Artisanal and Small-scale Mining
ATE	Average Treatment Effect
CAID	Cellule d'Analyses des Indicateurs de Développement (Development Indicators Analysis Unit)
CEGEMI	Centre d'Expértise en Gestion Minière (Expertise Centre for Governance of Mineral Resources)
COMBECKA	Coopérative Minière pour le Bien-être Communautaire de Kalehe (
COMIKA	Coopérative Minière de Kalehe (
DRC	Democratic Republic of Congo
FAO	Food and Agriculture Organization
FEC	Fédération des Entreprises du Congo (Federation of Enterprises of Congo)
GDP	Gross Domestic Product
IMF	International Monetary Fund
IPAPEL	Inspection provinciale de l'agriculture, pêche et élevage (Provincial Inspectorate of Agriculture, Fisheries and Livestock)
IPIS	International Peace Information Service
iTSCi	ITRI Supply Chain Initiative
NGOs	Non-Governmental Organisations
NPK fertiliser	Nitrogen (N), Phosphorus (P) and Potassium (K)
OECD	Organisation for Economic Co-operation and Development
OGP	Observatoire Gouvernance et Paix (Governance and Peace Observatory)
PCA	Principal Component Analysis
PDG	Président-Directeur Général (Chairmain and Chief Executive Officer)
PNUD	Programme des Nations Unies pour le Développement (United Nations Development Programme)
PS	Propensity Scores

PSM	Propensity Score Matching
ROSCAs	Rotating Savings and Credit Associations
SLF	Sustainable Livelihood Framework
SMDG	Société Minière de Goma (Goma Mining Company)
SOLFAP	Synergie des Organisations engagées dans la Lutte contre la Faim-la Pauvreté (Synergy of Organisations involved in the Fight against Hunger-Poverty)
SOMINKI	Société Minère et Industrielle du Kivu (Kivu Mining and Industrial Company)
UCB	Université Catholique de Bukavu (Catholic University of Bukavu)
UNECE	United Nations Economic Commission for Europe
USD	United State Dollars
VSLAs	Village Savings and Loan Associations
ZEA	Zone d'Exploitation Artisanale (Artisanal Exploitation Zone)

Abstract

Often seen as informal, dangerous and causing considerable environmental and health damages, artisanal mining has been the subject of a wave of criticism that has overshadowed the income opportunities it offers to rural people. By analysing the linkages between artisanal mining and agriculture, this dissertation demonstrates that despite its negative impacts, artisanal mining - like animal husbandry, wage labour and/or other rural livelihood activities - complements agricultural activities and provides rural people with additional income.

In order to understand the factors that drive farmers into artisanal mining, the impact of artisanal mining on their livelihoods, and the direction they can take should artisanal mining become unworkable, this dissertation draws on a case study of Kalehe Territory in eastern Democratic Republic of Congo. Theoretically, it relies on the sustainable livelihoods framework. Methodologically, it is a mixed methods study using both quantitative and qualitative methods and based on both secondary and primary data.

Findings show that, faced with endogenous and exogenous factors that negatively impact their farm income, farm households set up livelihood strategies, including diversification into artisanal mining. The latter help them not only to increase their off-farm income but also to make some investment and thus, develop other rural livelihood activities. However, for some political, technical and/or geological reasons, this livelihood already built around artisanal mining may face shocks leading artisanal miners to reorient. The five activities that might interest them are petty trade, market activities, farming, animal husbandry and motorbike taxi. The choice of farming in this case depends on artisanal miners' capabilities rather than by their estimates of the income or standard of living of farmers.

In brief, if artisanal mining is part of rural livelihoods activities adopted by farmers because agricultural income is unable to cover their survival needs, then policy decisions to discourage and prohibit artisanal mining need to be thoroughly rethought and supportive policies to limit the negative effects of artisanal mining need to be implemented. Similarly, if artisanal mining is threatened for geological or political reasons and alternative options are to be considered, then policymakers should already be developing strategies to increase not only farm incomes but to stimulate all possible rural livelihood activities. In the conclusion, this dissertation proposes some avenues of reflection for such policies.

Chapter I: General Introduction

1.1. Presenting the issue: why studying the linkages between artisanal mining and small-scale agriculture?

This PhD dissertation focuses on the linkages between artisanal mining and small-scale agriculture. Referred to as a low-tech and labour-intensive mineral extraction and processing, artisanal mining is widespread in Sub-Saharan Africa where it provides direct employment to tens of millions of people, and many millions more in service and support activities (Hilson, 2016a). Yet, the recognition of its importance has been controversial for a long time. Indeed, from its entry into the vocabulary of international development in the early 1970s, the sector has been considered as an appealing alternative for large numbers of (predominantly) rural poor in search of employment (Noetstaller, 1987; Geenen, 2014 ; Hilson, 2016b). Especially since the 1990s it has become associated with negative externalities such as environmental destruction, illegality and informality, which quickly overshadowed its economic importance, leading to a poor understanding of its organization and of its positive connection with other economic sectors. Since the 2000s, academic researchers in social sciences and development studies have advocated for critical rethinking of the sector and recommended a deeper study of its social and economic aspects, specifically looking at its connection to other sectors because, as noted by Hilson (2016b, p. 8), policymakers and donors should be convinced that artisanal mining "is a rooted and indispensable dimension of the prevailing livelihood 'complex' in rural sub-Saharan Africa". Agriculture and mining do not only occupy the same geographical space in most cases; they also share the same factors of production such as land, water, labour and capital, calling them to be in constant positive or negative interactions (Ofosu, Dittmann, Sarpong, & Botchie, 2020).

Starting from this observation, this dissertation seeks to provide an in-depth analysis of such a livelihood complex. As such it contributes to a debate that has started about a decade ago but that still has three major gaps.

Firstly, when justifying the rise and/or emergence of artisanal mining, the failure of agriculture to sustain the household survival alongside the year is presented as a primary factor prompting many farmers to engage in artisanal mining, permanently or seasonally, in search of survival. To explain this failure, proponents often focus on macro level causes such as the changes brought about by structural adjustment program and all the neoliberal economic policies (Hilson & Banchirigah, 2009; Bryceson, 2002; Aizawa, 2016; Banchirigah & Hilson, 2010;

Brugger & Zanetti, 2020; Hilson & Maconachie, 2020). They therefore "explain local outcomes as the result of global meta-processes" (Claessens, 2017, p. 23)[1], paying little attention to the specific micro-processes, which however reflect the daily lives of farmers and may better explain how agricultural livelihoods change in response to contextual shocks. Analysing the organisation of agricultural activities at the micro level would help, on the one hand, to understand the mechanisms through which farmers adopt other livelihood strategies, including orientation towards artisanal mining. On the other hand, it may help policy makers to identify problems in the agricultural sector which they can address to make it viable and thus control the enlargement of artisanal mining and/or prepare for the after mine[2].

Secondly, during the expansion of artisanal mining activities, the two sectors are viewed as having positive and negative linkages. On the one hand, they are considered complementary, each supporting the other in different circumstances and at different times (Fanthorpe & Maconachie, 2010; Cartier & Bürge, 2011; Maconachie, 2011; Arthur, Agyemang-Duah, Gyasi, Yaw Yeboah, & Otieku, 2015; Hilson, 2016a; Ofosu, Dittmann, Sarpong, & Botchie, 2020). On the other hand, in some literatures, artisanal mining is presented as a threat to agricultural activities because of its potential adverse effects on the environment or on the shared production factors (Bach, 2014; Arthur et al., 2015; Boadi, Nsor, Antobre, & Acquah, 2016; Ofosu et al., 2020). Although it does highlight the presence of these positive and negative links, the existing literature does not explore the counterfactual situation to analyse what would be the situation of one sector in the absence of the other. Such an analysis would first of all help to understand whether existing links between the two sectors are 'particular', i.e., they would not exist in the absence of artisanal mining. Moreover, it would provide a more fine-grained analysis of the rural livelihood complex in particular contexts.

Finally, because minerals are non-renewable resources subject to depletion or, because political decisions sometimes allocate the artisanal mining sites to industrial enterprises and/or promote the eradication of informal artisanal mining, some studies are oriented towards the role of agriculture in the future direction of artisanal miners. This orientation is motivated by the fact that agriculture is often presented by policy makers as the best alternative to artisanal mining in a rural (and especially African) context. Considering this to be a top-down view which does not reflect the expectations, needs and wishes of artisanal miners, the existing literature focuses on the presentation of livelihood activities perceived as attractive by artisanal miners

[1] Indeed, without denying the links between global processes and localised outcomes, Rigg (2007) has highlighted this tendency in the literature to present farmers as victims of global processes and to see local contexts as a simple stage on which the meta-processes of globalisation are elaborated (Claenssens, 2017)
[2] See below

(Banchirigah, 2008; Aubynn, 2009; Bush, 2009; Cartier, 2009; Hilson & Banchirigah, 2009; Adonteng-Kissi & Adonteng-Kissi, 2018; Prescott, et al., 2020). While their analyses are often limited to presenting these alternative livelihood activities, they would be more informative if they specified to what extent and for which category of artisanal miners a given activity is more attractive. Such specifications will not only inform policy makers about possible post-mining activities, but also identify the categories and characteristics of miners for whom they can offer farming as an option in the after mine.

In this dissertation, I contribute to the debates on the nexus between artisanal mining and small-scale agriculture by addressing the different gaps presented above. More specifically, I am aiming to:

- study the organisation of agriculture at the micro level in order to understand the factors behind its failure and how this failure drives farmers into artisanal mining;
- examine the specifics of existing symbioses between agriculture and artisanal mining in order to highlight their impact on farmers' livelihoods;
- analyse the circumstances under which, as well as the categories and characteristics of miners for whom farming may be an option in the after-mine context;
- propose and discuss some policies to support the farmer-miner interactions.

To better understand the issue at the micro level and thus achieve my objectives, I adopted a case study approach from the eastern Democratic Republic of Congo (DRC). The following section outlines the history of artisanal mining and agriculture in the DRC.

1.2. Contextualising the issue: artisanal mining and small-scale agriculture in the DRC

This section presents the history of the proliferation of artisanal mining in relation to the agricultural sector in the DRC. It shows how the interaction between these two sectors has historically been guided by a changing trend: firstly, an economy mainly oriented towards industrial mining has led to a certain neglect of agriculture and has favoured a shift from agriculture to artisanal mining. Secondly, various internal and external factors have led to the decline of industrial mining, increased the neglect of agriculture and reinforced the expansion of artisanal mining. Finally, the return to industrial mining threatens the artisanal mining-based livelihoods and may force rural populations to shift back from artisanal mining to agriculture.

Located in the Great Lakes region of sub-Saharan Africa, the DRC, second largest country on the African continent, has enormous agricultural and mineral resources[3]. Since the colonial period, its economy has been largely dependent on the exploitation and export of mineral resources (Peemans, 1975), the mining sector providing between 70-80% of the country's export earnings (Tshiani, 2016). Its huge stock of minerals was first exploited industrially by several companies, partly state-owned[4]. Holding a monopoly on mining rights and mining production, these companies effectively exercised authority over the DRC's mining sector and governed vast mining concessions particularly in Katanga and the eastern part of the country (World Bank, 2008). Nevertheless, the surplus they generated, instead of being transferred to other sectors to help them to finance their expansion, was either exported to Europe, used to develop the mining industries themselves or to pay taxes to the colonial state (Peemans, 1975).

The agricultural sector at that time, although not benefiting from the surplus generated by these enterprises, played an important role in their expansion, providing them, first a low-wage labour, then food at low price (Hyde, Van Gent, & De Wilde, 1968; Peemans, 1975; Perks, 2011). From 1890 to 1945, some peasants were forced to work in mines, industries, plantations and public works, and those who remained in agriculture had little incentive to thrive in it as they could only produce the crops chosen by the colonial administration and could only sell them at a fixed and low price to companies well chosen by the colonial administration (Peemans, 1975). Faced with this situation, many smallholders living in areas dominated by industrial mining have seen fit to move into the formal mining labour sector or into urban-based economies at the expense of the agricultural sector (Perks, 2011).

In the post-colonial period, the focus continued to be on industrial mining companies to the detriment of other sectors of the economy. Between 1970 and 1980, for instance, the mining sector accounted for at least 80% by value of the country's total exports and 55% of its GDP (Tshiani, 2016). However, as a result of various external problems, such as rising commodity prices, and internal problems, such as mismanagement, deteriorating infrastructure and disastrous economic policies, the mining production from these companies has declined, thus

[3] Its 80 million hectares of agricultural land, benefiting from a wide range of climatic and soil conditions, make it capable of supporting diversified agriculture and feeding not only its entire population, but about 2 billion people worldwide (http://www.fao.org/republique-democratique-congo/fao-en-republique-democratique-du-congo/le-pays-en-un-coup-doeil/fr/ consulted on 19/7/2021). Beside the agricultural potentials, the country is also described as a "geological scandal" with significant reserves of cobalt (50% of World reserves) (https://www.planetoscope.com/matieres-premieres/173-production-de-cobalt-dans-le-monde.html consulted on 19/07/2021), diamond (second largest reserve after Russia(https://fr.statista.com/statistiques/570459/pays-comptant-les-plus-grandes-reserves-de-diamants/ consulted on 19/07/2021)), high-grade copper, gold, coltan and many other minerals.

[4] Such as Gécamines (*Général des carrières et des mines*), OKIMO (*Office des mines de Kilomoto*), MIBA (*Minière de Bakwanga*) and MGL (*Minière des Grands Lacs africains*).

sustaining an economic crisis throughout the country. Gold production by Sominki, for example, was halved from over 600 kg in 1976 to less than 300 kg in 1996 (Geenen, 2014, p. 113) and the real GDP per capita fell from around USD 900 to around USD 400 over the same period (see Figure 1.6, appendices). Some mining company workers started clandestine artisanal mining on companies' concessions (Garrett, 2007). In the late 1970s, President Mobutu, in response to the continuing economic crisis, called on citizens to 'fend for themselves' and, in 1982, he 'liberalised' the exploitation and trade of precious metals, allowing any Zairian citizen to possess and transport diamonds, gold and/or other precious stones, the only requirement being that they be registered (Geenen, 2011). This liberalisation has in a way made official the artisanal mining which was already practised 'clandestinely'.

At the same time, some changes also took place in the agricultural sector in 1983 as part of the stabilisation programme instituted by the International Monetary Fund under the structural adjustment programme. Some measures, known as the '1983 measures', were put in place to encourage small-scale farmers by opening up rural markets and introducing competitive prices (Perks, 2011). However, as noted by Perks (2011), due to the removal of seed and fertiliser subsidies for smallholders, these measures did not reverse the situation, particularly in mining-rich areas characterised by decades of agricultural neglect and economic distortions in mining enclaves, as well as the subsequent emergence of an urbanised skilled labour force. As a result, the situation in the agricultural sector has continued to worsen and artisanal mining has continued to expand. For instance, while the share of agriculture in the overall value of production was 40% in 1958, it fell to 25% in 1966 (Peemans, 1975), 21% in 2005 and even reached 18% in 2015[5]. At the same time, agricultural fertiliser consumption dropped from 0,23 kilograms per hectare of arable land in 1983 to reach 0,10 in 2011[6].

The artisanal mining sector increased with the advent of a series of wars since 1996, especially in the eastern part of the country, the cradle of the various wars and permanent insecurity. At that time, industrial production felt close to zero, reinforcing the deterioration of the country's economy. Many people from diverse backgrounds therefore engaged in artisanal mining in search of livelihoods as the economic situation in the country deteriorated (Bashwira, 2017). Discouraged by frequent pillaging of farming land and equipment, many farmers gave up the hoe for the hammer i.e., they stopped investing in agriculture and turned to mining in the hope of making a quick profit, causing therefore a dramatic decline in agricultural production (IPIS, 2012). In 2000, the rising price of coltan, fuelled by increasing demand for it in the chemical,

[5] World development indicators (last updated date 15/02/2022; consulted 28/02/2022)
[6] World development indicators (last updated date 15/02/2022; consulted 28/02/2022)

space, electronics and military sectors, pulled many more people to artisanal mining in search of a livelihood. As a result, the sector became a source of employment for around 2 million people and accounted for 90% of the country's mining production (World Bank, 2008).

This booming artisanal mining sector was soon associated with a number of negative factors. Firstly, although most of the country's mining production came from artisanal mining, the majority of this production was considered to be informal[7], thus contributing less to the country's fiscal revenues (Geenen, 2012; IPIS, 2012). Secondly, through different channels, the sector has been closely associated with the ongoing wars and conflicts in the eastern part of the country. As noted by IPIS (2012), although not considered as the main cause of the conflict, mineral exploitation has been perceived as playing an important role in the financing of armed groups and the prolongation of conflicts in the eastern part of the country. Not only were some sites managed by enterprises owned by the occupying forces, but these forces also directly controlled several mining sites, managed the marketing of minerals and used the (forced) Congolese labour force (IPIS, 2012). Finally, the sector has been associated with environmental and social problems, potentially dangerous for the country's development. The use of certain toxic products such as mercury, the provocation of erosion and landslides, the use of children and pregnant women, etc., have led to the sector being considered 'unsustainable' (Nkulu, et al., 2018).

These negative factors quickly overshadowed the sector's economic importance and called for a critical rethink by policy makers. As a result, the Congolese government, under the leadership of international institutions, has embarked on a series of formalisation measures which favour the swinging back of pendulum to industrial mining and, at the same time, threaten the artisanal mining-based livelihood of millions of people (Mukotanyi, 2012; Buraye, Stoop, & Verpoorten, 2017). For instance, the DRC's mining law has been reformulated in 2002, giving precedence to large-scale mining. This law not only restricted the artisanal mining to "Artisanal Exploitation Zones (*Zone d'Exploitation Artisanale* or ZEA)" where technical and economic requirements do not favour industrial exploitation, but also allow the transformation into industrial zones of ZEA found suitable for industrial exploitation[8]. Other examples of formalisation measures include requiring artisanal miners to be members of cooperatives[9] and granting the artisanal miners' cards only to cooperative members; the setting up of a validation (certification) system for mining sites to distinguish between problematic sites (where there are human rights violations, the use of pregnant women and children, exploitation by armed

[7] For example, about 90% of gold production was deemed to be informal (Geenen, 2012)
[8] Loi N° 007/2002 du 11 juillet 2002 portant Code Minier
[9] Ministerial Decree No. 0706/CAB.MIN/MINES/01/2010 of 20 September 2010

groups,…) and so-called "green sites"[10]; the setting up of a traceability mechanism to ban the sale of minerals from "non-green" sites[11]. With these measures, some artisanal miners are forced to relocate to non-productive mining sites or to reorient themselves towards alternative activities.

When reorientation is considered, agriculture is often at the forefront of the alternative options presented by policy makers (Perks, 2011). Those who gave up the hoe for the hammer are asked to retake the hoe. However, since people were driven to artisanal mining due to the various problems they were facing in agriculture, the latter does not seem to be an obvious option, unless it has changed in the meantime. Yet, its situation remains critical:

> "The sector, consisting mainly of subsistence agriculture, is still unable to ensure the country's food independence and generate sufficient income and sustainable employment; production is only growing by 2% per year, compared to a population growth rate of 3.2%; […]; the contribution of the agricultural sector to GDP, which was around 40% in 2009, fell to around 17.4% in 2014 […]" (ANAPI, 2016, p. 10).

Hence the relevance of questioning agriculture as a reorientation option. The dissertation at hand addresses this aspect in the context of the eastern RDC. It analyses on the one hand the embeddedness of artisanal mining in agricultural-based livelihoods in order to highlight its indispensability overshadowed by the negative factors that have been associated with it. On the other hand, it reflects on the end of this artisanal mining, assesses the choice of agriculture as a reorientation option in this case and proposes some policies to strengthen the farming-mining linkages.

Empirical data from the territory of Kalehe in the province of South Kivu allowed me to achieve these objectives. In the following section, I present this case study and justify its choice.

1.3. Justifying the case study: Kalehe as an instrumental case

As Matthews & Ross (2010) point out, a case study involves the analysis of a single case or a small number of cases, with each case explored in detail and depth. It is particularly employed when the researcher wants a contextualised understanding of an issue or, when "there is a need to obtain an in-depth appreciation of an issue, event or phenomenon of interest, in its natural real-life context" (Crowe, et al., 2011, p. 1). Stake (1995) distinguishes three main types of case

[10] Ministerial Decree 0057/CAB.MIN/MINES/01/2012 of 29 February 2012 on the

[11] With this measure, only mineral from sites certified or validated as 'green' should be allowed to be sold. These are sites recognized as with no human rights violations and exempt from any connection with conflict, thus offering to the final consumers of the minerals a guarantee that the site is free of any link with conflict.

studies, namely intrinsic, instrumental and collective. An intrinsic case study is undertaken to learn about a single/unique phenomenon. Here, the researcher's primary interest is not to know more about a general problem, but to learn more about a particular case (Patnaik & Pandey, 2019). Thus, the researcher selects an intrinsic case not because it represents other cases, but because it is unique according to the research's objective (Stake, 1995). Unlike an intrinsic case study, an instrumental case study uses a particular case to acquire a wider appreciation of an issue or phenomenon. Here, the primary objective of the researcher is "to generate greater insight into the theoretical explanation that underpins an issue" (Patnaik & Pandey, 2019, p. 167). Because a good instrumental case study does not depend on the ability to defend its typicality (Stake, 1995), the case may or may not be considered typical of other cases (Patnaik & Pandey, 2019). In a collective case study, finally, the researcher studies several cases simultaneously or sequentially in order to obtain an even broader appreciation of a particular issue.

With the aim of generating greater insight into the existing studies on the linkages between artisanal mining and agriculture and, in order to get a wider picture of the subject in the RDC, I selected Kalehe territory in South Kivu province in eastern DRC as an instrumental case study.

Covering an area of 69130 square kilometres, South Kivu, one of the 26 provinces of the DRC, is located in the eastern part of the country where it shares borders with Rwanda, Burundi and Tanzania (see Figure 1.1 below). With an estimated population of around 5 million in 2011, it is one of the poorest provinces of the country whose poverty incidence was estimated at 84.7% in 2009 (PNUD, 2009; Kamundala & Ndungu, 2017). Described as an agriculturally oriented province because of its rich arable land and its favourable climate for agriculture, South Kivu should be able to meet most of its food needs and export the surplus. However, because of several challenges such as war, land pressure, lack of transportation infrastructures and obsolete cultivation techniques[12], its agricultural production is limited to domestic consumption, which is instead supplemented by food imports from neighbouring countries and elsewhere. Many remote villages are characterised by subsistence farming whose insignificant incomes are supplemented by other diversified activities to ensure survival (PNUD, 2009).

South-Kivu is also characterised by the coexistence of the agricultural and the mining sector. Being one of the mineral-rich provinces of the country, it has important deposits of gold, coltan, wolframite, cassiterite and various coloured stones such as amethyst and tourmaline. As in the other mineral-rich provinces of the country, these mineral deposits were first mined industrially.

[12] These challenges will be deeply analyzed in the second chapter

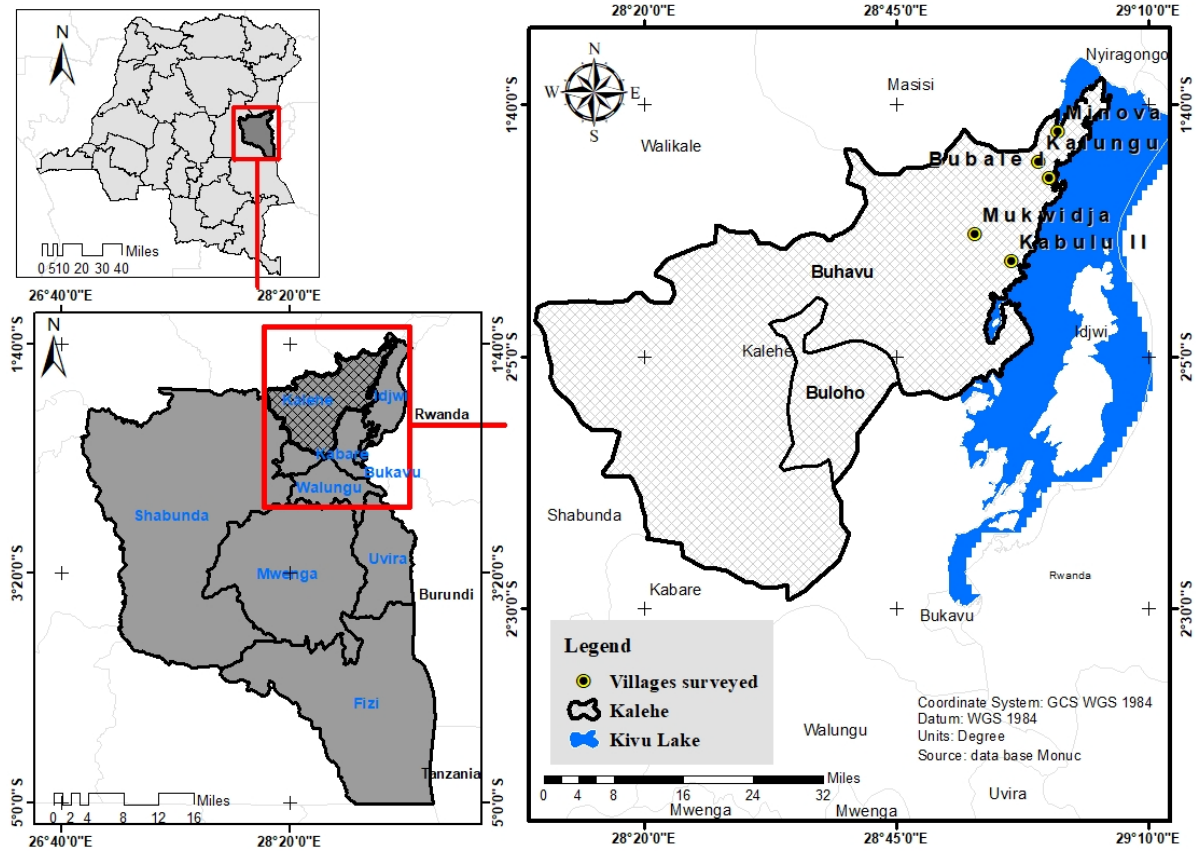
Then, as a result of a generalized socio-economic crisis and a decade of wars, many people started artisanal mining in the hope of earning an income that would meet their needs. Some of the population, especially young people, have left the agricultural sector to take up mining activities where they hope to obtain higher incomes than in agriculture (Mufungizi, 2016). Between 2009 and 2020, the International Peace and Information Service (IPIS) identified 117,000 artisanal miners scattered across 710 mining sites. They mainly mine gold (in 497 sites), cassiterite (in 200 sites), coltan (in 68 sites), wolframite (in 32 sites), copper (in 5 sites) and other minerals (in 13 sites)[13]. Currently, all these minerals are mined artisanally, with the exception of gold, which is also mined industrially in the Twangiza area (Radley & Geenen, 2021).

Administratively, South Kivu is divided into 8 territories, including Shabunda, Kalehe, Idjwi, Kabare, Fizi, Walungu, Uvira and Mwenga (see Figure 1.1 below). Although to a different extent, conditions are favourable for agriculture and mineral resources are artisanally exploited in all these territories (see Appendices, Table 1.1). Nevertheless, in Kabare and Walungu the soil is becoming increasingly poor due to overpopulation and erosion. In general, all the territories in South Kivu face similar problems that discourage agricultural production, aggravate food insecurity and encourage diversification of income sources (Ministère provinciale de l'agriculture, élevage, pêche et développement rural, 2013; DeVillé & Mufungizi, 2016). In some territories such as Fizi and Mwenga, while the land is fertile, the villages where mining sites are located are characterised by a strong attachment to mining activities and a pronounced neglect of agriculture. They are thus strongly dependent on food imports from other villages, towns and neighbouring countries[14] (OGP, 2010; Kamundala & Ndungu, 2017). In Shabunda and Kalehe, on the other hand, even in the resource-rich villages, agriculture is combined with artisanal mining. Shabunda is very isolated and almost disconnected from the other territories and major towns because the transport infrastructure to access there are almost non-existent. The evacuation of agricultural production is often only possible by air, which is expensive for small local producers (and encourages self-subsistence farming). Also, the persistence of various armed groups causes insecurity and negatively affects agricultural production (Ministère provinciale de l'agriculture, élevage, pêche et développement rural, 2013).

13 https://ipisresearch-dashboard.shinyapps.io/open_data_app/Consulted on 22/09/2021

14 At the beginning of my thesis, I wanted to focus my research on the territory of Fizi. However, during my first field trip to the Misisi mining site in 2015, I noticed that almost all the food consumed came from the neighbouring villages, although the population recognised that the land was fertile and favourable to agriculture. I found it difficult to investigate the links between artisanal mining and agriculture in this site as agriculture was not flourishing.

Figure 1.1 South Kivu and the villages surveyed in Kalehe



Source: Own conception

This dissertation focuses on Kalehe territory. Crossed by the national roads N ° 2 and N ° 3 and located at the edge of lake Kivu, between the two major regional towns Goma and Bukavu, Kalehe is easily accessible by road or by the lake. Its surface area is 5 057 km². In 2014, its population and its density has been estimated at 464 465 inhabitants and 90,2 inhabitants per km² respectively (Claessens, 2017). The territory is known for its flourishing agriculture. This is due to the low density of its population favouring the availability of agricultural land, the mountain climate with moderate temperatures, the alternation of two seasons including the rainy season that lasts eight months and the dry season for four months, and the rich and sandy-clay soil (APED, 2005). Since the dawn of time, the economy of this territory has been based on agriculture, livestock, petty trade and fishing. Intensive farming (palm oil, cinchona, coffee, tea) has existed in the past, but deteriorated from the *Zairianization*[15] (1974) to almost disappear in the 90s giving way to food crops like cassava and beans. Artisanal mining has emerged over

[15] Nationalisation measure by which the Congolese state (which became Zaïre) took control of all foreign enterprises in the agricultural, commercial and service sectors. All land owned by the settlers was confiscated, their agricultural plantations were transferred to certain local elites. However, for many analysts, this transfer, guided by patrimonialism and not by merit, resulted in the deterioration of these enterprises and the economic situation of the country (Peemans, 1975; Mudinga, 2017).

the last three decades and is an essential segment of the territory's economy, as it provides a livelihood for many of its inhabitants (Bashwira, 2017; Buraye, 2018).

I selected Kalehe territory as an instrumental case study for several reasons: first, the agricultural and mining environment of Kalehe mirrors characteristics present in the other territories (see Appendices, Table 1.1). For example, its clay and sandy soil is equally typical of clay and sandy territories of the province. Also, the main crops grown in the area are representative of the crops grown in the other territories (cassava, bananas, beans, maize, potatoes). In the same way, the main minerals exploited there are representative of the minerals present in South Kivu (gold, coltan, cassiterite and wolframite) and the main activities that are practised there are representatives of the activities practised in the other territories. Second, as mentioned above, unlike some territories where artisanal mining encroaches on agriculture, leading to food dependency, Kalehe is characterised by the co-existence of agriculture and artisanal mining, the former being a potentially flourishing sector due to the favourable conditions already described above. This co-existence makes feasible and straightforward the study of the linkages between the two sectors. Finally, while not related to the validity of the results, the last reason why I chose Kalehe territory is rather pragmatic. It concerns its accessibility. Indeed, compared to other territories where artisanal mining is widespread such as Shabunda, Fizi and Mwenga, Kalehe is relatively easy to access, either by road or by lake.

Administratively, Kalehe is made up of two chiefdoms. Buhavu chiefdom covers most of the territory and comprises seven administrative groupings (Buzi, Kalonge, Kalima, Mbinga Nord, Mbinga Sud, Mubugu and Ziralo). On the other hand, Buloho chiefdom comprises eight administrative groupings (Bitale, Ndando, Mulonge, Lubengera, Munyandjiro, Bagana, Musenyi and Karali) and extends over only a small portion of the territory in its central part. Although artisanal mining is spread all over the territory, it is most practiced in the Buhavu chiefdom and more specifically in the Mbinga Nord, Buzi and Ziralo groupings. Since the three groupings have the same agricultural and mining characteristics and, since Ziralo is characterised by a strong presence of armed groups, pronounced insecurity and difficulty of access[16], Mbinga Nord and Buzi groupings were explored. Indeed, as stressed by Crowe, et al. (2011), accessibility is a central consideration in the selection of case study.

As with all research, the case study approach has certain limitations. One of the criticisms levelled at it is that it lacks scientific rigour and provides little basis for generalisation, by producing results that may not be transferable to other settings (Yin, 2009 cited by Crowe, et

[16] It is not possible to reach Ziralo, neither by all-terrain vehicle nor by motorbike, whatever the season. From Buzi, it takes at least fourteen hours, including seven to eight hours by motorbike and six hours walking.

al., 2011). Among the ways to address these limitations, Crowe, et al. (2011) propose the use of theoretical sampling, respondent validation and, transparency throughout the research process. With theoretical sampling, researchers using the case study approach should rely on a clear conceptual framework. In my case, all the chapters of this dissertation have been based on the conceptual framework of rural livelihoods and the linkages between artisanal mining and agriculture clearly set out and explained. Respondent validation, on the other hand, refers to the involvement of participants in verifying the emerging findings and the researcher's interpretation, as well as gathering their opinions on the accuracy of these findings. Although this was not done in a systematic way after the analysis of all the data, I always tried to get a consensus with the respondents on the understanding of their answers. Thereupon, at the end of each focus group or individual interview, I always summarised my understanding and asked the respondents whether it was true or false. In case of an erroneous understanding, the respondents explained their ideas again and we parted with them on the same understanding. Finally, to achieve transparency, the researcher using a case study approach should describe in detail "the steps involved in case selection, data collection, the reasons for the particular methods chosen and the researcher's background and level of involvement" (p. 9).

To comply with this transparency requirement, in the following section, I present my research design, that is, the procedures I adopted to collect, analyse, and interpret the data (Creswell & Clark, 2011; 2017) obtained from my case study.

1.4. Designing the research: ontological and epistemological considerations

Data collection and analysis involve the use of different research methods and methodologies. Methods are "ways, techniques or tools for generating thoughtful, accurate and ethical data about a program, and also ways, techniques or strategies for manipulating those data" (Rallis & Rossman, 2003, p. 494). A methodology is a research approach, and may combine a range of methods (techniques, tools) with an underlying epistemological and ontological orientation, which reflect how a researcher perceived the world, and how he/she thinks knowledge about this world can be generated.

I adopted the mixed methodology approach throughout this research. This is an approach "in which the investigator collects and analyses data, integrates the findings, and draws inferences using both qualitative and quantitative approaches or methods in a single study or a program of inquiry" (Tashakkori & Creswell, 2007, p. 4). As discussed in the following paragraphs, the qualitative and quantitative approaches are based on different epistemological and ontological orientations. Thus, the mixed-methods approach provides a middle ground between the two and

allows researchers to exploit the advantages offered by one or the other and to overcome the disadvantages of either (Creswell & Clark, 2017).

Mostly focused on narrative data and analyses, qualitative methodologies are linked to the constructivism/interpretivism paradigm whereby "there are many realities that are constructed as the researcher engages with the participants" (Graff, 2017, p. 48). Ontologically, the researchers working within this paradigm believe that reality does not exist independently of the researcher, but is constructed in interaction and therefore in constant flux. Epistemologically, they believe that knowledge is created in interactions between humans (in this case, researchers and research 'subjects') (Guba & Lincoln, 1994).

Qualitative methodologies typically respond to "why?" and "how?" questions (Potter & Subrahmanian, 1998). They provide rich descriptions of complex phenomena, track unique or unexpected events, illuminate the experience and interpretation of events by actors, or give voice to those whose views are rarely heard (Soafer, 1999). With the aim of generating in-depth descriptions, qualitative research relies on different methods such as interviews, focus group discussions and participatory techniques. It generally uses inductive reasoning, starting with units of data to develop a theory, or starting with specific or particular elements to develop general elements (Graff, 2017).

On the other hand, quantitative methodologies are related to the positivism/post positivism paradigm. Using deductive reasoning and seeking to find the causes that precede or occur along with the effects, research under the positivist paradigm is supposed to be objective, value-free, hypothesis-based and measurable. The post-positivism paradigm, in turn, maintains that knowledge generation is influenced by researchers' values and their chosen conceptual framework. Quantitative methodologies are usually used to answer "what?" and "what if?" questions (Potter & Subrahmanian, 1998). Useful to study social phenomena, their main aim is to determine if and to what extent predetermined study variables are causally related. Normally, this method uses (quasi-)experimental designs to collect numerical data on a population sample or a sample of program participants and non-participants. Survey questionnaires with predetermined responses are submitted through personal interviews, telephone interviews or mailings. The goal is to generate reliable, generalizable and unbiased measures (Steckler, McLeroy, Goodman, Bird, & McCormick, 1992).

As these two methodologies (qualitative and quantitative) are broadly related to two different paradigms with opposed ontological and epistemological foundations, some researchers believe they cannot be reconciled. This is because, using interviews for example is not a decision about how to get data but a commitment to an epistemological position that is inimical to positivism

but consistent with interpretivism. Thus, as qualitative and quantitative methods are paradigms, when a researcher combines interview and questionnaire, she/he is not really combining quantitative and qualitative methods since paradigms are incommensurable (Bryman, 2004).The resulting tension has been termed as a "paradigm war" by Tashakkori & Teddlie (1998, p. 3).

It was not until the 1990s that researchers began to point to the similarities between qualitative and quantitative approaches and to call for recognition that the division between qualitative purists and quantitative purists was exaggerated (Graff, 2017). Mixed methods research has, since then, received a certain support and, the number of mixed methods studies has increased. Researchers using mixed methods are not required to choose between quantitative and qualitative methods, but determine how both methods will answer their research questions (Graff, 2017). From a paradigmatic point of view, three paradigmatic positions are advanced in mixed methods (Mertens, 2012; Bamanyaki, 2017). These are, the dialectic pluralism, which is a link between social constructivist and post-positivist paradigms, the pragmatic stance which involves the use of different methods to answer different research questions, and the transformative stance under which different methods are used to "support the enhancement of human rights and social justice" (Mertens, 2012, p. 256). In this study, I opted for the dialectic pluralism stance in which I adhered to the constructivist paradigm when conducting the qualitative-oriented data collection and, the postpositivist paradigm when conducting quantitative-oriented data collection.

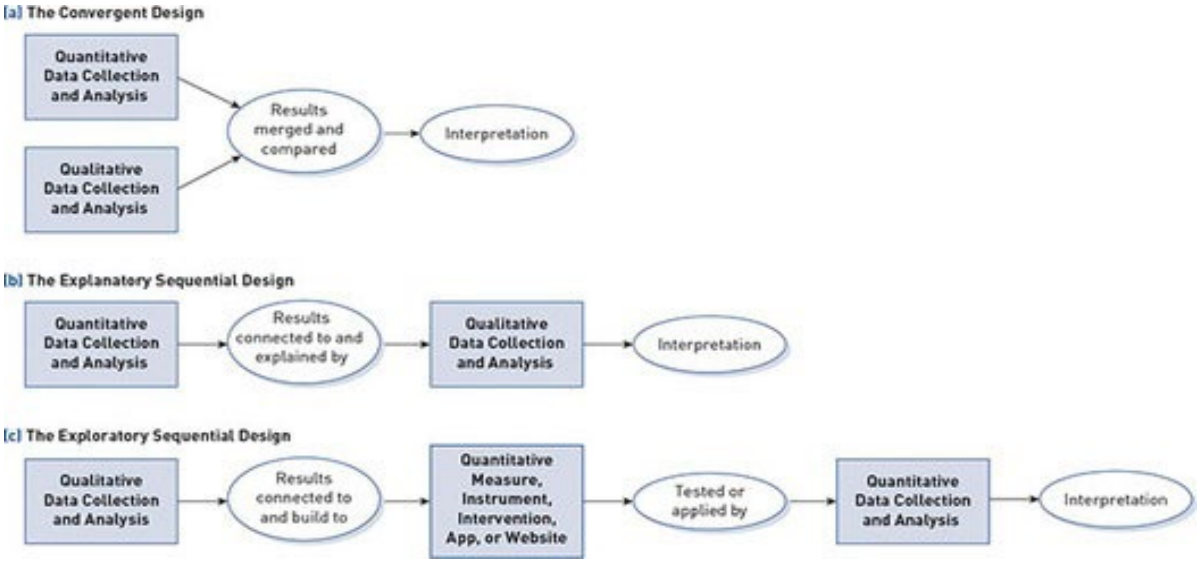
Various motivations encourage the use of mixed methods (Greene et al., 1989; Mayoh & Onwuegbuzie, 2015; Bamanyaki, 2017; Creswell & Clark, 2017). For instance, as pointed out by Creswell and Clark (2017), mixed methods help the researcher to explain the initial results of one of the methods when these do not allow for a full understanding. They thus offer more complete and corroborated results. Also, when the researcher does not know what questions to ask, what variables to measure and what theory to guide the study, mixed methods help him/her to explore first before administering the instruments. In this case, a qualitative exploration should be conducted first to determine the questions, variables, theories, etc. that are to be studied, and then a quantitative study should be conducted to generalise and test what has been learned in the exploration. In addition, by using the mixed method, it is possible to enhance an experimental (quantitative) study with a qualitative method, to describe and compare different types of cases and to develop, implement and evaluate a programme.

In this study, the choice of mixed methods was mainly motivated by the need to first explore before experimenting. On the one hand, having identified the links between artisanal mining

and agriculture in the existing literature, I had to first ascertain whether these links also existed in my study area and how they are operational, before developing the quantitative instruments to analyse them. On the other hand, I had to carry out an exploratory study to select the settings to be used as case studies: one setting where artisanal mining and agriculture predominate and another setting where artisanal mining is almost non-existent for comparison. It is for these two reasons that I also opted for the *exploratory sequential mixed methods design*. Indeed, once the researcher has decided to adopt a mixed approach and has reflected on the philosophical and theoretical underpinnings of the study, in the next step he/she has to choose the specific design that best fits his/her research questions.

Creswell and Clark (2017) have identified three core designs for researchers engaged in mixed methods research (see Figure 1.2 below). These are the convergent design, the explanatory sequential design, and the exploratory sequential design.

Figure 1.2 General Diagrams of the Three Core Designs



Source: Excerpt from Creswell and Clark (2017, p66)

In the *convergent design*, the researcher brings together the results of quantitative and qualitative data analysis to compare or combine them. The aim is to produce a more complete understanding of the problem, to validate one set of results with the other, or to determine whether participants respond similarly if they tick predetermined quantitative scales and are asked open-ended qualitative questions. The other two designs proceed in distinct interactive phases. In the *explanatory sequential design*, the researcher first collects and analyses quantitative data. Then he/she collects and analyses qualitative data in order to explain and deepen the quantitative results from the first phase. This qualitative phase therefore follows from the results of the quantitative phase. Finally, in the design adopted in this study, namely,

the *exploratory sequential design*, the researcher begins with and typically prioritizes the collection and analysis of qualitative data in the first phase. From this first phase's results, he/she design in a second phase a quantitative feature (e.g., new variables, design of an instrument, development of activities for an intervention, etc.) which he/she quantitatively tests in the third phase. He/she then interprets how the quantitative results draw on the initial qualitative results or how the quantitative results give a clear picture because they are based on the participants' initial qualitative perspectives.

After having explored my study area through qualitative methods, in the second phase I developed questionnaires that I used to collect quantitative data (third phase). In the final phase, the qualitative and quantitative data were analysed, complementing each other to get an overall picture.

1.4.1. Qualitative research methods

As pointed out previously, the design adopted in this study (namely the exploratory sequential design) starts with the collection and analysis of qualitative data. I gathered qualitative data in March and April 2017. The aim was to understand the organisation of agriculture, to identify the different links between artisanal mining and agriculture and to find at least a village that does not experience the presence and/or influence of artisanal mining to be used as a comparison village for my second research question (see chapter III). I purposely visited five villages where I conducted 23 individual semi-structured interviews, 13 focus groups alongside direct observation. These are Kabulu II, Mukwidja and Bubale I in the Mbinga Nord grouping and Kalungu and Minova in the Buzi grouping (see Figure 1.1 above). The selection of focus group participants was facilitated by the farmers' associations. I first identified farmers' associations in the different villages and contacted the leaders of these associations. The latter in turn prepared 4 to 12 farmers per focus group. In addition to the farmers, two focus groups of 11 and 12 participants respectively were organised with selected artisanal miners from the two existing mining cooperatives. For the individual interviews in the different villages, I interviewed some key informants such as local authorities (village chief, grouping leader, etc.), leaders of farmers' associations, market managers, large landowners, etc. depending on their availability. Discussions were conducted in Kiswahili and were recorded after asking permission from the participants. I was assisted by three research assistants who also helped me in the transcription and translation into French. Data were analysed using NVivo software for qualitative data analysis. These data from the qualitative survey are analysed throughout all chapters of this dissertation.

1.4.2. Quantitative research methods

Once the qualitative data had been collected, they were analysed, allowing me to identify the first trends and to prepare, in the second phase, the instruments for the collection of quantitative data. Two questionnaires with four modules each were prepared (one for farm households and one for artisanal miners). These questionnaires were programmed on a Computer Assisted Personal Interviewing (CAPI) Software, KoBo Collect. Indeed, using digital data entry, not only reduces time devoted to data cleaning, but also allow to detect errors beforehand.

With the help of a team of 11 people (including 10 enumerators and a supervisor) selected from a list of several candidates, I organised, in the third phase, a quantitative survey in December 2018. A call for enumerators has been launched, specifying that it concerned people with at least a bachelor's degree in Economics or other Social/human Sciences and with experience in data collection in mining sites and in agricultural households. On the basis of their CVs and cover letters, 15 people were selected. They all attended a week-long training, the last two days of which were devoted to testing the questionnaire. At the end of the test, ten candidates were selected as interviewers (three female and seven male) and one as supervisor (female).

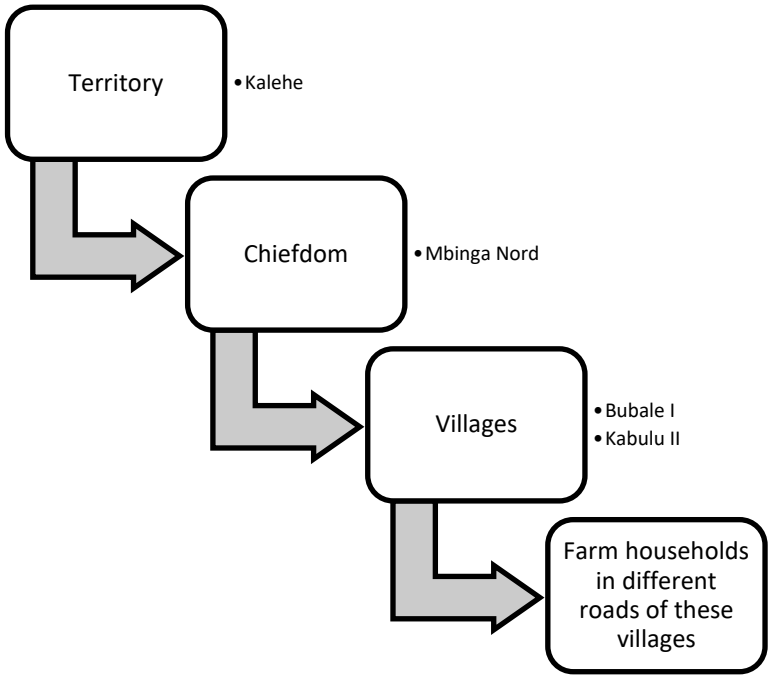
Farm households and artisanal miners constituted my target population. In this study a "farm household" is defined as any household that grows food crops for marketing in addition to self-consumption (Reardon, Delgado, & Matlon, 1992). A purposive stratification coupled with a random selection of households has been used (see Figure 1.3 below). After comparing the different characteristics in line with my research objective, Bubale I and Kabulu II villages in Mbinga Nord grouping were chosen from these 5 villages visited in 2017(see Appendices, Table 1.2, for the comparison). While artisanal mining is absent and does not influence daily life in Bubale I, Kabulu II is characterised by the predominance of artisanal mining and farming. Moreover, unlike Kabulu II, Bubale I is located along the Kivu Lake, and is therefore favourable for fishing. However, interviews with its inhabitants revealed that they have no incentive to fish, as fishing is strongly dominated by the inhabitants of Ibinja, a small island in Lake Kivu, located in Mbinga Sud grouping[17].

Villages are divided into sub-villages which in turn are divided into roads. To ensure that each sub-village and road is representative in my selection, since official statistics were lacking at provincial and territorial level, I contacted the village chiefs who gave me global estimated household statistics for the different sub-villages. A focus group was organized with the heads

[17] According to what was reported to me during the interviews, this lack of incentive comes from the fact that the fishermen of Bubale I are victims of invasions by the fishermen of Ibinja. The latter set traps for them and take away their working equipment (nets, canoes, etc.) in order to maintain the fishing monopoly in this area.

of all sub-villages to approve (or disapprove) these statistics and to give me information on the roads present in each sub-village. The selection was proportional to the number of households present in each sub-village and road. However, for some sub-villages, chiefs were unable to estimate the distribution of households per road. In this case, helped by all the chiefs present in the focus group, they estimated the size of each road as compared to other roads of the sub-village and the allocation was based on their estimation. Whenever the estimation was difficult, an equal proportion of households were surveyed in the concerned roads.

Figure 1.3 Stratification of the farm household sample



Source: Own conception

Due to the lack of a sampling frame, I used the area-based technique to reach my population. Thus, I assigned a sub-village to each enumerator (two or three enumerators per sub-village if it is large). A list with the number of surveys to be carried out in each road of the sub-village was given to each enumerator. Guided by the chief of the sub-village, the starting point was the beginning of the road and each time, the enumerator skipped 4 households to survey the 5th. When the road was geographically large and households were scattered, it was divided into three parts: based on the instruction of skipping 4 households each time, some households were interviewed at the beginning, others in the middle and others at the end of the road. A total of 501 farm households were interviewed. However, 5 questionnaires that were very poorly completed were subtracted, leaving 496 farm household observations. The questionnaire was divided into different modules regrouping questions related to the households' demographic, social and economic characteristics, as well as questions related to farming activities. These

quantitative data from farm households are analysed in the second and third chapters of this dissertation.

On the other hand, miners at the Kalimbi mining site were surveyed. Kalimbi is the largest mining site in the Mbinga Nord grouping and is rich in cassiterite (tin) deposits. It is located in the centre of Nyabibwe, in the village of Kabulu II. Kalimbi was first exploited industrially by the French company SMDG (*Société Minière de Goma*) since 1979. After the international fall in tin prices, the company went bankrupt and stopped mining in 1986. This opened the door to artisanal miners who operate exclusively there to this day. They are divided between two large pits (Koweït and T20) which were managed by the two existing mining cooperatives at the time of the survey. These are COMBECKA (*Coopérative Minière pour le Bien-être Communautaire de Kalehe*) and COMIKA (*Coopérative Minière de Kalehe*).

Kalimbi is among the first artisanal mining sites in South Kivu where the formalisation measures mentioned in section 1.2 have been implemented. For instance, in addition to being erected as a ZEA in 2008, the mining traceability system was launched there in 2011[18]. In 2012 the site was officially validated as a "green site" by the ministerial decree 0636/cab.min/mines/01/2012. This means that it has been recognized as with no human rights violations and exempt from any connection with conflict, thus offering to the final consumers of the minerals a guarantee that the site is free of any link with conflict.

From a census conducted by Kilosho Buraye in August 2016 in collaboration with the two mining cooperatives active in the area at this time, it turned out that Kalimbi had relatively few artisanal miners at the time. This census reported 246 active miners including 62 team leaders and 184 miners (Buraye, 2018). However, given the high mobility of artisanal miners, these figures should be updated. I contacted the mining cooperatives to get the updated lists, but no update had been made to the 2016 existing lists. Also, artisanal miners often do not keep a telephone number for a long period of time[19], so a large proportion of miners on the lists could not be reached.

I tried to contact team leaders identified by the cooperatives and reached few of them. The idea was that each team leader would give me the number of miners working in his pit(s). However,

[18] Known as the ITRI Supply Chain Initiative (iTSCi), this mechanism is operational in Katanga, Maniema, North and South Kivu provinces. Consisting of data collection in the mineral supply chain (traceability), risk assessment and third-party auditing, this mechanism was introduced in the Kalimbi site (chosen as a pilot site in South Kivu) in June 2010. Following a ministerial decree temporarily suspending artisanal mining in some of the eastern provinces (Maniema, Ituri, North and South Kivu), it stopped after three months of operation and did not resume until October 2012. By labelling the bags of minerals produced at this site and tracking their trade routes, the iTSCi traceability mechanism aims to show that it is possible for international companies to source minerals from the DRC. More details can be found in Buraye (2018) and Bashwira (2017).

[19] Because, often highly indebted, they prefer to change phone numbers to cover their tracks.

this seemed to be difficult because, as they reported, the working system is such that the team leader does not have a fixed number of workers assigned to his pit. Indeed, the latter only hires the *conducteur (*a kind of technical director who guides the works in the pit) and/or supervisor (when he has several pits, to monitor daily activities of all the pits). Other workers are day labourers who move from pit to pit depending on the expected production and need of manpower. I then resorted to the site manager (*gestionnaire de carrière*) who keeps a notebook in which he records on a daily basis every person who enters the site and the pit in which he will be working for that day. Thanks to this notebook, I have established a list of team leaders and miners who frequent the Kalimbi mining site. Each morning, after checking the miners who had been reached, I distributed to each enumerator the list of miners he had to investigate (who had not yet been reached). Enumerators were guided by the quarry manager and some team leaders to reach the people on their list.

While cooperatives estimated at 250 the number of miners working at Kalimibi, I have reached 275 miners including 31 team leaders. After subtracting the incorrectly completed questionnaires, I was left with 268, including 237 miners and 31 team leaders. This decrease in the number of team leaders compared to the 2016 census can analogously mean a decrease in the number of pits at the site. This may be explained by the fact that the 2016 census was conducted in the middle of the dry season (August) when mining activities are flourishing. Since my survey was organized in December, in the middle of the rainy season, some pits may have been out of reach because of water and their team leaders may have become 'ordinary' miners in other pits. These quantitative data from artisanal miners are analysed in the fourth chapter of this dissertation.

In sum, the empirical analyses in the various chapters of this dissertation are based on qualitative data from 23 individual interviews, 13 focus groups, and direct observation (all chapters), as well as quantitative data collected from 496 farm households (second and third chapters) and 268 artisanal miners (fourth chapter).

1.4.3. The researcher's role: Positionality

> "Reflexivity informs positionality. It requires an explicit self-consciousness and self-assessment by the researcher about their views and positions and how these might, may, or have, directly or indirectly influenced the design, execution, and interpretation of the research data findings" (Holmes, 2020, p. 2).

Because qualitative research is interpretive, the researcher is engaged in a continuous and intensive interaction with the participants. Given that such interactions may raise some strategic

ethical and personal issues, the researcher has to make explicit the procedures adopted to access the research site and the ethical issues that may arise (or have arisen). He/she must also explicitly and reflexively identify personal biases, values and backgrounds (e.g., gender, history, culture and socio-economic status) that shape the interpretations formed during the study (Creswell, 2014). I do this exercise in the paragraphs that make up this section.

Regarding my educational background and work experiences, I first did economic and management sciences at undergraduate level and rural economics at graduate level at the Catholic University of Bukavu (UCB). Afterwards I pursued a master in Governance and Development at the University of Antwerp. While during my undergraduate and graduate studies I was exposed to quantitative methodologies, my master studies and gradual involvement in a number of research projects introduced me to qualitative methodologies. My entry into the professional world was marked by my integration as a research assistant into the Expertise Centre for Governance of Mineral Resources (CEGEMI) at the UCB where I had the opportunity to familiarise myself with data collection in different mining sites in South Kivu (Kamituga, Lugushwa, Luhwindja, Misisi, etc.). Thus, although I had not yet conducted research in the territory of Kalehe before my doctoral research, I could easily adapt to it because I already had some experience of other territories in South Kivu. While this may seem to be a strength, it can in some cases be seen as a weakness leading to the inquirer biases if the researcher is not open to new information, remains stuck in past experience or lean towards certain themes (Creswell, 2014). In order not to fall into this trap, I was very careful not to let my experience in other mining sites guide my methods or interpretation. My background in rural economics, in which I took various courses on the Congolese rural and agricultural economy, sparked my interest in understanding the organization of agriculture, the challenges faced by farmers, and the beneficial links that agriculture can have with artisanal mining.

Throughout my interactions with research participants, I was either an 'insider' or an 'outsider' depending on the circumstances. As noted by Holmes (2020), an insider is "someone whose personal biography (gender, race, skin-color, class, sexual orientation and so on) gives them a 'lived familiarity' with and a priori knowledge of the group being researched" and an outsider is "a person/researcher who does not have any prior intimate knowledge of the group being researched" (Holmes, 2020, p. 6). Having a father of 'Havu' ethnicity and a mother of 'Shi' ethnicity, I can easily understand conversations that are held in 'Kihavu' or 'Mashi'[20] although I am not able to speak both languages well. Thus, during interviews with participants, I could easily utter a word or exclamation in one of these languages, thus making the participants

[20] These two languages are almost similar and are dominant in Kalehe

consider me as part of their community and be more open. While being considered an insider confers advantages to the researcher such as easy access to the culture under study, the ability to produce a more truthful, authentic and thicker description, etc., this same position can also be disadvantageous to the research. For example, being very close and familiar with the culture, the insider researchers may be unable to raise provocative or taboo issues; they may be seen as having more knowledge of the situation and thus not benefit from more explanation, etc. (Holmes, 2020). To counteract these disadvantages, when I introduced myself, I always took care to specify that although I had parents of such ethnic origins, I was born and raised in the city of Bukavu, thus indirectly warning the participants that I could sometimes ask questions or that I might always need more explanation for issues that might seem trivial to an 'insider'. So, I became an insider and outsider at the same time.

Being an insider or outsider may not only influence how the researcher is perceived but, it may also have an effect on how the researcher analyses and interprets the data. As an insider, I had some advantages when analysing and interpreting the data. For example, some of the local expressions (languages, agricultural measurements, etc.) are already familiar to me that I did not need to waste much time to understand the idea behind them. The risk with this is to have preconceptions and to draw premature conclusions if these preconceptions seem to be confirmed (Fleming, 2018). One of the solutions proposed by Fleming (2018) is "to use a 'critical friend' who can interrogate and challenge your assumptions" (p. 316) because what is "perceived as routine and familiar and 'as expected' from the researchers' point-of-view, can be new and unfamiliar to a third party" (p. 316). This role was very well played by my three promoters/supervisors who always led me to 'think outside the box' and to have a rigorous interpretation of my data.

My gender and marital status also influenced the research process to some extent. On the one hand, as a woman, I was culturally seen as having little physical strength and as being more vulnerable, thus attracting the sympathy of some respondents who were eager to help me. Others saw me as a good example to set for their daughters who "often tend to neglect studies believing that studies are only for men[21]". They were therefore ready to welcome me and give me the information I needed because "I need to move forward to set an example for other girls/women[22]". Being a woman did not only have advantages. One of the disadvantages is linked to a cultural belief that during their menstrual period, women are a source of bad luck and curse. Therefore, they should not approach or enter a mining site at the risk of bringing bad

[21] Interview with the representative of the Administrator of Kalehe territory
[22] Interview with the representative of the Administrator of Kalehe territory

luck and making the minerals disappear. So, in some cases, I had to negotiate and solicit the intervention of several people in order for me and my female investigators to be accepted into the mine site. It was in such contexts that my marital status played a positive role. Some participants showed me respect and facilitated access to data, not only because I was a married woman, but also because I was married to someone they knew and who had left a positive social mark. Indeed, in the year before my first field trip (in 2016), my husband also conducted a field trip to the Nyabibwe mine site as part of his PhD research. He established good contacts with the mining cooperatives, the miners and the local administration, so that a phone call from him could help me solve some practical issues (accommodation, transport, appointments with local authorities, etc). However, my marital status was sometimes a burden, especially when I had to delay my projects and plans many times and justify myself to my promoters/supervisors because my child got sick and I had to stay by his side to assist them instead.

With regard to the procedures adopted to access the research site, a letter written by my employer (UCB) in collaboration with the CEGEMI research centre was given to me for each field trip. This specified the reason for the research, the period of the research, the place where the research would be conducted and the source of funding for the research. I had to present this letter to the authorities (e.g., provincial minister of mines, provincial minister of agriculture) and clearly state the objective(s) of my mission. They would then stamp and sign it to show their agreement. This exercise was done at all levels: provincial, territorial, grouping, village, sub-village, ... Once the authorizations were obtained, I could then contact the respondents.

The interviews always started with an explanation of the research and its purpose, after which the respondents could ask a few questions and give their consent for the next step. I also explained to them the reasons why I had to record the interview and asked for their permission for the recording. Once the permission was obtained, the interviews could start without any problem.

After presenting the methodological approach adopted for the writing of this thesis, I present in the following section the overall theoretical framework on which I have relied in writing the different chapters.

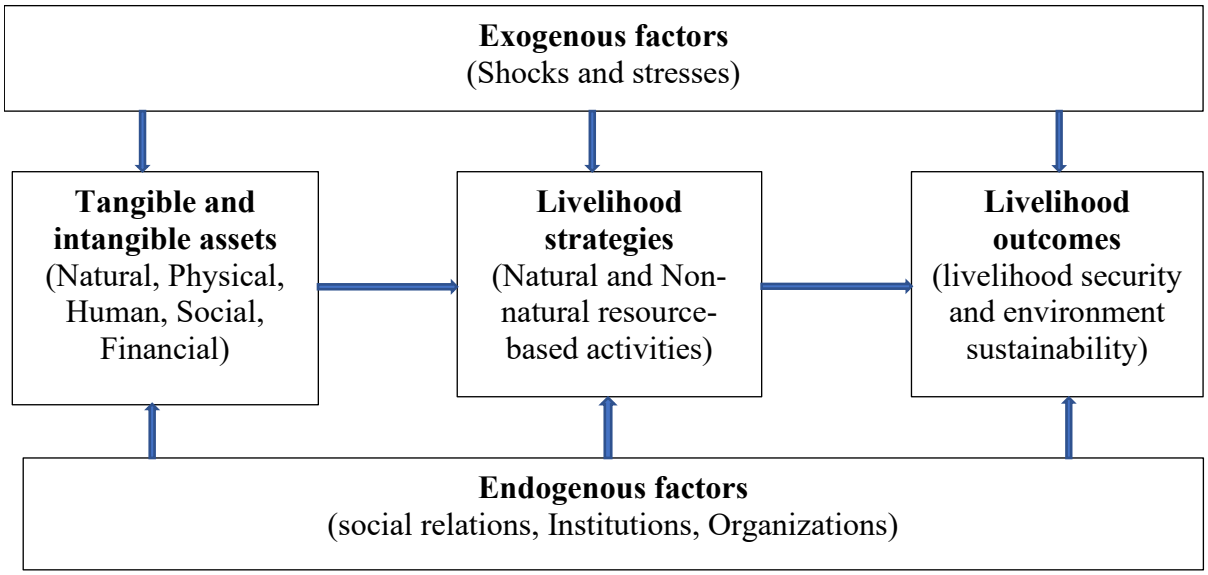
1.5. Overall theoretical framework

Throughout this dissertation, I adopted the sustainable livelihoods framework as theoretical approach to understand how artisanal mining and agriculture interact within a complex rural livelihood. Defined as “all activities involved in finding food, searching for water, shelter,

clothing and all necessities required for human survival at individual and household level" (Mphande, 2016, p. 17), a livelihood is in short, a means of making a living. A sustainable livelihood is the one that "can cope with and recover from stress and shocks, maintain or enhance its capabilities and assets, and provide sustainable livelihood opportunities for the next generation; and which contributes net benefits to other livelihoods at the local and global levels and in the short and long term" (Chambers & Conway, 1991, p. 6). An analysis of livelihood systems therefore entails an examination of the factors involved in the way people make their living (Kamuzora, 2004 cited by Shitima, 2018). Such analyses have given rise to the sustainable livelihood framework (see Figure 1.4 below).

First developed by Chambers & Conway (1991), the framework has been used and modified by various researchers and development practitioners to explain how households fall into poverty and the opportunities they have to escape it (Carney, et al., 1999). The starting point for this framework is the existence of a set of tangible and intangible assets that households can use to meet their survival needs. These are the *natural assets* such as land and water; the *physical assets* created by the economic production process such as tools and machineries; the *human assets* which refer to the labour available to the household, its health, its education and skills; the *social assets* or the community to which the household can turn to obtain any kind of material or non-material support; and the *financial assets* such as credit and savings to which the household can have access.

Figure 1.4 The sustainable livelihood framework



Source: Adopted and Modified from Shitima (2018, p. 45) and inspired by Ellis (2000)

Access to, use of and valorisation of these assets by households is mediated by a great number of contextual, social, policy and economic factors (Ellis, 2000). These are, on the one hand,

endogenous factors such as social relations, institutions and organizations and, on the other hand, exogenous factors such as macro-level trends and shocks. Endogenous factors are critical for livelihoods as they contain the agencies that hinder or facilitate exercise of capabilities and choices by households. Social relations refer to the social position the household occupies within the community and mostly encompass factors acquired by birth such as gender, religion, caste, class and ethnicity. As noted by Chambers & Conway (1991), accident of birth[23] largely predetermines many livelihoods. For instance, being born in a village in India predisposes to be assigned in a caste with particular professional occupations such as potters or shepherds. Institutions refer to formal and informal codes of behaviour that constrain human interaction and aim to reduce uncertainty and thus, establish a stable structure for human interaction (North, 1990 cited by Ellis, 2000). Examples of institutions may include land market arrangements, different laws, or the way markets work in practice. Organizations refer to groups of individuals tied by some common purpose to achieve objectives. Examples of organizations include government agencies, administrative bodies, NGOs, associations and private companies. Exogenous factors, on the other hand, are what Chambers and Conway (1991) refer to as the external aspect of vulnerability, which includes shocks and stresses. While shocks are sudden, traumatic and unpredictable pressures such as floods, epidemics and fires, stresses are continuous and cumulative, predictable and distressing pressures such as rising population, declining resources and/or their seasonal shortages.

Given their asset status, facing these endogenous and exogenous mediating factors leads households to adopt or adapt their livelihood strategies over time. These include a range of natural and non-natural resource-based activities that generate the means of survival for households to respond to the changing pressures and opportunities they face. As noted by Ellis (2000), these livelihood strategies are often classified into broad types based on the objectives of the research or policy work. For example, while Chambers and Conway (1991) identified six types of strategies, Scoones (1998) listed three. All of these typologies can be synthesized into the livelihood diversification in that they suggest that households diversify, either on-farm, off-farm or away of the farm. The latter includes migration as a diversification strategy (Ellis, 2000).

When adopted by the household, these livelihood strategies should lead to certain outcomes. Ellis (2000) distinguishes two set of outcomes namely those related to the livelihood security and those related to the environment sustainability. The first set which refers to the change in

[23] By accident of birth, the authors are referring to the fact that one does not choose the conditions in which he/she is born. This means that people are born into a certain family, into a certain clan, into a certain country, with a certain sex... by accident and not by choice.

the overall activity portfolio risk, renders households less or more capable to cope with shocks or to manage stress while the second set entails changes in the resilience and stability of natural resources. In the same context, Dorward, et al. (2009) note that the adoption of a livelihood strategy by the household can result in a "hanging-in" outcome when - after a shock - it helps the household to recover to its pre-existing livelihood level and to stabilise its assets. Alternatively, it can result in a "stepping-up" outcome when it results in higher income which allows the household to invest in the same livelihood by acquiring more assets and thus increase its productivity and its income. Third, a "stepping-out" outcome refers to an outcome that helps the household to diversify its activities to get higher and more stable incomes. Finally, a "muddling through" outcome does not bring any positive change, and in the worst case, implies a decline in the quality of life and the household income (Brugger & Zanetti, 2020).

1.5.1. Artisanal mining as part of rural livelihoods: Putting the framework to work

While the rural population has long been described as a homogeneous class with uniform livelihoods (mainly based on agriculture), a shift in the activity pattern of rural communities was observed in rural studies in the mid-1990s in sub-Saharan Africa. Rural populations were increasingly transforming their livelihoods, occupation and settlements away from agrarian patterns[24] by diversifying more and more their sources of income (Brugger & Zanetti, 2020). A rural livelihood is therefore a "complex structure comprising of mostly agriculture, with part of the population diversifying into non-farm activities in order to attain a sustainable livelihood to get better income for their households" (Mphande, 2016, p. 18).

Whereas activities such as animal husbandry, hunting and gathering, wage labour, petty trade, etc. have been fully recognised as complementing agricultural activity and providing rural people with additional income, the recognition of artisanal mining as part of complex rural livelihoods has long been overlooked. Often seen as informal, dangerous and causing considerable environmental damage, artisanal mining has been the subject of a wave of criticism that has often overshadowed the income opportunities it offers to rural people (Hilson, 2016b).

However, over the past 19 years, there has been a glimmer of hope, especially as studies published during this period recognise that despite its informality, artisanal mining "is at the heart of a complex livelihood diversification dynamic now firmly rooted across sub-Saharan Africa" (Hilson, 2016b, p. 7). This growing recognition of the importance of artisanal mining as a livelihood has prompted the beginnings of research directly focused on understanding the

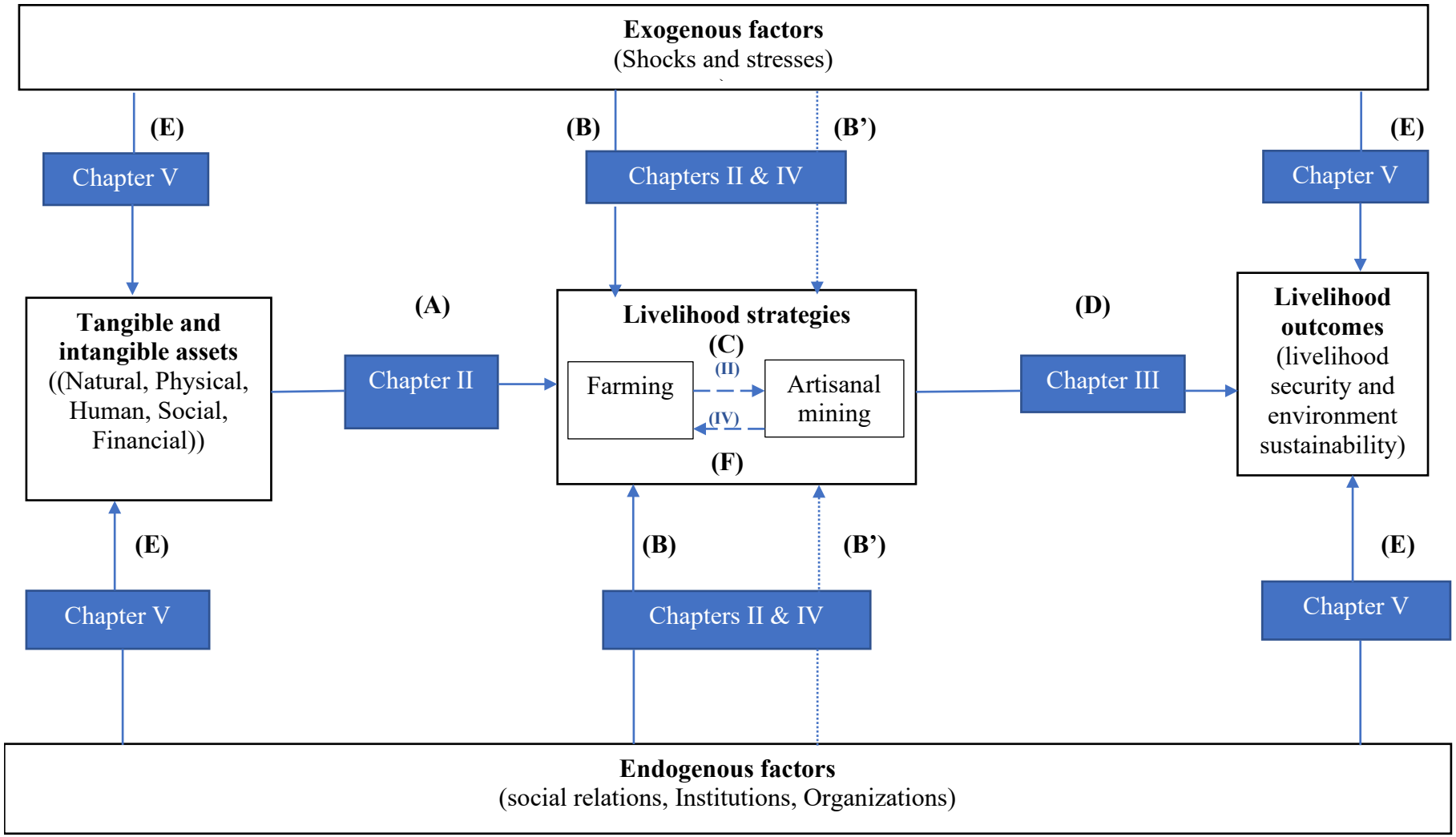
[24] A phenomenon Bryceson (1996) has referred to as 'de-agrarianisation'.

interactions between artisanal mining and other rural livelihoods (Malone, Smith, & Zeballos, 2021), into which this PhD dissertation is part. It also stimulated attention to questions such as: how (and why) do rural households adopt artisanal mining as a livelihood activity? whether this adoption has positive or negative effects on their livelihoods? what will happen to them if artisanal mining becomes impossible? What will need to be done to make artisanal mining more beneficial to them? As explained below (see also Figure 1.5 below), all of these questions, to which this dissertation has made some contributions by focusing primarily on farm households, fit well within the livelihood framework.

The starting point in *chapter II* is the analysis of the different assets (capitals) present in Kalehe (rural area) and to which farm households can have access for their farming activities (A in the figure). Next, the chapter analyses the endogenous and exogenous factors that restrict farm households' access to these assets and how these endogenous and exogenous factors negatively impact farm income (B in the figure). Finally, the chapter analyses different livelihood strategies adopted by farm households faced with low farm income, including their involvement into artisanal mining (C in the figure). On the other hand, as advocated by the livelihoods analysis framework, the adoption of a livelihood strategy should normally produce outcomes (positive or negative). *Chapter III* of this dissertation therefore analyses the outcomes of farm households' involvement in artisanal mining (D in the figure).

While farm households have taken to artisanal mining to maintain their livelihoods, this activity is also affected by both endogenous and exogenous factors (B' in the figure). Not only are mineral resources exhaustible and can, if mismanaged, be depleted at any time; but artisanal mining uses rudimentary tools that may no longer reach the minerals at a certain stage. Faced with this threatened livelihood, artisanal miners have to develop alternative survival strategies, of which returning to agriculture is one option (F in the Figure). Therefore, *chapter IV* of this dissertation revisits livelihood strategies.

Figure 1.5 Putting the framework to work



Source: Author's conception

However, unlike Chapter II in which I analysed the livelihood strategies of farm households, Chapter IV instead analyses the choice of alternative activities as part of the livelihood strategy of artisanal miners.

Finally, if endogenous and exogenous factors affect access to assets and thus impact on the livelihood activities available in rural areas and the outcomes that rural people can derive from them, policies are needed to foster and sustain positive impacts. In *Chapter V*, dedicated to the general conclusion of this thesis, I have tried to reflect on some policies along these lines (E in the figure).

1.5.2. Some existing critics on the livelihood framework

Although the sustainable livelihoods framework has been popularised and adopted by several organisations and researchers, it has not been immune to criticism. These often focus on the way the framework conceptualises the issue of access to livelihoods resources and the relationship between access and decision-making (De Haan and Zoomers, 2005). In addition, the framework has been criticised for its lack of engagement with the process of economic globalisation, power and politics, its lack of rigorous efforts to address long-term secular changes in environmental conditions, and its failure to take into account long term shifts in rural economies and wider questions about agrarian change (Scoones, 2009).

Regarding the issue of access to resources, authors like De Haan and Zoomers (2005) and Scoones (2009) have raised the dynamic nature of this concept, which is unfortunately often not taken into account (or only marginally) in the livelihood framework. On the one hand, although the framework recognises that access to resources is affected by social exclusion, which is "a process in which groups try to monopolise specific opportunities to their own advantages" (De Haan & Zoomers, 2005, p. 33), it does not refer to the changing nature of this exclusion. Indeed, given that livelihood activities engendered process of inclusion and exclusion, power relation between actors is embedded in a dynamic process of 'wielding' and 'yielding'. However, this is often overlooked in the livelihood framework. Some frameworks that have tried to take power relation aspect into account have either added another capital to the list of tangible or intangible assets, namely 'political capital' or, have considered that the power relationship is indirectly included in the mediating contexts (endogenous and exogenous factors) (Scoones, 2009). Yet, as Scoones (2009) mentions, these additions do not really address the complex intersections of structural power bases. What is really needed is an examination of the broader structures of inequality, focusing on how

livelihoods are structured by relations of class, gender, caste, ethnicity, ... and asking at the outset who wins, who loses and why. This will thus allow a good understanding of the process of marginalisation, dispossession, accumulation and differentiation in the access to livelihood opportunities.

On the other hand, while global transformation continues apace, the framework is criticised for failing to engage with debates on globalisation and its effects on access to livelihoods (Scoones, 2009). As the framework does not address wider global processes and their impact on local livelihoods, Scoones (2009) maintains that more details are needed to explain how particular forms of globalisation and related processes of production and exchange generate both processes of marginalisation and opportunities.

The second set of criticisms relates to the relationship between livelihood strategies and decision-making within the household. De Haan and Zoomers (2005) are mainly critical of the fact that, when explaining the livelihood strategy, the framework often considers the household as "a single decision-making unit maximizing its welfare subject to a range of income-earning opportunities and a set of resource constraints" (Ellis, 1998 cited by De Haan and Zoomers, 2005, p.38). For the authors, this consideration is to be questioned because, not only gender studies have succeeded in highlighting intra-household differences; but also, livelihoods have become increasingly diversified and less likely to be organised in one place. In addition, the current trend is rather individualistic, assuming that men, women and children have different interests. Thus, the household behaviour should not always be seen as deliberate and conscious and the concept of 'household strategy' needs to be rethought (De Haan & Zoomers, 2005).

Another criticism of the livelihood approach relates to its lack of a long-term vision. Although the term sustainable in the livelihood framework implies livelihood strategies that are durable, stable, resilient and robust in the face of both internal and external shocks, Scoones (2009) holds that, the livelihood framework only provides a snapshot view describing desperate coping and short-term adaptation, and does not reflect longer-term changes in environmental condition and in rural economies. One way of thinking about long term changes, the author argues, would be to identify different future strategies or pathways in the livelihood analysis.

Although I have tried to skim over some of them (not in a systematic way), I do not claim to have addressed these various criticisms in this dissertation. For instance, I have shown in the second chapter how power relations negatively influence farmers' access to certain assets such as land,

agricultural infrastructure, etc. thus negatively impacting their farm income. Also, by demonstrating how the integration of artisanal mining into the livelihood strategies of farm households allowed some households to become landowners themselves, the third chapter of this dissertation documents in some way how the process of inclusion is created by livelihood activities.

1.6. Thesis layout

A part from the introductory chapter (chapter I), this PhD dissertation is structured around four other chapters, each of them addressing one of the above-mentioned research questions.

Chapter II identifies the livelihood opportunities available to peasants, the barriers that prevent them from taking advantage of them, and whether the survival strategies they adopt include artisanal mining.

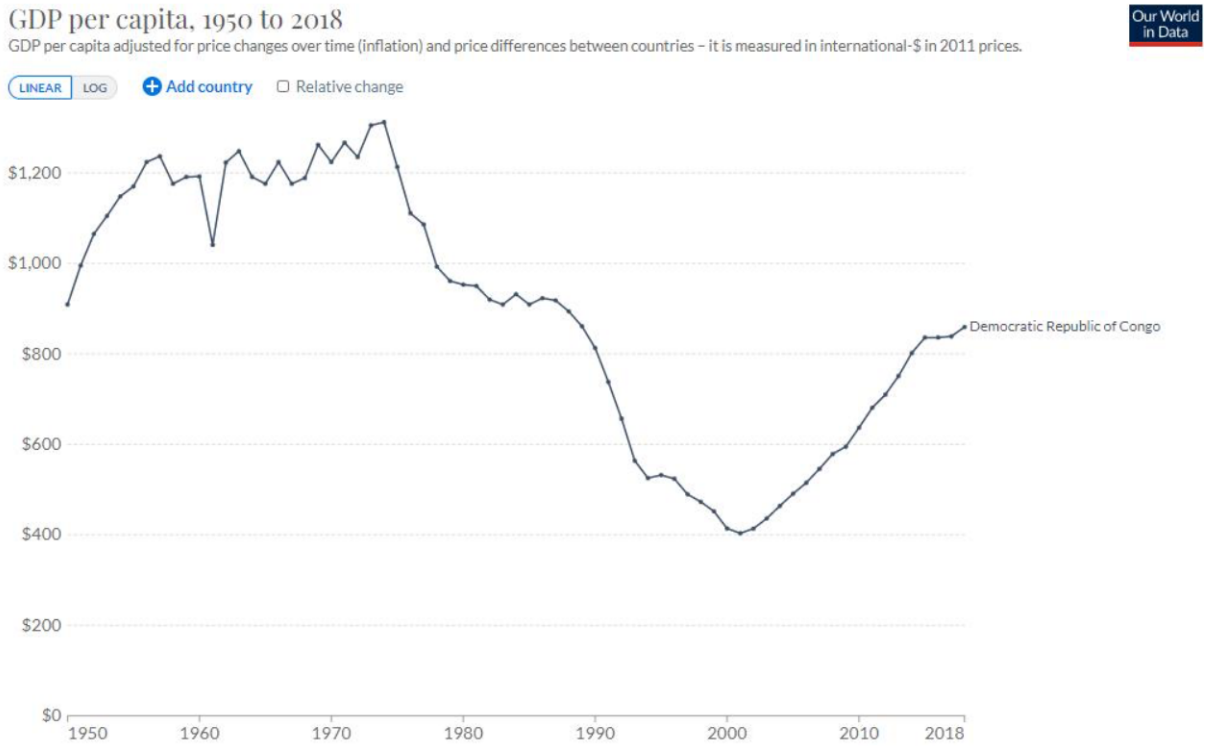
Chapter III makes a first attempt to quantitatively analyse the effect of artisanal mining on farmers' livelihoods. It compares farm households living in the vicinity of an artisanal mining operation with those that have no connection to it on the basis of five main links identified in the literature, thus forming five related hypotheses.

In addition to presenting the different activities that may be of interest to artisanal miners if artisanal mining becomes impossible, **Chapter IV** presents the extent to which these activities are of interest, with a particular focus on agriculture, the activity that is often presented to them in such a case. It also analyses the likelihood of an artisanal miner choosing agriculture as an alternative if artisanal mining becomes impossible.

Finally, **Chapter V** concludes this dissertation by reviewing the salient findings, discussing some policy options and proposing some avenues for future research

Appendices I

Figure 1.6 The DRC's real GDP per capita from 1950 to 2018



Source :
https://upload.wikimedia.org/wikipedia/commons/a/a5/Economic_growth_of_Congo_DR.jpg
consulted on 18/5/2022

Table1.1 Territories of South Kivu and their agricultural and mining characteristics

Territory	Main economic activities (ranked by importance)	Agricultural characteristics	Mining characteristics
Kalehe: 5057km^2; 226km of roads; 90 pers./km^2	Agriculture, livestock, fishing, artisanal mining and petty trade	Mountain climate; moderate temperature; fertile sandy and clay soil; subsistence farming dominated by cassava, potatoes, bananas, maize and beans	Important mining resources: cassiterite, coltan, gold, wolframite
Shabunda: 25216km^2; 393 km of roads; 23 pers./km^2	Agriculture, fishing, livestock, artisanal mining, petty trade, hunting	Equatorial climate; it rains all year round; sandy and very fertile soil; subsistence farming dominated by cassava, bananas, peanuts and rice	Important mining resources: gold, cassiterite, coltan…
Mwenga: 11 172 km²; 350 km of roads; 28 pers./km^2	Agriculture, livestock, petty trade, artisanal mining, hunting, forestry	Humid tropical climate; fertile sandy-clay soil; subsistence farming dominated by cassava, bananas and rice	Important mining resources: gold cassiterite, coltan, wolframite…
Idjwi: 310 km^2; 182km of roads; 550 pers./km^2	Agriculture, petty trade, fishing, livestock	Mild and humid temperate climate; fertile sandy soil in the northern part and clay in the southern part; Subsistence farming dominated by cassava, beans, bananas and pineapples	Some mining resources: coltan, cassiterite
Fizi: 15 789 km^2; 517 km of roads; 19 pers./km^2	Artisanal mining, fishing, petty trade, agriculture, livestock	Temperate and cold climate in the north, hot and humid in the south; very fertile sandy soil; subsistence farming dominated by cassava, maize and soya	Important mining resources: gold, cassiterite, coltan
Uvira: 3 146 km^2; 127 km of roads; 126 pers./km^2	Agriculture, livestock, trade, fishing	Semi-arid climate and a tropical micro-climate in the Ruzizi plain; Sandy and fertile soil; Subsistence farming dominated by rice, maize, beans and cassava	Some mining resources: Cassiterite, gold, iron and amethyst
Walungu: 1 800 km^2; 233 km of roads; 254 pers./km^2		Cold tropical and mountain climate; clay soil, increasingly poor due to erosion and overpopulation; subsistence farming dominated by sweet	Important mining resources: gold, cassiterite, coltan and wolframite

		potatoes, cassava, beans, potatoes	
Kabare: 1 960 km^2; 241 km of roads; 253 pers./km^2	Agriculture, livestock, trade, fishing, stone quarrying	Mountain climate; clay soil, increasingly poor due to erosion and overpopulation; subsistence farming dominated by cassava, bananas, potatoes, beans and vegetables	Some mining resources: coltan and cassiterite

Source: Author's conception

Table 1.2 Some points of similarity and difference between the study areas

Groupings	**Villages**	**Activities performed classified according to their importance**	**Similarities**	**Some particularities (differences)**
MBINGA NORD	Kabulu II	Agriculture, Artisanal mining, Petty trade, Livestock, Fishing, Other occupations	- Have agriculture as their basic activity - Enjoy the same climatic conditions favourable to agriculture - Cassava is the main staple food and is grown everywhere - Coffee cultivation is present and constitutes a source of income for some households	- Artisanal mining occupies a significant portion of the population and plays an important role in the economy
	Mukwidja	Agriculture, Fishing, Petty trade, Other occupations		- Being close to Nyabibwe, it is directly and indirectly affected by artisanal mining - Fishing is widely practiced and plays an important role in the economy - Being located on the edge of Lake Kivu, it is easy to transport agricultural production to the cities of Bukavu and Goma via the lake

BUZI	Bubale I	Agriculture, Petty trade, Livestock, Fishing, Other occupations	- Land is owned by a small number of large landholders while many smallholders are landless - All experience the same agricultural problems (e.g., lack of infrastructure) with the exception of Nyabibwe where there are additional problems related to the existence of artisanal mining	- Agriculture and petty trade go hand in hand and support the local economy - Éloigné des sites miniers, ce village ne subit pas directement les effets de ceux-ci - easy to transport agricultural production to the cities of Bukavu and Goma via the lake
	Kalungu	Agriculture, Petty trade, Transporter (portefaix[25]), Livestock, Other occupations		- Located on the road to (and near) the Numbi mining site, experiences the direct and indirect effects of artisanal mining - Easy to sell the production in the center of Minova which is near
	Minova	Agriculture, Petty trade, Livestock, Fishing, Other occupations		- Major commercial centre for agricultural products for people from the North and South Kivu. It is affected by artisanal mining because traders from the surrounding mining sites regularly buy their products there.

Source: Author's conception

[25] Load carriers. Being on the road to the mining site of Numbi, the food and non-food supplies of the latter pass through Kalungu; thus, the porter constitutes a significant source of income for the small farmers of Kalungu who do not have sufficient means for land tenure or to start another non-agricultural activity.

Chapter II: "From peasant to extractive peasant": Artisanal mining as a livelihood strategy of peasants in Kalehe

2.1. Introduction

In an environment where artisanal mining and agriculture coexist, the linkages between them are often analysed as part of livelihood strategies. The latter, as explained in the previous chapter, imply the modification of the household's mix of activities in response to changes in its asset situation and/or the circumstances it faces (Ellis, 2000; Dorward, et al., 2009; Brugger & Zanetti, 2020).

In such analyses artisanal mining is often considered as a seasonal activity, or an activity people engage in to complement the revenues they have from agriculture or to cope with shocks, when harvests fail or in periods of conflict (Fanthorpe & Maconachie, 2010; Cartier & Bürge, 2011; Maconachie, 2011; Arthur et al.,2015; Hilson, 2016; Ofosu et al., 2020). Indeed, while production and income from agricultural activities are often irregular and limited due to different institutional problems, trends (e.g., seasonality) and shocks (e.g., abrupt changes in prices, climatic conditions, ...), household consumption and investment needs are regular and unlimited. Hence, households try to adopt some strategies to meet their consumption requirements and aspirations and to invest for the future. When these strategies involve the extraction of commodities, the household falls into the category of extractive peasants as defined by Lahiri-Dutt. These are "rural workers in less affluent nations who have been shifting to or alternating with, other livelihoods to make a living through commodity extraction" (Lahiri-Dutt, 2018a, p. 1).

As mentioned in the general introduction and elaborated in the next section, to explain this shift, the existing literature focuses more on macro causes such as changes brought about by neoliberal policies which have negatively affected agricultural productivity and income. In this chapter, I rather take a micro approach to present the various endogenous and exogenous factors underlying the integration of artisanal mining into the livelihood strategies of peasants. Drawing on the sustainable livelihoods framework presented in the previous chapter, I tried to understand the livelihood opportunities available to Kalehe peasants, the barriers that prevent them from taking advantage of these opportunities, and whether the survival strategies they adopt include artisanal mining. I use a mixed methodology, analysing quantitative and qualitative data collected in Kalehe in 2017 and 2018.

In the second section, I explore the different factors underlying the transition from peasant to extractive peasant. The third section presents the different livelihood opportunities available in Kalehe and the extent to which they are used in the agricultural activities. The fourth section presents the farming process[26] in Kalehe. In the fifth section, I present and discuss different constraints and difficulties faced by Kalehe peasants during this process. The sixth section analyses the different adaptive strategies that Kalehe peasants adopt to maintain their survival and the seventh section presents some concluding notes.

2.2. From 'peasant' to 'extractive peasant': towards livelihood strategies

Often used in several fields and disciplines, the term "peasant" is widely debated and controversial (Bernstein & Byres, 2001; Edelman, 2013; Lahiri-Dutt, 2018a; Bernstein, 2021)[27]. In this chapter I refer to the definition used in the interdisciplinary fields of peasant and agrarian studies, where in its narrow sense, the term describes people engaged in subsistence-based or small-scale agriculture (Lahiri-Dutt, 2018a; Bernstein & Byres, 2001). In its broad sense, the term "peasant" does not only refer to farmers but goes beyond farming (Bernstein & Byres, 2001; Edelman, 2013; Bernstein, 2021). It is somehow accepted to designate "a broad range of people, engaged in subsistence based or small-scale agriculture in Asia, Africa and South America, and includes those who own small pieces of land and those who are tenants on such lands, including the sharecroppers and landless agricultural labourers" (Lahiri-Dutt, 2014, p. 7). In the mining areas, in addition to this agricultural livelihood, peasants are increasingly associated with the artisanal extraction of minerals, giving them the qualification of extractive peasants, in the words of Lahiri-Dutt. When does their transition from "peasant" to "extractive peasant" occur?

The answer to this question lies in the livelihood literature presented previously. In effect, the term extractive peasant, as defined by its pioneer Lahiri-Dutt, designates peasants who decide to engage in mineral extractive activities as part of livelihood strategy, either in exchange of, or to supplement incomes from, farming or related livelihoods to overcome changes brought by neoliberal economic policies (Lahiri-Dutt, 2014; Chowdhury & Lahiri-Dutt, 2016; Lahiri-Dutt, 2018a). On their own or in group, with or without license, as wage labour on irregular or contract basis, these peasants decide to work in smaller mines and quarries or to steal from existing or abandoned larger mines. Lahiri-Dutt (2014) identifies six main push and pull mediating factors causing their shift from an

[26] By "Farming process" I refer to the process of producing and marketing the crop.
[27] Edelman (2013), for example, distinguishes four kinds of definitions depending on whether the term is used in the historical, social scientific, activist and normative fields.

agrarian to a mining economy. These include: (1) the push or agricultural poverty factor which involves the various forces that negatively affect the productivity of the agricultural sector and thus make it unsustainable; (2) the structural reform factor which encompasses all the economic reforms to liberalise land markets and to attract the Foreign Direct Investment (FDI); (3) the rentier state factor which concerns all the States' initiatives to earn revenue incomes from mineral extractive sector; (4) the mining for development factor which translates the tendency to equate mining with development and thus, to establish an extractive model which favours large corporations and/or the local communities in mining; (5) the environmental refugee factor which reflects both the local and global processes that cause the environmental degradation at the local level and entails uncertainties of precipitation and temperatures and finally, (6) the pull factor concerns the rising commodity prices which increases the incentives to earn cash incomes from commodity extraction.

Although presented separately, these six factors overlap. While some of them evoke exogenous factors such as shocks and stresses in the farming or related sectors, others underline the responsibility of institutions and organisations through economic reforms (endogenous factors). Indeed, by putting peasants under great pressure, these reforms have made agriculture less and less economically viable, pushing them through what Bryceson (1996; 2002) refers to as "deagrarianisation" or "depeasantisation", defined as a "long-term process of occupational adjustment, income earning reorientation, social identification and spatial relocation of rural dwellers away from strictly agricultural-based modes of livelihood" (Bryceson, 2002, p. 726). For instance, the liberalization of land and agricultural markets has contributed to increased land insecurity and decreased peasant's agricultural production. Then, to comply with the World Bank and IMF obligations to secure their loans, many states have withdrawn their support to agricultural activities by eliminating subsidies on farm inputs, by removing non-tariff barriers and by privatising crop parastatals enterprises (Hilson, 2016). Moreover, convinced that mining can spur growth and development and encouraged by the Breton woods institutions under the structural adjustment policies, many states have amended their mining codes in the 1980s and 1990s in order to attract foreign investment in the sector. The large-scale extraction undertaken by these foreign companies has not only led to land dispossession and forced displacement, but has also had negative effects on the environment, making agriculture less and less productive. Many peasants have been deprived of their land and way of living, and have been forced to turn to other livelihoods. This has been exacerbated by the increasing mineral prices which pulled many of them

into the mining sector. Once they integrate mining into their livelihoods, they become extractive peasants.

These factors as presented by Lahiri-Dutt (2014) are in line with the existing literature explaining the growing importance of the artisanal mining sector. In effect, over the last two decades two lines of arguments were developed as regard to the expansion of the sector (Tschakert, 2009; Geenen, 2018; Hilson, 2016; Pijpers, 2014; Brugger & Zanetti, 2020). The first is the "distress-push" school which considers artisanal mining as an activity in which people are engaged because they lack other livelihood opportunities, or they face difficult financial situations and are desperate to escape poverty. The second which is the "demand-pull" school argues that artisanal mining is comprised of "rush-type" activity fuelled by fortune seekers. According to proponents of this school, farming and other livelihood activities may still be productive but, pulled by the hope of getting rich quick, people choose to engage in artisanal mining to improve their social statuses and to secure cash to finance a business in their hometowns.

It is clear from all of the above literature that the integration of artisanal mining into peasants' livelihoods occurs as part of their livelihood strategy. While this literature frequently presents neoliberal policies as an important factor that has driven the failure of agriculture, case studies to understand how this failure is driving peasants into artisanal mining are rather limited. This chapter therefore contributes to the existing literature on this aspect. It attempts to present and analyse the various factors underlying the integration of artisanal mining in Kalehe peasants' livelihood strategy. To do so, I will first present the different livelihood opportunities available to them before presenting the different obstacles they face that may lead them to rethink their livelihood strategies and/or integrate artisanal mining into their livelihoods. My analysis considers peasants in its narrow sense, i.e., households whose main activity is agriculture, even though sometime I will refer to those that are engaged in other activities but rely on agriculture in one way or another for their livelihood. To begin with, in the following section I present the livelihood opportunities, and assets, and how they are integrated in the farming process in Kalehe.

2.3. Agricultural livelihood opportunities in Kalehe

In order to meet their survival needs, Kalehe peasants have, like other peasants, a range of tangible and intangible assets on which they can rely for their agricultural activities. In terms of natural assets, they benefit from a set of biophysical factors that favour agricultural land use. Indeed, located at about 1500 m asl, being of Plinthic Ferralsols nature and of volcanic origin with silty

clay texture, these lands are fertile and favourable to a diverse range of subsistence and commercial crops such as cassava, beans, maize, sweet potatoes, soybean, coffee, cinchona, tea, etc. (Pypers, et al., 2011; Maass, Musale, Chiuri, Gassner, & Peters, 2012; Munyahali, et al., 2017; Heri-Kazi & Bielders, 2020). Enjoying a tropical highland climate, Kalehe is characterized by a bimodal rainfall pattern which provides on average 1500-1800 mm per year and allows crop cultivation over 325 days per year[28] (Pypers et al., 2011; Munyahali, et al., 2017). In addition to these soil and climate-related potentials, being located alongside the Kivu Lake, Kalehe peasants may enjoy the positive effects of the latter such as lake transport to reach the cities of Goma and Bukavu as well as access to fish products for food diversification. Other natural resource-based activities such as forest and mineral exploitation may be available for livelihood diversification thanks to the presence of forest[29] and various mineral resources throughout the territory.

Consistent with other studies conducted in Kalehe such as the studies by Munyahali, et al. (2017); Mufungizi and Gaspart (2017); Heri-Kazi and Bielders (2020), my survey data indicate that households farm an average of 2 fields (N=496; Min=0; Max=8; SD= 1.28)[30], with an average size of 0.3 ha (N=481; Min=0.0007; Max=6; SD= 0.7203) per field and, grow a variety of subsistence crops such as cassava, beans, maize, potatoes, etc. (Appendices, Figure 2.2). In more than 50% of cases, the field exploited belongs to the household. When this is not the case, the exploitation is done either under a rental contract or - in the vast majority of cases - under a sharecropping contract (Appendices, Figure 2.3). Indeed, in the history of land in Kalehe, agricultural lands were once customary properties available to all and managed by the customary chief (*Mwami*) and his collaborators (*Bashamuka, Bagula and Bashizi*) through the *kalinzi* contract. Through this contract, a peasant in need of agricultural land had to pay to the *Mwami* or his collaborators a small initial payment called *Muganda* and start the exploitation. Then, to continue to work the land, he had to pay an annual rent either in produce or in labour. However, different factors such as demographic pressures and migration, political decisions as well as the emergence of new economic classes, have limited land access for some peasants[31]. This resulted in a system in which large concessions from inheritance or purchase are in the hands of a minority of farmers (landowners) who either

[28] As everywhere in the South Kivu, the crop year is divided into seasons A, B and C. Crop cultivation is done during the A and B seasons. The former lasts from mid-September to mid-January while the latter goes from mid-February to mid-June. It is followed by a short dry season (season C) during which only some peasants whose land are located in valleys and drained marshlands cultivate (Munyahali, et al., 2017).
[29] Part of the Kahuzi-Biega National Park is in Kalehe.
[30] N= Number of households; Min=Minimum; Max=Maximum; SD= Standard Deviation
[31] For more details see (Van Acker, 2005; Mudinga, 2017)

exploit them and/or rent them to the vast majority of subsistence peasants (For more details see Van Acker, 2005; Utshudi & Ansoms, 2011; Claessens, 2017; Mudinga, 2017; Ansoms, Mudinga, Bisoka, Cioffo, & Claessens, 2019). Not owning their own land or having inherited only a small portion of land, often insufficient to support their families, the majority of subsistence peasants increase their productive capacity by renting land from large landowners. Two types of arrangement can be made[32] namely the *louage*, i.e., the fixed land rent agreement and the sharecropping agreement. For the former, depending on the size of the field and its fertility, the landowner sets a price that varies between 20 and 100 US dollars per growing season, an amount that the tenant will pay at the beginning of the activities or after the harvest period according to their agreement. For the second, however, the landowner gives to the farmer permission to work part of his field in exchange for a share of the harvest (called *lugabane*)[33] or for the farmer's labour input, i.e., work two or three days per week for the landowner (called *salongo*).

In terms of physical and financial assets, Kalehe is not well endowed. Indeed, the infrastructure for transport, processing and storage of agricultural products, the power line and water supply, as well as financial institutions are almost non-existent. However, the territory has certain advantages in terms of these infrastructures (CAID, 2017). First, even if they are in poor condition, two national roads cross Kalehe, including 100 km of the national road N°3 that connects the city of Bukavu to the city of Goma. Second, the high voltage power line that connects the two cities also crosses Kalehe, although the latter is almost unelectrified[34]. Third, thanks to the motorized pirogues that travel on the Kivu Lake, Kalehe can easily be connected to other territories such as Idjwi and Kabare and to the cities of Goma and Bukavu. Fourth, in addition to the Kivu Lake, Kalehe's hydrography shows 12 rivers with waterfalls with the potential to provide water and electricity. Fifth is a favourable environment for livestock, the latter being often used as a means of savings to replace non-existent financial institutions in rural areas of poor countries (Maass et al., 2012).

In Kalehe, agricultural production is done using traditional tools such as hoes, axes, machetes (Appendices, Figure 2.4). These can be purchased either directly from sellers in Bukavu or Goma, or from local sellers who have sourced them in these cities. In addition, some organizations such as NGOs and associations can sometimes distribute different tools to farmers. Those who do not

[32] From all individual interviews and focus groups conducted with farmers in Kalehe in 2017
[33] Most of the time, 50% for each of them.
[34] Only a few grid connections in the village of Minova. There is also a mini hydroelectric plant in Bitale village, Buloho chiefdom (inaugurated in 2020). In other villages, such as Bubale I and Kabulu II, people copes with accessing services that require electrical power (solar panels, generators,….)

have their own tools often resort to their neighbourhood (family, friends, …) or to the association in which they have membership, and get the tools for a specific work, either for free or for a certain amount of money. They have to hand them over as soon as the work is finished. Seeds can either be purchased, taken from the past harvest, or received from the association in which the peasant has membership. Production is stored in bags or baskets. Although mainly perishable, this production undergoes little or no processing at the local level, due to the lack of processing facilities. Those who sell all or part of their production do so largely to intermediaries (Appendices, Figure 2.5), either on- farm, at the market in the cities of Bukavu and Goma, or at the local market (Mufungizi & Gaspart, 2017).

To satisfy their financial needs, such as investment in schooling or any other investment, some farmers resort to selling their livestock. These are made up of large (such as cows, goats, pigs, sheep) and small (such as hens, rabbits, guinea pigs, etc.) livestock (Appendices, Figure 2.6). Maass et al. (2012) have noted that small livestock are often used for household consumption while large livestock are often used for investments. Those who do not have livestock can borrow money from their social network, often at exorbitant rates (Mulumeoderhwa, et al., 2019). In addition, informal financial institutions such as Rotating Savings and Credit Associations (ROSCAs) and village savings and loan associations (VSLAs) are present in different peasants' association and constitute for some peasants a recourse in case of need[35]. For those who can access the telephone, three communication networks are operational and offer, in addition to phone services, money transfer services.

Finally, the labour market is very thin, i.e., it is often difficult to find a balance between labour supply and demand. Therefore, depending on the extent of their social network, households rely on family labour (close and distant kin), friends and associations. Although family labour is most commonly used, households occasionally use paid or unpaid non-family labour (Appendices, Figure 2.7) to perform the various production tasks.

Access to education and health care to strengthen this available workforce remains critical even though the territory has 505 elementary school, 245 secondary schools, 4 higher institutes, 7 hospitals and 71 health centres (CAID, 2017). For instance, consistent with the study by Mulumeoderhwa, et al. (2019) in Kalehe, only 8% (N=496) of household heads in my database

[35] Interview with the president of the synergy of women's associations who is also a farmer and owner of a restaurant in Nyabibwe ; Interview with the head of the solidarity mutual of Nyabibwe who is also a farmer

have completed secondary school (Appendices, Figure 2.8), 45% of households do not have access to food several times during the year, 46% do not have access to medicines and health care when they feel ill, 16% do not have access to drinking water several times, and 23% do not have access to cooking fuels for their domestic needs several times (Appendices, Figure 2.9). However, certain characteristics of the household heads have the potential to enhance their experiences and skills in agriculture. Not only do they have farming as their main activity (86%; N=496) in which they have already spent an average of 25 years (N=424; Min= 1; Max= 80; SD=14), but they also have (or have had) a parent who is a farmer (96%; N=496) and they belong to associations (47%; N=496) that aim to improve agricultural production. In addition, various actors, whether at the national, provincial or local level, have the mission of strengthening the skills and experience of farmers through, for example, seed control, extension of new technologies, distribution of agricultural inputs, etc. Agronomist monitors are deployed in the different locality of the territory for the follow-up and the daily accompaniment of the peasants.

It appears from the above that, to expand and develop their agriculture-based livelihood, Kalehe peasants have various assets on which they can rely, although the latter are sometimes insufficient or unsuitable (e.g., physical assets). To better understand how these different assets are used in agricultural production, it is first necessary to understand how agricultural production is organised. The following section presents the farming process in Kalehe. By "Farming process" I refer to the process of producing and marketing the crop.

2.4. Presenting the farming process in Kalehe

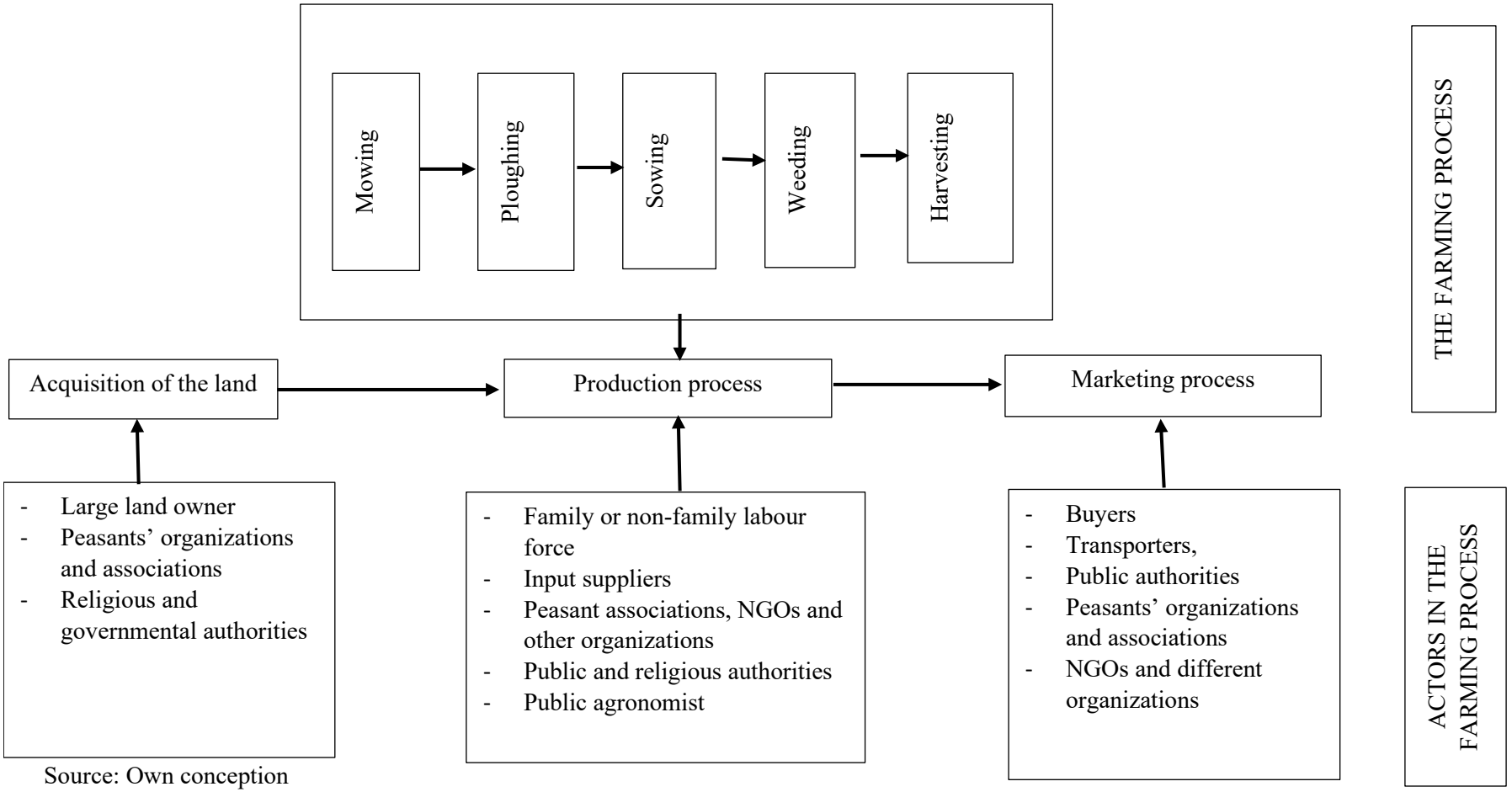
In Kalehe, the farming process can be divided into three stages (see Figure 2.1 below) during which the intervention of different actors/factors strengthens or weakens peasants' involvement in agriculture. The first is the acquisition of the land to be exploited. As I explained earlier, this stage largely concerns poor small peasants who have small plots of land insufficient to cover their households' needs – or who have no land at all– and who, as a result, resort to large landowners to expand their production capacities. These large landowners are either customary authorities, religious authorities, or local notables who live in the areas or in the cities of Goma and Bukavu, or who occupy various governmental positions in the capital city of Kinshasa or in other large cities (Claessens, 2017; Mudinga, 2017). At this stage, NGOs, various farmers' organizations and associations, religious and governmental authorities at the local, provincial and even national levels

can accompany peasants in the process of acquisition and mediation of related conflicts. Therefore, they may affect the process in different ways.

Once the acquisition process is concluded, the peasant enters the production process, which begins with the preparation of the land (mowing and ploughing), followed by the sowing and weeding, and ends with the harvest. Depending on the fertility of the field or the crop grown on it, the first weeding may intervene one or three months after sowing. After three months some products like beans and maize can already be harvested. However, for products like cassava, a second, third or fourth weeding can be done before harvesting 12 to 16 months after sowing[36]. At this stage, in addition to the family or non-family labour force involved in production work, other actors such as agricultural input suppliers, peasant associations, NGOs and other organizations, public and religious authorities, the public agronomist, etc. may be involved in the provision of inputs and the extension of new technologies.

[36] From all individual interviews and focus groups conducted with farmers in Kalehe in 2017

Figure 2.1 Actors involved in the agricultural process in Kalehe



Source: Own conception

Following the production phase, farmers can market their crops. There are three types of marketing. In the first, intermediaries buy the crops from the farm, harvest and process them, and sell them to retailers or consumers. In the second type, the harvesting and processing is done by the peasant himself, who sells them to intermediaries, retailers and consumers, either on the farm or at home. Finally, in the third type, after harvesting and processing, the peasant goes to the market to sell to intermediaries, retailers or consumers. In addition to buyers, other actors such as transporters, public agents in charge of providing transport and storage infrastructure as well as security and/or regulation of the functioning of the markets, peasant associations and different organizations, can affect the gain that the peasant makes at this marketing stage.

In the following section I analyse the extent to which the intervention of these different actors in the farming process affects the agricultural livelihoods of Kalehe peasants.

2.5. Actors in the farming process and vulnerability of Kalehe Peasants

As mentioned above, the farming process is divided into three main stages in which different actors intervene. In analysing the difficulties faced by peasants throughout the farming process, I will highlight how the behaviours of certain actors are likely to negatively affect agricultural livelihoods.

2.5.1. Land acquisition process

Regarding land acquisition, the main difficulty faced by farmers is related to the nature of the contract. Although the *louage* contract is preferred by peasants, they find its price exorbitant due to their low financial capacity, leading them to opt for the sharecropping arrangement, as stated by this farmer:

> *"It is only because we do not have [financial] means but if we had, we could go for a fixed land rent arrangement instead of cultivating a land whose harvest will be shared with another person*[37] *".*

Indeed, the sharecropping contract seems to have a negative effect on the agricultural income through different channels that discourage them from making more effort to increase their income. First, sharecroppers think they are overexploited because they bear all the expenses incurred in the production process but have to half-share the harvest with land owners whose only contribution is the land [38]. Second, given that land owners do not bear any of the production

[37] Focus group with farmers of Kalungu
[38] Focus group with farmers (cassava producers) in Nyabibwe

expenses, they, most of the time, sell their share at a low price as compared to the market price. Thus, while they will have incurred high costs in the production process, sharecroppers are forced to sell at a low price which does not cover incurred expenses[39]. Third, as explain by this farmer from Mukwidja, this kind of contract makes sharecroppers dependent on the landowner so that, no matter what the urgency in which he finds himself, he cannot harvest anything without the landowner's agreement:

> "*If you have agreed with the landowner that you will share on the 50% basis, [...] even if your child gets sick and you know that the crops have already reached their maturity, you cannot harvest anything without the landowner's agreement [...] they [the landowners] are not like us ... they live in abundance and have no pressing needs ... we are suffering*[40]"

Fourth, the *salongo* contract creates a feeling of overexploitation on the part of land tenants[41]. This is because, by dedicating two to three days a week to work in the landowner's farm, they do not find enough time to work in their own fields, resulting in underutilization of the received land. Besides, they most of the time receive "hard" land which, they argued, is difficult to exploit leading to low productivity.

All of the above arguments advanced by tenants tend to blame the landowners. However, when the latter's point of view is taken into account, the blame goes the other way around as stressed in the following quote:

> "*There are those we call 'cigabane*[42]*', they come to you and say: 'I really need a piece of land that I have to exploit for my family's needs, please help me'[...] It is not you who will tell him that the cassava has reached maturity. He will, but when? In a cassava cutting, we usually have ten cassava plants. At the time of weeding, he will take five, and then he puts the soil back to deceive your vigilance. When he sees that the place where he had removed the 5 cassavas is starting to rot, he says to you: 'Let's harvest the cassava now because it is already mature!'. As a result, at harvest, instead of finding for example five bags [of cassava] you will only get two […]. For the 'louage' contract, we do it by square meter: we know that on a square meter we can plant as many cassavas, we then calculate and determine the share of each of us. In reality, [the rent price is fixed so that] the landowner takes one third and two thirds must then go to the*

[39] Focus group with members of the Nyabibwe women's agricultural associations
[40] Focus group with farmers in Mukwidja
[41] All focus groups with farmers in Nyabibwe, Mukwidja, Kalundu and Minova
[42] Those working under the « *lugabane* » contract

tenant to cover expenses and provide for his needs [...]. Regarding the salongo, [the tenant] considering himself strong what does he do? He takes a field at Cirimwami's, another at Kalwira's, another at Constantin's and another at François's [...]. These are 4 concessions in which he will make the salongo [...] he therefore makes commitments to which he is unable to respond, as a result of which he will find the salongo restrictive[43]".

By analysing the views of tenants and landowners[44], we can conclude from these quotes that both parties lack confidence in each other, the one side blaming the other. This can bear some consequences. Indeed, many studies have analysed the impact of the land tenure system on farm income, investment and productivity (Place, 2009; Akram, et al., 2019; Lovo, 2016; Benin, Place, Nkonya, & Pender, 2006; Gao, Sun, & Huang, 2017; Bandiera, 2007; Singirankabo & Ertsen, 2020; Banerjee & Ghatak, 2004). In these studies, tenure insecurity is analysed through three dimensions namely, the lack of land title, the short-term tenancy contract, the lack of transferability and the risk of expropriation. Although their results are somewhat mixed in that the effects found in one place may be different from the effects found in another, studies on the effect of short-term tenancy contracts argue that farming under a fixed rent contract or sharecropping contract reduces the likelihood that the tenant will invest in soil conservation techniques (Lovo, 2016) or in potentially more productive long-term crops such as trees (Bandiera, 2007; Akram, et al., 2019). This is because he/she is insecure knowing that he/she can be evicted at any time (Banerjee & Ghatak, 2004). In fact, according to theories of moral hazard in agriculture, due to risk aversion or the limited liability of both parties in the short-term tenancy contract, landowners are often unable to provide tenants with incentives to put in more effort (Bandiera, 2007). This is what is observed here in the case of Kalehe. On the one hand, with the idea that landowners are overexploiting them, tenants develop cheating mechanisms to try to earn more - one example being the one highlighted in the quote above where they steal crops from the field behind the back of the landowner -. They may even adapt their livelihoods strategy and/or reduce their efforts in increasing farm productivity[45]. On the other hand, having in mind that tenants are not honest, landowners may also develop other mechanisms to make more profit from the operation. They can for example threaten the tenant by increasing the land price, by multiplying the number of *salongo* days or by doubling the

[43] Focus group with landowners in Nyabibwe and Mukwidja
[44] These mutual accusations came up in all the interviews and focus groups I had with tenants and landlords. In the focus groups where both parties were represented, I remember that this generated debates and discussions that could last more than 30 minutes
[45] Focus group with farmers in Nyabibwe

landowner's share in the sharecropping contract[46]. This will nurture the "accusations vicious circle" and may discourage both of them. According to Banerjee and Ghatak (2004), good tenancy laws can contribute to a good distribution of crops and, greater secure rights can positively impact productivity and investment (Akram, et al., 2019). Therefore, these negative effects would be avoided if other actors (notably religious and government authorities) were invested in building the right institutions that govern land markets in Kalehe. However, they may have no incentive to do so because, as mentioned above, some of them are landowners themselves.

2.5.2. Production process

In the production process, peasants point to some negative factors underlying their low productivity. These are[47], on the one hand, plant diseases, the lack of necessary tools and the farming methods used. These factors, as pointed out in the quotes below, come from different sources such as farmer's ignorance in the application of cultivation methods;

> "*You take the same seed that you have been using for ten years and at the same place; [...] which has already lost all its germinating power, but you continue to use it. If it gave 10 seeds last year, this year it will give 5, next year 3. Don't say: 'ebishogolo bya fire[48]!' No, They're not dead! It is your seed [...]*[49]"

> "*We have seeds that no longer seem to be adapted to the soil here, and we receive no training in farming methods adapted to our land*[50]"

Climatic disturbances are also presented as major threat.

> "*They [farmers] may say to themselves, 'the rain will come on the 15th of this month and we will plant after that date', but sometimes the drought persists; it becomes difficult to plant the seed... and those who do may lose... this is a big difficulty for the farmers here*[51]"

> "*Sometimes after cultivation, because we cultivate on steep slopes, when the rain falls, there is erosion that goes through the field and washes away all the crops*[52]".

[46] Focus group with landowners in Nyabibwe and Mukwidja
[47] All focus groups with farmers in Nyabibwe, Mukwidja, Kalungu and Minova
[48] Expression in local language meaning, the 'bean leaves are dead!'
[49] Interview with a landowner and farmer in Mukwidja
[50] Interview with the head of the solidarity mutual of Nyabibwe who is also a farmer
[51] Focus group with the leaders of the synergy of agricultural associations in Minova
[52] Focus group with the leaders of the synergy of agricultural associations in Minova

On the other hand, peasants denounce a certain neglect from the institutions which should normally accompany them, but which, according to them, are only there to swindle them. In the various quotes below, they explain how they are victims of crop theft in the fields or at home and/or of livestock invading their fields.

> "*When you've already found a field, you've cleared it, you've cultivated it and you've sown it, the first difficulty you're going to face is theft; you prepare for the harvest and the thieves set up plans to steal your crop [...] or if they don't steal, the herders bring in goats that are going to ravage the whole crop [...]. This discourages us*[53]".

For some peasants, this is related to the fact that the security of people and their property is not guaranteed, as a result of the overlapping roles of public institutions and the lack of financial means:

> "*We have a problem here, we are penalized, we are bothered […] we have government agronomist instructors and we farm but their presence is not felt because they are only there to bother us. I find goats ravaging my crops and when I talk to the owner, he answers me with disdain: 'what can you tell me?' I keep quiet because he is the owner of the field. If I go to the agronomist and complain, he says, 'Before I come to check, you have to give me $5 and in dollars [not in Congolese francs]! and when he arrives at the field the owner of these goats gives him for example 20$ and he will no longer monitor my crops […]. Others bypass the agronomist and go to the FARDC*[54]*[...] we finally don't know who should do what [...] this is a frequent and very serious problem that makes us work at loss*[55]"

> "*We have agronomist instructors from IPAPEL*[56] *but they no longer carry out their missions; they have become taxers*[57]"

As they receive nothing in compensation, they claim that in such cases they often work at a loss[58].

In addition to documenting the effect of low level of schooling and lack or poor skills I already mentioned, these various quotes also show how peasants are vulnerable to exogenous factors

[53] Focus group with farmers in Kalungu
[54] Force Armées de la République Démocratique du Congo, the national army.
[55] Focus group with farmers in Nyabibwe
[56] "Inspection provinciale de l'agriculture, pêche et élevage(IPAPEL)" , a technical service of the Ministry of Agriculture
[57] Interview with the head of the Synergy of Organizations Committed to the Fight against Hunger-Poverty (Synergie des Organisations engagées dans la Lutte contre la Faim-la Pauvreté/SOLFAP) in Mukwidja
[58] All focus groups with farmers in Nyabibwe, Mukwidja, Kalundu and Minova

such as climate conditions or to endogenous factors such as the poor implication of the government and other organisations. They are consistent with other studies already conducted in the area. For instance, Mulumeoderhwa, et al. (2019) found that 14% of farmers in Mbinga Sud - one of the *groupings* of Kalehe -, are threatened by flooding and erosion because their fields are located on hills. Their study also highlighted that, peasants in Kalehe are victims of climatic disturbances and crop diseases and that they lack protective equipment, thus running the risk of injury. Within the same framework, analysing the vulnerability of Kalehe peasants to climatic hazards, Heri-Kazi and Bielders (2020) note that their fields face four types of degradation caused by climatic hazards, namely, water erosion which has the highest severity index, followed by soil exhaustion, loss of organic matter and soil compaction. Likewise, after experimenting with fertilizer application, Pypers, et al. (2011) concluded that farmers are impressed with fertilizer but are reluctant to use it because they lack experience and access to fertilizer and farming tools that facilitate its application. Similar results were found by Maas et al. (2012) who reported that only one-third of the farmers they interviewed acknowledged having already had access to technical assistance or extension service. The latter, the study argues, was most of the time inadequate or not in accordance with their needs. Problems of theft and devastation by animals are noted by Mulumeoderhwa, et al. (2019) and Maas et al. (2012). The first study argues that crop destruction by animals is a high risk for 29% of farmers and that the problem of crop theft is a risk faced by 50% of farmers 23.3% of these respondents attribute this problem to unemployment and the presence of armed groups in some villages. The second study notes that theft, and in particular theft by armed groups, is a major problem faced by peasants, especially herders.

All these difficulties encountered by Kalehe peasants in the production process raise questions about the role of actors such as government institutions, NGOs and other organisations, who should normally assist peasants in this process. Through public expenditure, infrastructure development and strengthening of extension service, these actors have a positive impact on agricultural productivity and income (Llanto, 2012; Elias, Nohmi, Yasunobu, & Ishida, 2013; Verhofstadt & Maertens, 2014; Urgessa, 2015; Berhane, Ragasa, Abate, & Assefa, 2018). However, Berhane et al. (2018) highlight that their interventions are often characterized by difficulties such as lack of flexibility in the delivery system, lack of necessary materials, inadequate linkages between research and extension, overworked agents and lack of an information management system, etc., which often prevent them from fulfilling their missions, thus leaving farmers to their fate. The following quote from an agronomist instructor in Kalehe presents these difficulties:

"*The first difficulty is that we, state agents, are not paid. We are mechanised but not paid*[59]*. To move from my place of residence to my place of work I have to pay for transportation. We have no means of transportation, [...]. Secondly, the state also rejects us! We would like to work hard, but when you find that you have no basic salary, I ask myself 'if I go there, how will my children live?' I can work with courage if I know that at the end of the month, I will be paid [...]. Thirdly, this lack of financial and technical means makes it difficult to be understood by peasants. When we want to sensitize them, instead of listening to us they tell us 'Are you agronomists? other agronomists used to give us medicines for our crops, saws, pliers, tridents and, they were making a regular follow-up of all our crops [...] but you, you only know to talk but you don't give anything'*[60]".

This quote documents the weak involvement of the government, which allocates only about 2%[61] of its budget to the agricultural sector, while the latter directly or indirectly occupies 70%[62] of the active population. Faced with all of these problems, Kalehe peasants are experiencing a low productivity of their land. For instance, taking the case of cassava, Munyahali et al. (2017) note that in the DRC the average yield of cassava storage roots is very low, varying around 8.9 t per ha, whereas its potential yield is ranging between 75-90 t per ha. In their experiment in Kalehe in 2014 and 2015, the authors found that the application of NPK fertilizer significantly increases the average yield of storage roots by 19% to 21%. This proves that farmers' access to fertilisers can increase their productivity.

2.5.3. Marketing process

In the marketing process, farmers are confronted with two sets of constraints. While the first set is related to the lack of infrastructure, the second is related to the harassment and multiplicity of taxes they face. With regard to infrastructure, many farmers I interviewed cited the lack of markets as the major constraint they face when marketing their produce. Market is defined here from two angles. From the first angle, it refers to the physical place where buyers and sellers meet. Indeed, apart from Minova where farmers acknowledged that they have a large market which attracts large buyers from all over the territory and even from the neighbouring cities of

[59] Mechanised state agents in the DRC are those who are listed and fulfil all the conditions for being paid (and are therefore included in the files of the payroll control services). To be mechanised but not paid simply means that the agent should normally receive his or her salary, but the latter, for one reason or another is not paid at the end of the month.

[60] Interview with the agronomist instructor in Nyabibwe

[61] Budget Ministry/DRC (2020). https://budget.gouv.cd/wp-content/uploads/budget2021/plf2021/lf2021_vol2_depenses.pdf consulted 01/04/2021

[62] http://www.fao.org/republique-democratique-congo/fao-en-republique-democratique-du-congo/le-pays-en-un-coup-doeil/fr/ consulted 01/04/2021

Goma and Bukavu[63], farmers of other villages of Mbinga Nord and Buzi groupings consider existing markets as "small markets", commonly called "*Caziga nshege*[64]". These small markets are often operational only twice a week, constituting a major constraint to farmers who sell perishable products and who, as I mentioned earlier, lack storage facilities (Mufungizi & Gaspart, 2017).

From the second angle, market refer to customers (buyers). Farmers argued that these small markets are often frequented by small buyers with very low purchasing power, resulting in low selling prices and therefore low farm income:

> "*There are many difficulties. The first is that farmers do not have a fixed price. Why not? Consumers have no money [have low purchasing power]. You bring your crop to the market, the buyer says: "here is the money I have", he imposes the price. Knowing that you have nothing in your pocket, you say to yourself: "let me take this money as it is"*[65]."

As pointed out in the quotes below, driven by pressing needs in their households, farmers are obliged to sell at a low price, crops that are sometimes not even mature, feeding thus the vicious circle of low income and maintaining food shortages in their communities.

> "*If we take the example of maize, here we grow maize but if you say to a farmer 'if you let this maize dry you will earn more' [he cannot accept], he harvests this maize long before [it dries] and is going to sell it at a lower price [...] whereas if he waited, he would earn a lot of money*[66]".

> "*There are people from the neighbouring territory of Kabare who come here to collect cassava. Apparently, Kabare's soil is no longer productive. They, most of the time, buy cassava that is still underground (5 months or even 3 months) at a very low price. At the harvest time all the production goes outside, and the population here remains hungry*[67]".

The issue of agricultural price volatility in Kalehe has been raised by Mulumeoderhwa, et al. (2019). Their study argues that 60% of farmers consider price volatility as one of the highest risks they face in their farming activity. According to these authors, farmers in most cases

63 Focus group with farmers of Minova ; Focus group with the leaders of the synergy of agricultural associations in Minova
64 An expression in Kihavu meaning "Provided I eat"
65 Focus group with landowners in Nyabibwe and Mukwidja
66 Focus group with farmers of Minova
67 Chief of the Mbinga Nord locality (groupement)

attribute this price volatility to the fact that the price is being imposed on them by buyers. On the other hand, Fafchamp (1992) has analysed the consequences of price volatility on the farmer's integration into the market. The author notes that, as a result of very high transport costs and low agricultural productivity, markets for food crops are thin and isolated, exposing farmers to volatile prices that are strongly correlated with their own agricultural productivity. As a result, farmers focus on food self-sufficiency to protect themselves against food price risks.

Peasants could increase their income by selling their harvest in large markets and in cities where the purchasing power is high. However, discouraged by the lack of transport and conservation infrastructures and poor agricultural policies, they are obliged to sell to intermediaries from neighbouring territories or from large markets such as Bukavu and Goma. As highlighted in the quote below, these intermediaries offer a low price and set up mechanisms to discourage local farmers.

> "*[...] and if we go with these intermediaries to sell our production in Bukavu, they cooperate with the transporters to divert our merchandise or [set up other mechanisms] so that the buyers do not come to us [...]. That is why we prefer to sell at a low price on our markets instead of bringing the production to Bukavu*[68]".

With regards to other mechanisms, a farmer from Mukwidja described the experience that completely discouraged him from going to Bukavu to sell his crop. In fact, when he arrived at the market in Bukavu, he needed to go to the toilet and left his jacket behind. According to him, the intermediaries inserted bullets in it and called the police, accusing him of being a member of armed groups. Besides incarcerating him, the police stripped him of all his merchandise and all the money he had. Since that day, he has sworn never to go to Bukavu to sell his products[69].

The question of the trade-off between selling on-farm or on the market in Kalehe, Kabare, Idjwi and Ruzizi plain has been widely discussed by Mufungizi and Gaspart (2017). They argue that, while selling on the market may be preferred by farmers, transport costs and other non-monetary transaction costs such as time spent waiting for a customer at the market, perishability of produce, theft and other market risks limit their willingness to sell on the market. With respect to intermediaries, the authors note that when the peasant sells his harvest on the market, he earns more by selling to an intermediary than if he sold to a consumer. This is because, the authors highlight, intermediaries are often organized in associations in which prices and supply arrangements are set and controlled in the market, and sanctions and penalties are provided for

[68] Focus group with farmers in Mukwidja
[69] Focus group with farmers of Mukwidja

members who do not comply. However, if the intermediary comes to buy on-farm, he/she has the ability to set a monopoly price and thus to penalize the peasant. The scope of action of these associations is often limited to the market, and buying on-farm gives the intermediary more opportunity to gain on the price. This may explain why they set up mechanisms to discourage farmers from selling on the city market, as was the case for this farmer from Mukwidja.

The second set of constraints that peasants face in the marketing process is related to multiple harassments and taxes. They pointed out that there are different military roadblocks on the way to the field or market to which each person who passes with food products must leave a certain amount. Basically, these barriers were erected to secure the population and their property. In turn, population had to provide food for the soldiers committed there. However, this people engagement has been made compulsory by these soldiers who impose the quantity that must be provided at each passage without taking into account the capacity of the passer-by [70]. In addition, as the quotes below underline, farmers who decide to sell their produce either on local or on external markets via the lake are subjected to exorbitant taxes and multiple harassment by soldiers and other public maritime agents.

> "*There are many difficulties! First of all, there are soldiers on the lake who are not paid by the State, that's where they get their remuneration from. These maritime agents and all these people get their money from farmers. We are the ones who pay all these state agents*[71]"

> "*We pay the soldiers here at the maritime service, the marines [...]. Here in Mukwidja we pay in cash and when you get to Kabonde, you pay [in kind] in terms of cassava; when you get to Bukavu, you pay in cash again. You pay money for each package. Here we notice that agriculture is subject to over taxation and threats, military threats on the road*[72]"

To escape this situation, some of them simply choose to sell their harvest from home or in the field.

> "*We are also bothered by the multiplicity of taxes. Our State does not distinguish a simple farmer from a professional seller [...] that is why many [smallholder] farmers prefer to sell their harvest at low prices in the fields or at home to avoid these expensive taxes...*[73]".

[70] Different focus group in Nyabibwe
[71] Focus group with landowners in Nyabibwe and Mukwidja
[72] Focus group with farmers of Mukwidja
[73] Focus group with farmers (cassava producers) in Nyabibwe

All these different taxes and payments increase farmers' transaction costs and, as noted by Mufungizi and Gaspart (2017), restrict smallholder participation in the market. The effects of taxation and corruption on growth and development have been analysed by Fisman & Svensson (2007) based on the case from Ugandan firms. The authors found that a one-percentage point increase in the rate of bribes payment decreases the firm's annual growth rate by 3.3% and a one-percentage point increase in the rate of taxation decreases the firm's annual growth rate by 1.5%. Thus, taxes and harassments can negatively impact on agricultural production and farmers' income. Furthermore, DeVillé & Mufungizi (2016) found that in fishing activities in Kalehe, due to over taxation some fishers and salesmen had to abandon their activity.

From what has been discussed so far, it appears that, although some are in limited supply, Kalehe has certain natural, physical, financial, social and human assets that peasants can rely on to sustain their livelihood. Throughout the agricultural process, peasants face endogenous mediating factors, such as landowners (through land contracts), public agents such as agronomists, government authorities, the army and the police (through their respective missions), NGOs and farmers' organizations (through associations and different projects); as well as exogenous factors such as climatic disturbances, plant diseases, cattle rambling and theft. These endogenous and exogenous factors limit peasants' access to assets, thus negatively impacting their productivity and income. As I mentioned in the introduction, although peasants face limited income, their needs are often pressing. This being the case, they develop strategies to supplement their low income in order to meet their needs as much as possible.

In the following section I identify the different adaptive strategies adopted by Kalehe peasants to deal with difficulties in the agricultural sector, in order to verify whether artisanal mining is part of their survival strategies.

2.6. Artisanal mining and the adaptive strategies of Kalehe peasants

Adaptive strategies as defined by Ellis (2000) referring to Davies (1993;1996), encompass those long-term strategies the household adopts to face adverse events, trends and cycles. These strategies are made up of natural and non-natural resource-based activities that generate the means of survival for the household. For instance, due to an adverse trend in agriculture the household may intensify its agricultural activities or, expand them by acquiring new lands; it may sell some of its assets and invest in non-agricultural activities, or else, it may find other options outside the rural setting (*Ibid*.). Kalehe peasants are not spared from this reality. Like other peasants, they implement different strategies to maintain their livelihood threatened by

different situations of vulnerability to which they are exposed in their agricultural activities, as discussed in the section above.

To cope with different difficulties encountered in agriculture, Kalehe peasants attested that they either expand their agricultural activities or engage in non-agricultural activities. One of the strategies they use to expand agricultural activities is to intensify agriculture by diversifying crops:

> *"[…] to ensure the survival of our households, we do an association of excellence [association of crops], that is, in addition to cassava, we cultivate beans, maize and taro in the same field. First, we start to harvest beans. After beans we harvest maize and, taro is harvested after maize. we do the weeding, and we wait some more time! when we finish harvesting the taro, the cassava will also have already reached maturity*[74]".

The crop association system in South Kivu has already been documented by Pypers, et al. (2011) and Ndjadi, et al. (2021). In these studies, the authors note that, in order to mitigate the various risks especially related to crop diseases, farm households in South Kivu resort to crop association (intercropping), planting cassava or banana with other crops such as beans, soybeans or vegetables. This may be one of the reasons why 50% of households still rely solely on agriculture despite the vulnerability to which the activity is exposed.

Farmers can also extend their agricultural activities by investing in other sectors that depend on agriculture. This is what was done by Mrs E[75] from Nyabibwe as explained in Box 2.1 below.

[74] Focus group with farmers of Mukwidja
[75] Having guaranteed anonymity, I cannot give the name of the person.

Box 2.1: Example of the agricultural extensification strategy by Mrs E in Nyabibwe

Mrs E's husband is an agronomist. After their marriage, the couple was living in Bukavu where the husband worked in the public administration as an agronomist. However, he spent months and months without being paid and life became increasingly difficult for the couple and their children who were gradually added to the household. Knowing Mrs E's husband's experience in agriculture, one of his friends called him to Nyabibwe to manage his fields. They therefore left Bukavu to settle in Nyabibwe. There, the husband started to acquire his own fields with his salary. Being from Kamituga, the husband also had knowledge in the mining sector. After the mining company left Nyabibwe, the husband went into mining and left the agricultural activities to his wife. The situation in Nyabibwe was becoming increasingly difficult with repeated wars and the deterioration of transport infrastructures. As a result, people from outside Nyabibwe no longer came to Nyabibwe to buy agricultural products and Mrs E had difficulty selling her produce. Lacking storage facilities, she opened up a restaurant where she started to prepare food from her fields. The money from the restaurant and from her husband's mining activities is used to pay for farm labour. Mrs E also invested in goat breeding. The products of the breeding are also used in her restaurant.

Source: Interview in Nyabibwe

This story of Mrs E, in addition to showing how farmers use the extensification strategy to cope with the difficulties encountered in farming, demonstrates how the different assets that the household possesses can be used to set up a livelihood strategy. Therefore, it documents Ellis (2000)' argument that asset substitution can take place within asset groups and that livelihood strategies are not static but change in accordance with changing opportunities. Firstly, Mrs E's husband had a human asset (his knowledge of agronomy) which he used in the government service but which was less paying because of the lack of salary. He then used his social asset (his relative in Nyabibwe) and his human asset to forge another livelihood in agriculture. As the opportunity arose in the mining sector, he also used his experience from Kamituga (his human asset) to earn more income by diversifying his activities into mining.

Beside the strategy of expanding agricultural activities, some households diversify their income sources by investing in off-farm activities. These are petty trade, followed by fishing or artisanal mining (depending on whether the household is in a village where either of these two activities is possible), livestock rearing, and various other activities such as masonry, carpentry, portage, etc. As mentioned in the quotes below, households diversify in these activities mainly to meet their various needs that agricultural income is unable to cover:

"*I also grow crops and do small-scale trading [...] I sell rice, oil and flour. This helps me a lot. When I come back from the field, I go to the market. My small business helps me to find money to pay for my children's schooling, food and to cultivate the field [to pay for labour to work in the field]*[76]";

Or to cope with the seasonality of agricultural activities and the time lag between sowing and harvesting:

"*This is just a way of organising ourselves because planting today does not mean harvesting the same day. So, the man has to work in the quarry [in artisanal mining] where he can quickly find the means of survival, and the woman will then take care of the farming*[77]"

"*As you see me here, I am a farmer, a herder, a carpenter (I make beds) and I do any other activity that comes up. I only get the farm income after one year, the livestock income as well. But when I make a bed, I can even earn 5,000 CDF a day. This helps me to send my children to school or to feed them*[78]";

Or else, to build up a safety net to enable the household to meet urgent needs that may arise spontaneously.

"*Livestock farming is our reserve economy. You will notice that at the beginning of the school year, many goats are sold at the market. Why do peasants do this? Many farmers, when they have harvested their crops, buy a small goat in the hope of selling it at the beginning of the school year to pay their children's school fees or during the festive periods of Christmas and New Year to buy clothes*[79]".

These results show that the responses of Kalehe peasants to various constraints they face in their agricultural livelihoods are in line with the literature developed earlier. They show that the major adaptive strategy of Kalehe peasants consists of reorienting or readjusting different assets at their disposal, both on-farm and off-farm. For instance, since they have land that is favourable to different crops, they use crop association to counteract risks, especially risks related to climate change or plant diseases, which I mentioned earlier. Or, to deal with the problem of lack of markets and storage facilities, they develop activities that will allow them to increase the consumption of their own production. Finally, to compensate for the decline in agricultural income, they direct their efforts towards non-agricultural activities, including artisanal mining.

[76] Focus group with farmers in Nyabibwe
[77] Interview with a village chief in Nyabibwe
[78] Focus group with farmers in Nyabibwe
[79] Focus group with farmers in Minova

As a result, according to Lahiri-Dutt, they move from being peasants to being extractive peasants. To what extent is artisanal mining included in their diversification strategy?

A look at the activities that take place in Kalehe shows that its economy is diversified. In line with CAID (2017) and Buraye (2018), my results from the Mbinga Nord grouping, indicate that many activities contribute to the income of peasant households. Although 50% of households in my database rely on agriculture and do not diversify their income sources, on average 2 (N=496; Max=4; Min=1; SD= 0.65) activities contribute to the household income (Appendices, Figure 2.10). For the 50% of households who diversify their income source, i.e., in which at least two activities contribute to the household income (Appendices, Figure 2.11), in addition to agriculture (reported by all but one household), petty trade contributes in 45% of households, artisanal mining in 16%, fishing in 6%, livestock in 4% and, other activities such as wage labour, technical occupations (masonry, carpenter, tailor, hairdresser, ...), transport occupations (motorbike driver, driver of small motorised pirogues, porter) and day labour, in 42% of households.

Observing Figure 2.11, one may note that artisanal mining only contributes to the income of 16% of households compared to petty trade and other occupations whose contribution is recognised by more than 40% of households. These figures tend to overlook the extent to which artisanal mining is involved in the adaptive strategies of Kalehe peasants, in relation to these other two sets of activities. However, the involvement of artisanal mining may be more than that shown in Figure 2.11. First, the data used in this figure considers all the households in the database, i.e., those living in a village where artisanal mining is practiced and those living in a village where artisanal mining is not present. Taken separately (Appendices, Figure 2.12), it is notable that in the village where artisanal mining is not practiced, those who diversify into the non-farm sectors are more likely to be involved in petty trade (over 50%) and other occupations (44%), and are also more involved in fishing and livestock than their counterparts. Of course, diversifying into fishing also depends largely on whether the village is located close to the lake or the river where fishing is possible. In contrast, when artisanal mining takes place in the village, other occupations (masonry, sewing...) are recognised as contributing to the household income of 40% of households, and petty trade and artisanal mining of 33% and 32% of households, respectively. Thus, the implication of artisanal mining is not so small as suggested by Figure 2.11. Secondly, as will be discussed in the next chapter, involvement in artisanal mining can be direct or indirect. Figure 2.11 only shows direct involvement where one or more members of the household work directly in artisanal mining. However, through its multiplier effects, artisanal mining creates forward and backward linkages which have indirect effects on

other sectors and can thus explain the involvement of households in these other sectors. For instance, a mining site attracts other people from outside the village. These people will need to eat, drink, sleep, clothe themselves, in short, to meet their basic needs. They are therefore potential consumers who can encourage peasants to expand their agricultural activities, to engage in petty trade, or to invest in restaurants, sewing, etc. Thus, if we considered the indirect implication of artisanal mining, its implication to Kalehe peasants livelihood diversification as presented in Figure 2.11 would be even higher. The issue of artisanal mining's multiplier effects and its impact on Kalehe peasants' livelihoods is discussed in more detail in the next chapter.

2.7. Conclusion

This chapter draws on the literature which argues that peasants engage in artisanal mining as a livelihood strategy. While this literature often focuses on the structural adjustment programme and other neoliberal policies to explain the failure of agriculture as the main cause of this engagement, this chapter has taken a micro-level approach to understanding how livelihoods change in response to contextual shocks. Based on the case study of Kalehe territory in eastern DRC, it has built on the sustainable livelihoods framework to present the different agricultural livelihood opportunities available in Kalehe and how these are integrated into farming activities, to identify the different constraints faced by Kalehe peasants in their farming activities, and to analyse the different coping strategies they adopt to deal with these constraints. In addition, the extent to which artisanal mining is taken into account in these livelihood strategies was also examined. My analyses show that, although sometimes in insufficient quantity and quality, various assets on which Kalehe peasants can rely for their agricultural-based livelihood are available. However, peasants face different endogenous and exogenous factors that prevent them from taking full advantage of these assets and thus lead them to adopt certain strategies to maintain their survival. These strategies include diversification into non-agricultural activities including artisanal mining. Kalehe peasants thus move from being peasants to being extractives peasants. Two sets of conclusions can be drawn from these analyses.

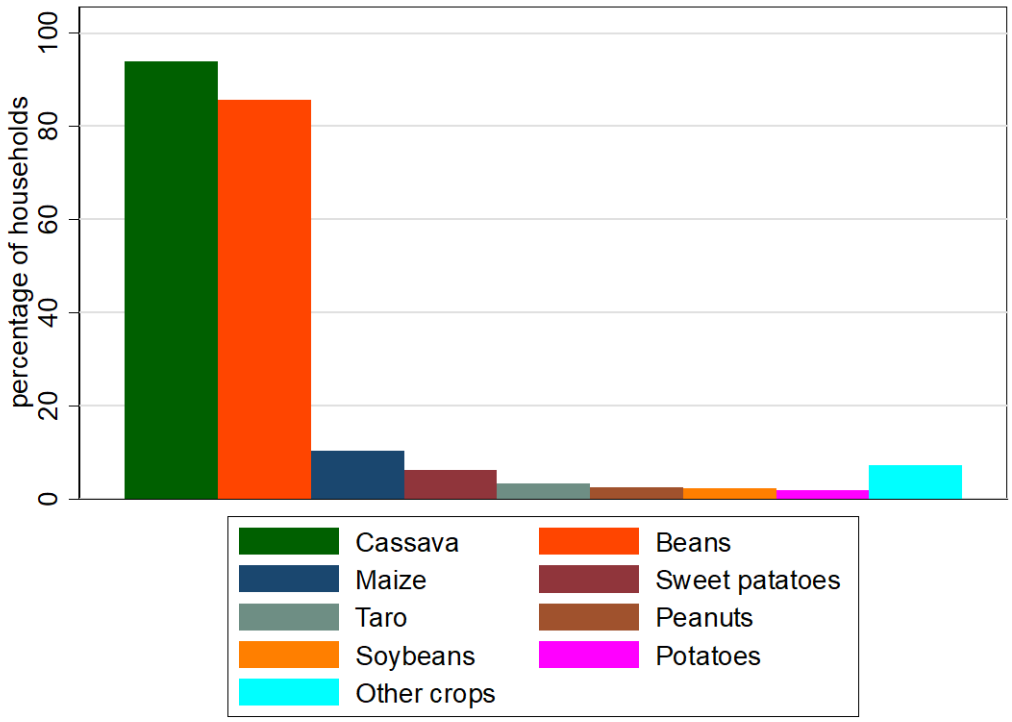
On the one hand, I have pointed out in the literature that institutions and organizations contain agency that impedes or facilitates the use of available assets (Ellis, 2000). In Kalehe, they are more inclined to impede access to and use of these assets. First, land market arrangements are questionable and far from undergoing imminent change, as the very actors who were supposed to bring about change are themselves involved in the land system and can therefore block it. Second, the way in which activities are organized is also problematic. The institutions that should govern the organization of production and marketing of agricultural goods are either

almost non-existent, or exist but are poorly monitored or implemented. Finally, organizations such as government agencies, administrative bodies and various associations are not fulfilling their mission, either because they are poorly endowed or because they are more focused on their own interests. As a result, exogenous factors such as climatic disasters, plant diseases and theft make the farmers of Kalehe increasingly vulnerable and have a negative impact on their production and income, leading them to develop alternative livelihood strategies. Given all of these problems, what policy should be put in place to enable Kalehe peasants to fully enjoy the assets available to them in organizing their agricultural activities? Some options are discussed in the general conclusion (chapter V).

On the other hand, analyses show that diversification is the main adaptive strategy adopted by peasants to maintain their survival. They diversify in agriculture either by adopting the intercropping system or by creating outlets such as restaurants to absorb their surplus production. This strategy may work for a while, but if activities increase, peasants will still face the above-mentioned problems. Hence institutional and organizational change in the agricultural sector is still necessary. They also diversify away from agriculture by engaging in non-agricultural activities, the first of which is petty trade, whose contribution to household income is recognized by more than 40% of households, while mining is recognized by 32% of households that diversify in the village where mining is present. However, its indirect contribution may be even higher if one takes into account the linkages it creates with other sectors through its multiplier effects. The following chapter therefore attempts to analyse these linkages and determine their effects. Indeed, as I have mentioned in the literature, the adoption of adaptive strategies may produce either positive or negative outcomes on the existing livelihoods. Thus, in the following chapter, positives and negatives effects of direct or indirect integration of artisanal mining on the livelihoods of Kalehe peasants will be widely discussed.

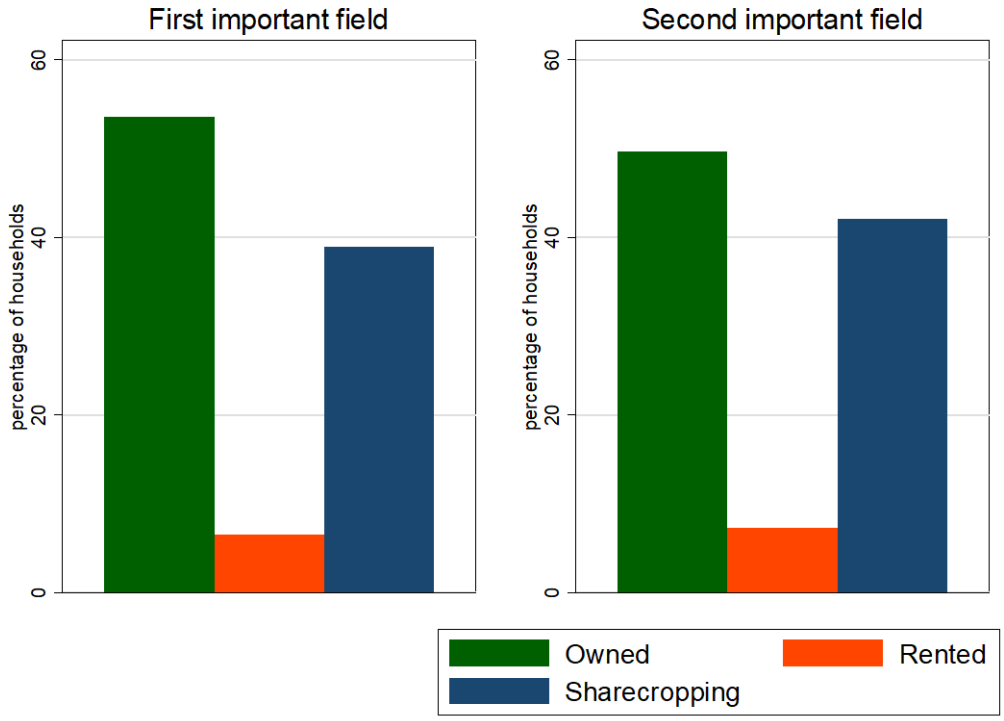
Appendices II

Figure 2.2 Important crops grown



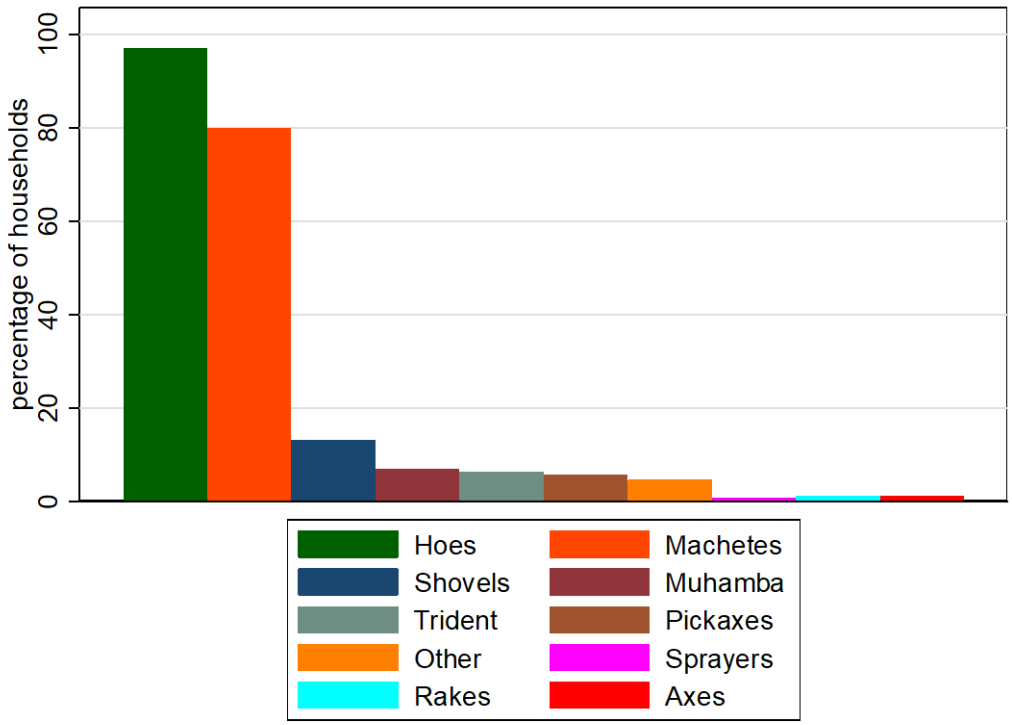
Source: Own conception based on data collected in Kalehe/December 2018

Figure 2.3 Ownership of the two most important fields



Source: Own conception based on data collected in Kalehe/December 2018

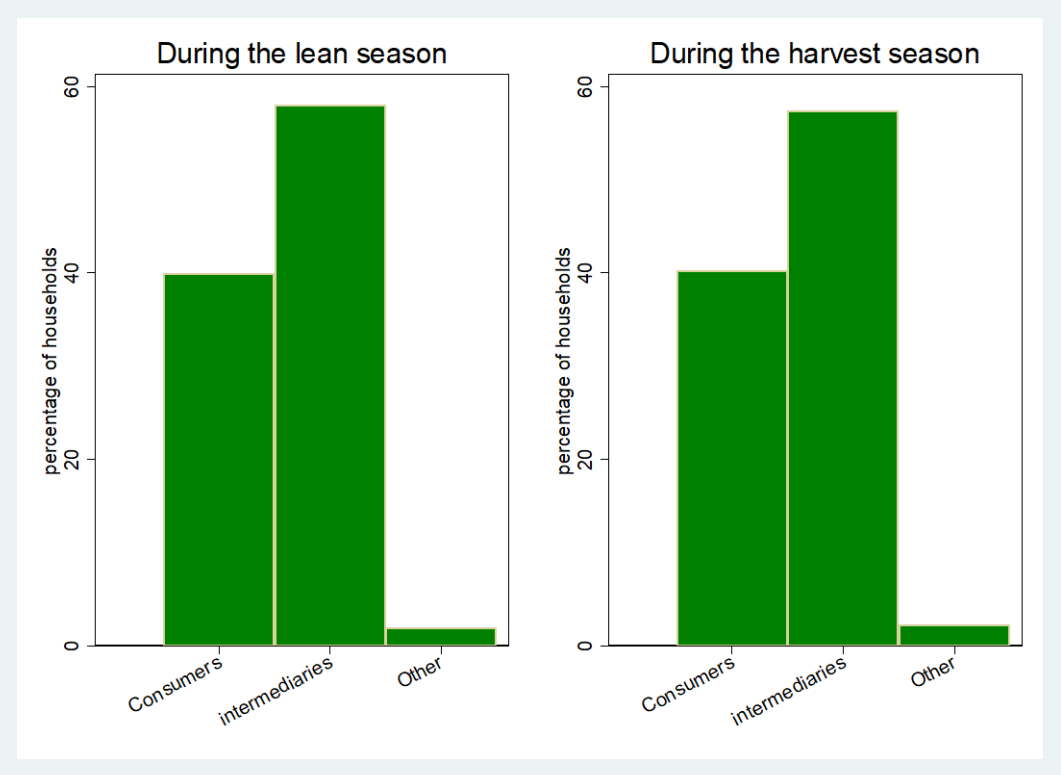
Figure 2.4 Farming tools used (% of households that own them)



*** Muhamba = a small hoe used for planting**

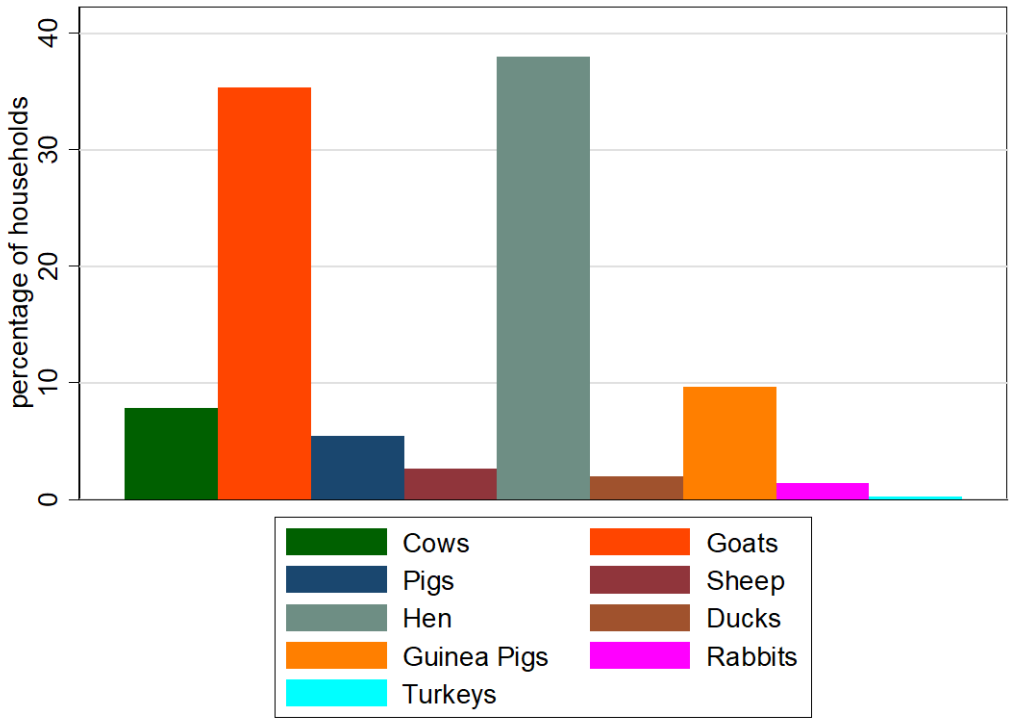
Source: Own conception based on data collected in Kalehe/December 2018

Figure 2.5 The agricultural production is sold to:



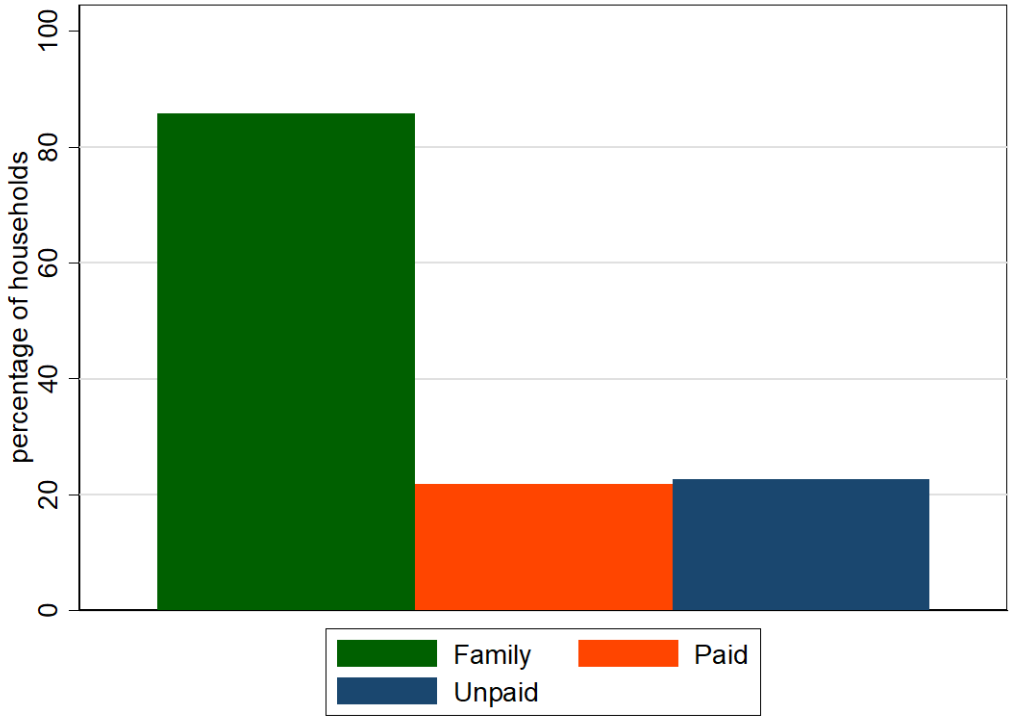
Source: Own conception based on data collected in Kalehe/December 2018

Figure 2.6 Ownership of Livestock in Kalehe



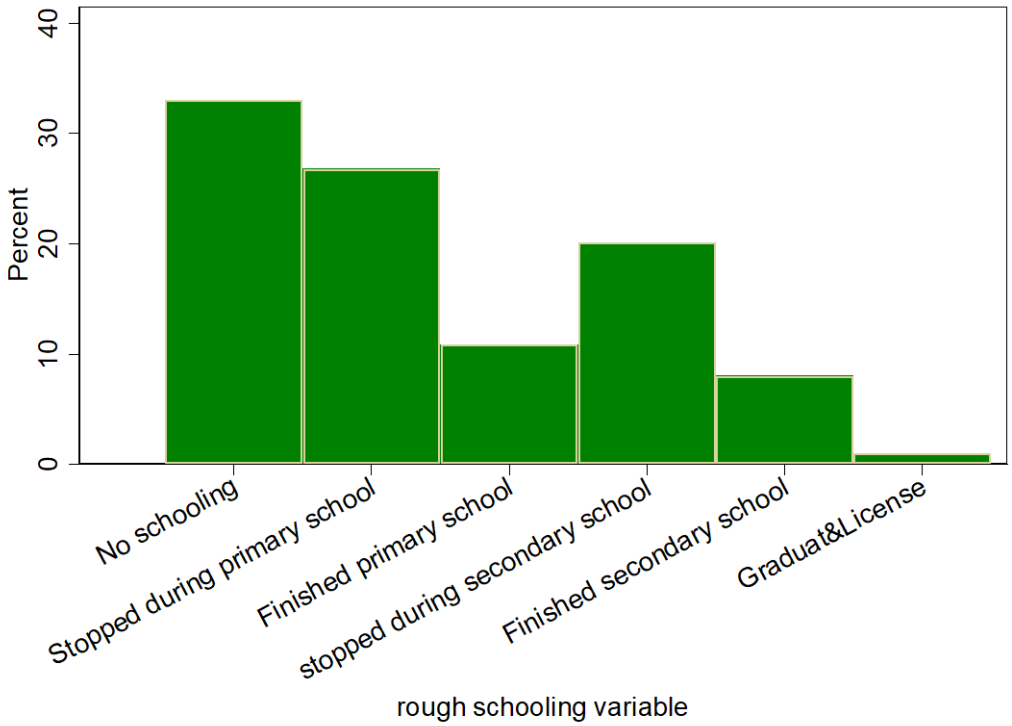
Source: Own conception based on data collected in Kalehe/December 2018

Figure 2.7 Type of labour used by peasants in Kalehe



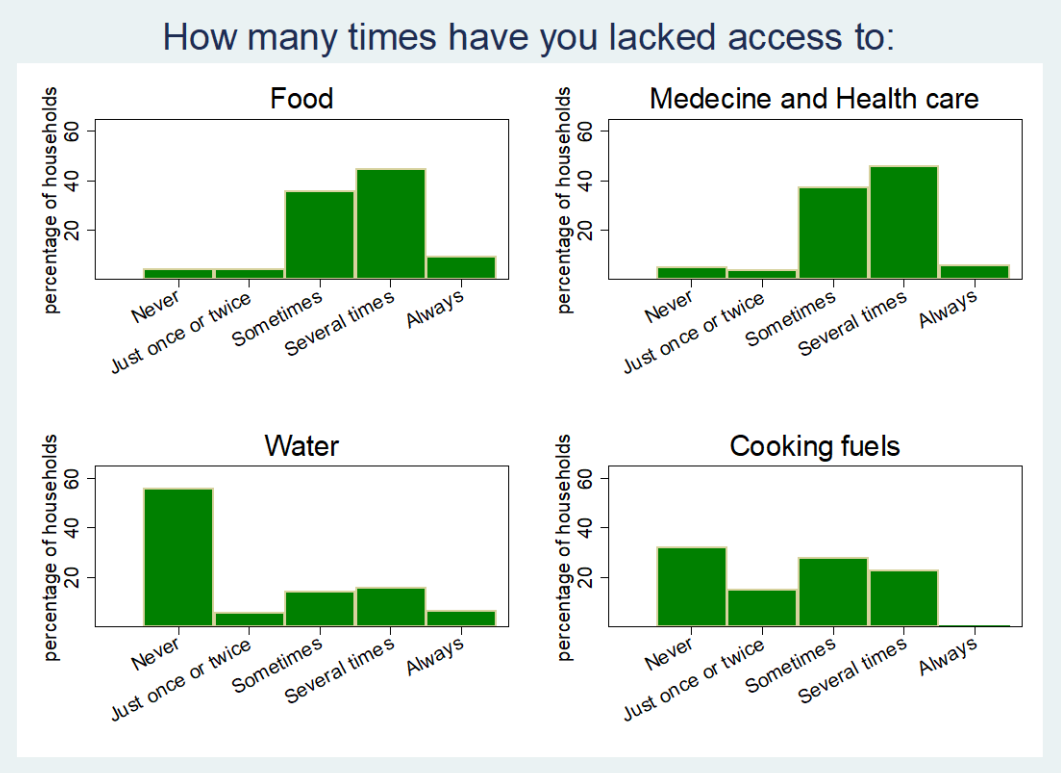
Source: Own conception based on data collected in Kalehe/December 2018

Figure 2.8 Level of schooling of the household head



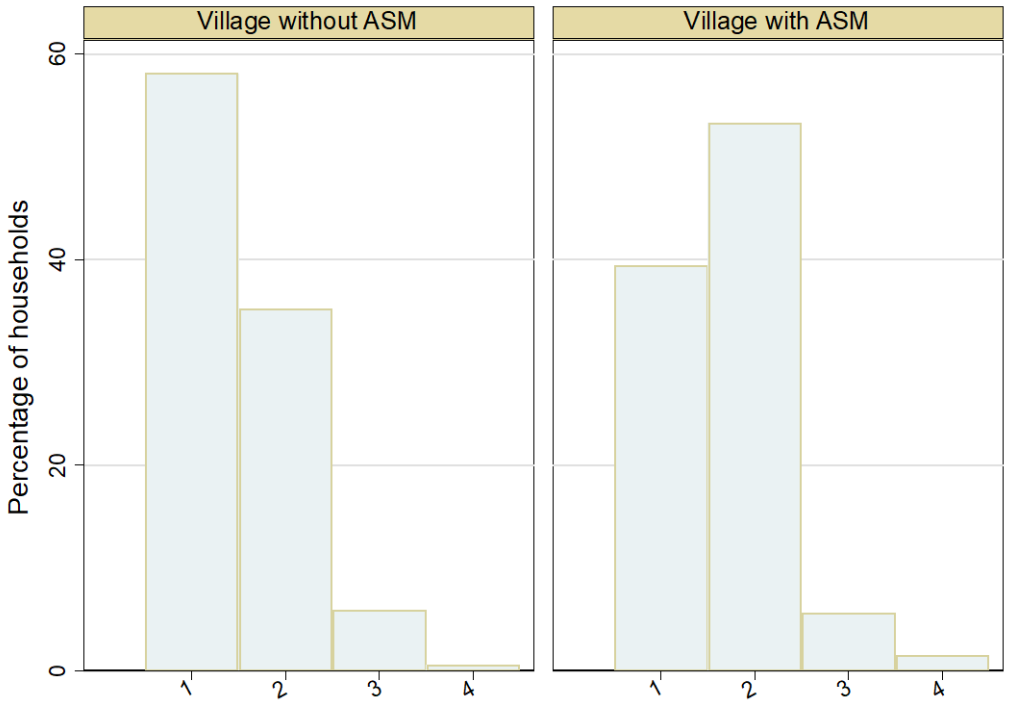
Source: Own conception based on data collected in Kalehe/December 2018

Figure 2.9 Access to food, healthcare, water, and cooking fuels



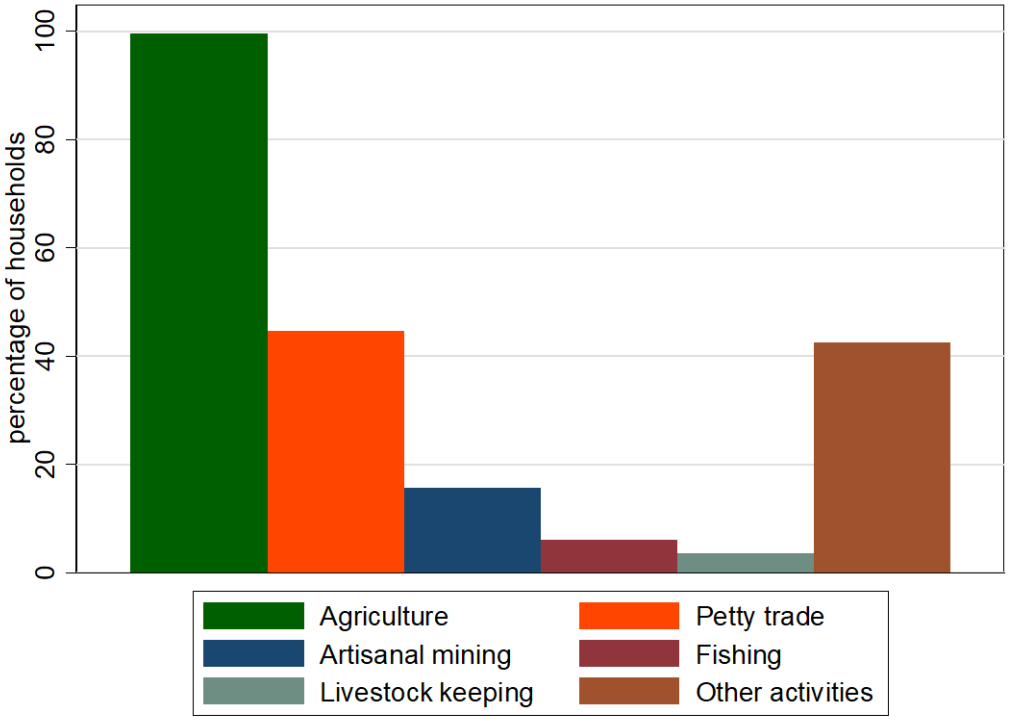
Source: Own conception based on data collected in Kalehe/December 2018

Figure 2.10 The number of economic activities that contribute to household income



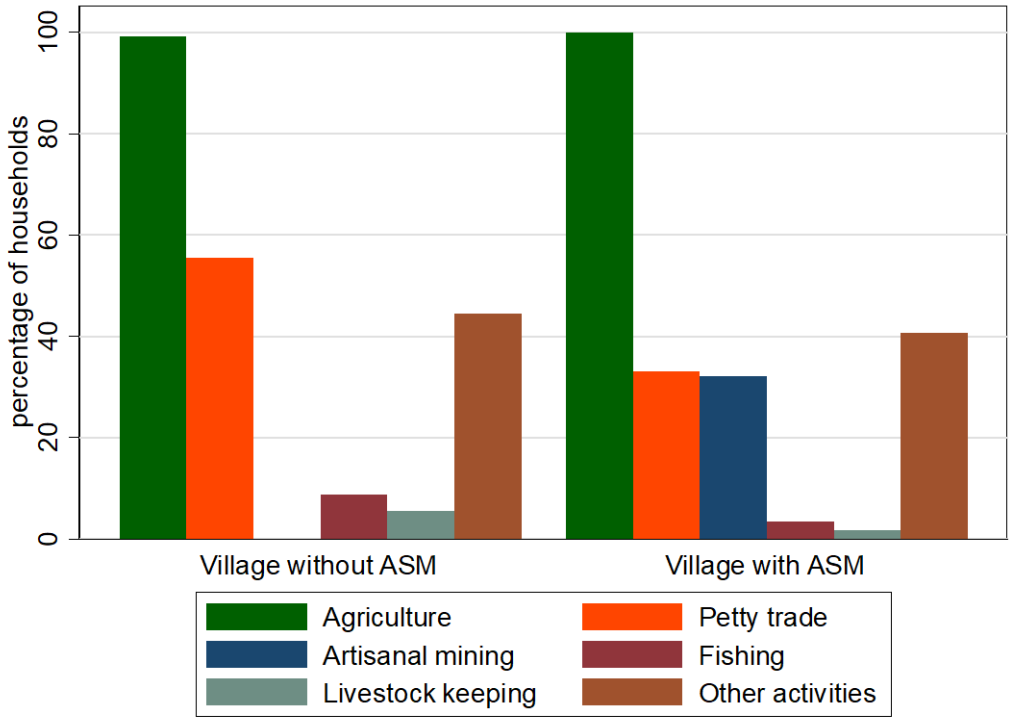
Source: Own conception based on data collected in Kalehe/December 2018

Figure 2.11 Activities practiced in households that diversify (having 2 or more activities)



Source: Own conception based on data collected in Kalehe/December 2018

Figure 2.12 Activities practiced in households that diversify (whether ASM is available in the village or not)



Source: Own conception based on data collected in Kalehe/December 2018

Chapter III: "Mutualism or predation?": The effects of artisanal mining on agriculture-based livelihoods

3.1. Introduction

The previous chapter shows that artisanal mining is one of the non-agricultural activities present in Kalehe, which farm households may resort to as a livelihood strategy when agriculture is vulnerable to endogenous and/or exogenous factors. Yet, as the sustainable livelihoods framework argues, a livelihood strategy involves diverse livelihood outcomes. These may not only be reflected in more or less household's capability to cope with shocks or to manage stress but, they may also reflect changes in the resilience and stability of natural resources. What, then, are the outcomes of the presence of artisanal mining among the livelihood strategies of Kalehe peasants?

In this chapter, I contribute to the existing literature by quantitatively analysing the contribution of artisanal mining to the livelihoods of Kalehe peasants and I shed further light on artisanal mining indispensability and embeddedness in rural livelihoods. Based on 23 individual interviews, 13 focus groups and quantitative data collected from 496 farm households in Kalehe, I use the propensity score matching method to determine this contribution by comparing farm households living in the vicinity of an artisanal mining operation with those who have no connection to it. I rely on the existing literature on the linkages between artisanal mining and farming which usually describes the relations between artisanal mining and farming in terms of competition and complementarity (Pijpers, 2011), leading me to assume positive and negative outcomes.

The first section reviews the existing literature on the linkages between artisanal mining and agriculture and identifies existing gaps that will be filled by this study. The second section identifies the links between these two sectors in Kalehe and presents the hypotheses that will be tested in this chapter. The third section describes the data analysis process. The fourth section presents the results while the final section provides some discussion and concluding notes.

3.2. "Mutualism or predation?": Literature review on the linkages between artisanal mining and agriculture

Depending on the situation, the existing literature considers the interaction between artisanal mining and agriculture to be either mutualistic or predatory. While in a mutualistic interaction all actors benefit from the interaction, in a predatory interaction one party benefits while the

other is harmed. Mutualism is explained by the complementarity between these two sectors. *Firstly*, in many contexts, the two activities occur in different seasons. In such contexts, while artisanal mining is easily carried out during the dry season, farming usually takes place during the rainy season, so that the two activities provide each other with a safety net during difficult times. Fisher, et al. (2019) have documented this seasonal complementarity in Indonesia. They found out that during the dry season in July-September when farming activities are not possible, farmers engage in mining activities to increase their income during this hungry season. However, in October and November as farmers start the field preparation activities, mining slows down to almost completely disappear between November and April when farming activities are intense (see also (Fanthorpe & Maconachie, 2010; Maconachie, 2011; Cartier & Bürge, 2011; Hilson, 2016a; Ofosu et al., 2020)). It should be noted though that the two activities can also be maintained jointly during both seasons, i.e., some people may be both miners and farmers throughout the year (Mkodzongi & Spiegel, 2019).

Secondly, revenues from one sector are used to invest in the other sector. Thus, money from mining is used to buy farm inputs and pay for farm labour, and money from agriculture is used to buy mining tools. On this issue, Hilson (2016b) notes that at Chakuza in Mozambique, proceeds from artisanal gold mining have enabled individuals to buy fertilizers and other crucial farm inputs, while in Liberia many farm families grow rice to attract and feed labourers recruited specifically to mine for diamonds. The author also noted that in Ghana and Burkina Faso, strengthened linkages between artisanal mining and agriculture were at the basis of wealth creation. In these countries, there was a flow between both activities and the resulting earnings were used to finance the construction of bigger houses, send children to schools and pursue other businesses ventures. Urama (2013) stressed that given the credit constraints experienced by poor households in developing countries, mining may constitute a source of cash income for farmers and help them to strengthen their farming activities, to overcome food insecurity and to send children to school. Similarly, inspired by Binns (1982), Maconachie (2011) argues that in Sierra Leone, the income generated by the sale of food crops in the mining sector is reinvested by farmers into their homes, families and, most notably, in the expansion of cash crops such as coffee, cocoa and citrus fruits. Other examples can be found in Arthur et al., (2015); Fisher, et al. (2019); Hilson (2016b); Hilson (2016a); Hilson & Garforth (2013); Mkodzongi & Spiegel (2019); Ofosu et al. (2020).

Thirdly, since artisanal mining produces a relatively high income, and workers at mining sites are in search of food, agriculture can provide food to miners. Thus, mining sites constitute an important market for farmers where they can sell their product at a relatively high price (Ofosu

et al., 2020). On this issue, taking the case of gold exploitation in Sierra Leone, Cartier and Bürge (2011) have demonstrated how gold miners are an important market for agricultural products and could lead to the development of activities that outlast short-term mining activities (see also (Maconachie & Binns, 2007)).

Fourthly, as the two sectors evolve together, the actions of one for its own benefit can become beneficial to the other or to the whole community. On this issue, Urama (2013) noticed that in order to facilitate transport and export of mining products, transport infrastructures may be upgraded, thus benefiting farming activities as well. Cartier and Bürge (2011), found that in Sierra Leone, mining indirectly affects farming activities because it facilitates investment in transport facilities (such as the acquisition of motorbikes) and therefore promote rural-urban mobility and entrepreneurship in urban centres. The same results were found by Fisher et al. (2019) in Indonesia where miners were able to purchase motorbikes and used them either as motorcycle taxi or to transport farming produce to the markets. In the same location, taxes paid by miners were used to finance some village projects which indirectly benefited farmers as well.

In addition to mutualist interactions, the literature also points to the predatory nature of artisanal mining, the latter being perceived as destroying the agricultural environment (Arthur, Agyemang-Duah, Gyasi, Yaw Yeboah, & Otieku, 2015; Boadi, Nsor, Antobre, & Acquah, 2016). This perception comes from the fact that the two sectors evolve on the same geographic space and therefore share important production factors such as land, water and labour. With regard to land, the literature indicates the destruction of crops, food insecurity, higher land costs and land degradation as negative impact of artisanal mining on agriculture (Bach, 2014; Arthur, Agyemang-Duah, Gyasi, Yaw Yeboah, & Otieku, 2015; Boadi, Nsor, Antobre, & Acquah, 2016; Ofosu, Dittmann, Sarpong, & Botchie, 2020) . This argument is based on the fact that, during mining booms, the discovery of mineral deposits on cultivated land results in the destruction of crops in the search for minerals and the upward appreciation of surrounding land, causing land prices to rise. After the mining boom, the abandoned land is left exhausted and no longer suitable for agricultural activities. This situation leads to low agricultural production and food insecurity. Furthermore, as agricultural lands are located near mining sites, the literature argues that some farmers are victims of crop theft by artisanal miners (Amboko, 2010).

Regarding water, the use of chemicals such as mercury and cyanide in the mining production process contaminates water sources used by farm households for domestic or for field irrigation purposes. This contaminated water not only infects crops in the fields and makes

the land infertile, but also negatively affects the health of farmers and thus decreases their productivity (Kitula, 2006; Arthur, Agyemang-Duah, Gyasi, Yaw Yeboah, & Otieku, 2015; Mujere & Isidro, 2016; Boadi, Nsor, Antobre, & Acquah, 2016; Nkuba, Bervoets, & Geenen, 2019; Ofosu, Dittmann, Sarpong, & Botchie, 2020). In addition, in the process of artisanal mining, depending on the ore, miners need a lot of water for washing and processing. To meet their water needs, they may divert water streams that were once used by agricultural households, thus depriving them of water for their domestic and farming needs. This lack of water affects not only crops but also farm labour, resulting in low agricultural production (Kitula, 2006).

Finally, artisanal mining is considered to negatively affect agricultural labour through its "pull effects" (Hilson & Garforth, 2013; Hilson, 2016a; Hilson & Laing, 2017; Ofosu, Dittmann, Sarpong, & Botchie, 2020). Indeed, artisanal miners' income being relatively higher, it attracts many farmers who abandon agriculture in favour of mining (Cartier & Bürge, 2011). Explaining this situation in the context of Guyana, Hilson and Laing referred to the statement of this rice farmer: "*after the gold price rose, they [the workers] givin' up [and so] labour gone, milling gone down, so production dipped*" (Hilson & Laing, 2017, pp. 238-239). In such cases, Hilson and Garforth (2013) noted in the context of Ghana, it is usually the wives who remain in charge of the farm while the husbands and young boys go off to mine. Yet, for some reasons, women's labour productivity may be lower as compared to men's (Njuki, Kihiyo, O'ktingati, & Place, 2006). As some of these farmers no longer return to farming for various reasons, the presence of artisanal mining may lead to agricultural labour shortages, resulting in lower agricultural production and higher prices for agricultural goods[80] (Arthur, Agyemang-Duah, Gyasi, Yaw Yeboah, & Otieku, 2015). Moreover, due to the *Dutch disease* mechanism, a mining boom may increase some inputs prices on the domestic market, increasing therefore the agricultural production costs and consequently food prices (Hilson & Laing, 2017; Ofosu, Dittmann, Sarpong, & Botchie, 2020).

This literature review reveals the existence of a substantial literature on the linkages between artisanal mining and agriculture, and helps to anticipate some outcomes from adopting artisanal mining as a livelihood strategy. For instance, if the literature argues that income from artisanal mining allows for investment in the construction of large houses and sending children to school, as a result, it can be predicted that the adoption of mining as a livelihood strategy may allow the household to increase its capacity to cope with shocks and manage

[80] If there is a labour surplus in the agricultural sector (which is likely if labour to land ratios are high), such a situation can, however, lead to higher agricultural labour productivity

stresses. However, the literature still presents some gaps. Firstly, there is a lack of quantitative analyses on the effects of artisanal mining on farming activities (but see Ofusu et al, 2020 for a recent contribution). Secondly, the literature so far provides no clarity on counterfactual situation to analyse what will be the situation of one sector in the absence of the other. Such analyses, would highlight the effects that each of these two sectors has on the other. In the context of this thesis, as I already mentioned in the general introduction, it would inform policy makers about the entrenchment and effects of artisanal mining on agriculture-based livelihoods. Such information can guide them when making decisions affecting artisanal mining.

This chapter is therefore a first attempt at a quantitative analysis of the outcomes of artisanal mining on farmers' livelihoods. It explores the counterfactual by comparing farm households connected to an artisanal mining operation with those that have no connection to it, and analyses whether the differences observed between these two groups are due to the presence of the artisanal mining operation or to other factors. To achieve these objectives, I first identified the linkages between the two sectors in Kalehe during the pilot survey conducted in 2017. These linkages were compared with the existing literature and, as presented in the next section, helped to formulate the hypotheses that guided this study. These hypotheses were tested on the basis of quantitative data collected in 2018. The data collection procedures in 2017 and 2018 were described in the general introduction.

3.3. Linkages between artisanal mining and agriculture in Kalehe and the study hypotheses

Individual interviews and focus groups conducted in Kalehe in 2017 (referred to here as 'the pilot survey') revealed various links between artisanal mining and agriculture. In parallel with the literature presented above, I have grouped them into five main links on the basis of which I have formulated the hypotheses that will be tested in this chapter.

3.3.1. Artisanal mining complements income from agriculture

As this interviewee noted, existence of this link is justified by the fact that farm households need to diversify their sources of income in order to consolidate or sustain their main income from agriculture:

> "*In agriculture you don't sow today and harvest on the same day; it takes time... therefore it's important to find another activity that complements that agriculture to*

allow you to live... that's where mining comes in because people say that if I go there today, I hope to find something the same day...[81]"

The literature (e.g. Haggblade, Hazell, & Brown, 1989; Ellis, 1999; 2000; Barret, Reardon, & Webb, 2001; Bryceson, 2002) shows that in rural areas of developing countries, the total income of farm households is in most cases a mixture of income from agricultural activities and non-farm activities. According to the same literature, farm households undertake non-farm activities for several reasons. These reasons are grouped into two broad categories, namely "push" and "pull" reasons. For the former, people diversify their sources of income because of the various difficulties they face (anticipate) and which may negatively impact their main sources of income. For the latter, diversification is motivated by the expectation of high earnings, the achievement of strategic complementarities such as the association of livestock farming with agriculture, specialisation according to the comparative advantages of superior technologies, skills or endowments, etc.

On the basis of this literature, it can be assumed that even in the absence of artisanal mining, farm households would diversify their income sources and supplement the income they derive from agriculture. However, one question remains: Does the presence of artisanal mining make a difference? In other words, is off-farm income different in the absence of artisanal mining? The first hypothesis is then formulated as follows:

- *Artisanal mining is likely to have a positive effect on non-farm income, i.e., the presence of artisanal mining is likely to increase the non-farm income of farm households*.

3.3.2. Artisanal mining facilitates the marketing of agricultural production at a relatively high price

The above literature review revealed that artisanal mining facilitates the flow of agricultural production. This finding has been reinforced by the pilot survey and, documents how artisanal mining can be an indirect livelihood strategy[82]. The rationale for this link is that artisanal mining attracts a large number of people who earn a relatively frequent and high income, especially when the mining pit is in its high production period. Also, agricultural food is consumed by all categories of the population regardless of the activity carried out (farmer, miner, etc.). This implies that the presence of artisanal mining is likely to increase the number

[81] Interview with the chief of Mbinga Nord grouping
[82] In the sense that the household may not be directly involved in the artisanal mining operation but, thanks to the presence of the latter, it expands its agricultural activities to cover the food demand created by the presence of the artisanal mining operation

of consumers of agricultural products. Faced with consumers with relatively high incomes, farmers reported having the facility to sell their farming products at a relatively high price:

> "*The advantage we have is that we cultivate. When we have the very first production, those miners who are not farming find us and we sell to them at a price that benefits us. The money that they [miners] find flows into the mining site and farmers benefit.*[83]"

> "*...They [artisanal miners] spend on mineral exploitation the time they should be spending on agriculture. And we take advantage of their money because they cannot eat those minerals. They can't work without eating. Where will they get the food? From the farmer. They will look for us and we're going to sell... at a slightly higher price. They buy in bulk and we find money for schooling of our children, to pay for hired labour in our fields... there we are happy...*[84]"

As the quotation below highlights, this link indicates a certain mutualism between mining and agriculture, as the former produces finance and the latter produces food, resulting in a gain for both sectors.

> "*There is a complementarity between these two activities ... farmers cultivate so that miners buy their production and miners mine to buy the agricultural production ... these two activities support each other because you cannot mine without eating and you will only eat what comes from agriculture ... these two activities go hand-in-hand*[85]"

From the above, I postulate that farmers may sell their production at a higher price in the presence of artisanal mining than in its absence. This leads to two hypotheses formulated as follows:

- *Artisanal mining is likely to increase the share of sold farm production on the total household production i.e., in the presence of artisanal mining, the household is likely to sell a large part of its production*
- *Artisanal mining is likely to increase the price of agricultural products, i.e., the price of agricultural products is likely to be higher in the presence of artisanal mining*

[83] Focus group with farmers in Nyabibwe/Kabulu II
[84] Focus group with the farmers of Mukwidja
[85] Focus group with artisanal miners in Nyabibwe

3.3.3. Artisanal mining facilitates investment in agriculture

In line with the existing literature, the pilot survey revealed that in Kalehe, artisanal mining facilitates investment in agriculture, thus helping households to further secure their income. As explained in the quotes below, this investment takes the form of purchasing agricultural land, paying external labour for farm work, purchasing other farm inputs and other assets such as livestock and houses.

> "*If you work here [in the mining quarry] and you're smart, you can find $100 and you put $50 into agriculture and with the other $50 you buy a goat or a calf [...] If you're smart you can, thanks to this activity, have a field, a house, and so on*.[86]"

> "*And thanks to the [mining] quarry, a lot of people can buy cows, fields and even plantations; and then the mother [wife] takes responsibility for those fields, she has them cultivated [she pays people to cultivate them] while the husband is engaged in mining*.[87]"

The literature on livelihoods developed in the first chapter of this thesis (see for example: (Ellis, 2000); (De Haan & Zoomers, 2005); (Moser C. , 1998); (Conticcini, 2007), etc.) shows that in an uncertain environment, when agents are vulnerable to any situation that affects their sources of income, they develop mechanisms to deal with it. Thus, even in the absence of artisanal mining, farmers may find other ways to invest. The question remains whether artisanal mining makes a difference, i.e., whether farmers invest less (or more) in the absence of artisanal mining. Four hypotheses are formulated:

- *Artisanal mining is likely to increase the number of livestock owned by farm households*
- *Artisanal mining is likely to increase the number of agricultural tools used by the household*
- *Artisanal mining is likely to increase the number of agricultural lands owned by the household*
- *Artisanal mining is likely to increase the number of paid external labour used by the household*

[86] Focus group with artisanal miners in Nyabibwe
[87] Focus group with leaders of women's agricultural associations in Nyabibwe

3.3.4. Artisanal mining creates land conflict

The pilot survey revealed that the presence of artisanal mining results in changes in the resilience and stability of natural resources creating different kinds of conflicts including land conflicts and social conflicts. As highlighted in the quotations below, land conflicts mainly result from the discovery of minerals on agricultural land and can take several forms:

> "*Here, when minerals were discovered, farmers looked for documents at the mining cadastre; the area was then qualified 'mining operation zone', then, when the exploitation was allowed, the delimitation of the mining quarry led to conflicts between concessionaires [farmers] and mining operators because when minerals are discovered in your field, they are exploited by someone else and the owner of the field gets side-lined... that was the basis of the conflicts*[88]"

> "*... populations have remained owners of the agricultural concessions that are adjacent to the mining concessions. Now, as soon as they [miners] find out that...no, the [mining] vein goes to the other side, even there it's exploitable, it causes conflict... there's jostling around*[89]"

> "*Here in our quarry, there is an honorary deputy who bought a piece of land to be used as pasture for his cattle; when the minerals were discovered on that land, miners began to dig it up and the cows were in danger of falling into holes. This honorary deputy came to us for advice and we said, 'You cannot watch out a miner, if he knows there are minerals in your concession he will always go in, even at night'....*[90]"

Social conflicts may have several origins, the most important of which are highlighted here. First, there is the indebtedness of artisanal miners. Driven by the hope of a large production, they frequently get into debt and promise to pay when they get a high production. However, they may not achieve this production and then find themselves unable to pay these debts. This situation is at the root of misunderstandings and conflicts.

> "*A miner is someone who hopes for something he doesn't see. He can come to the market and say, "Give me those $10, $20 pants because tomorrow I'm going to hit the mother lode", but after that, there's no follow-up. This then creates conflict between the two groups in terms of debts, debts that are not paid*[91]"

[88] Interview with the chief of Mbinga Nord grouping
[89] Interview with the representative of the Administrator of Kalehe Territory
[90] Interview with the president of the synergy of women's agricultural associations; trader and farmer from Nyabibwe.
[91] Interview with the President of the Federation of Enterprises of Congo (FEC), Nyabibwe extension

Second, artisanal mining is reportedly disruptive to families. This is due to the fact that some miners once they have reached a high production level use this income to take in other women leaving their families helpless.

> "*...there are other households where the presence of these minerals is considered a source of conflict because the money the man makes from this exploitation belongs to him and he is not accountable to his wife. Sometimes he uses that money to take another wife, you know? We often see this kind of situation*[92]"

Third, there is theft. As can be seen from the various quotations below, theft results from the fact that artisanal miners are used to a daily income, especially during the high production period. However, there are times when they can go months without earning anything. To ensure their survival during these periods, they reportedly resort to stealing crops from the fields or stealing from people's houses, thus creating conflict situations. In addition, farmers whose fields are next to mining quarries are allegedly victims of crop theft perpetrated by miners who work in these quarries.

> "*Miners are already used to living a comfortable life, they eat and drink and we [farmers] we work; they [miners] find that it's [agriculture] not a job. When he [miner] doesn't earn in the mining quarry anymore, what does he do? he starts stealing. […] if you've been keeping your things, he gets them. They steal because they don't have any money up there [in the mining quarry] ... you know... they even steal bunches of bananas in the field, cassava in the field and at home...*[93]"

> "*The mining quarry penalizes us too! ... when it is said that the price of minerals [cassiterite] is falling, all those who had already erected their homes in the mining quarry come back here. Those who were destroying your crops when they were working in the mining quarry start to steal them. If you have grown colocases, vegetables, maize, etc., they steal everything because they have no other source of income...*[94]"

> "*You have your field next to the mining quarry and your cassava grows. When these miners pass by, they are attracted [by this cassava], they harvest it to go and eat it at their home. It can happen that this cassava is bitter and not directly edible… these*

[92] Interview with the president of the synergy of women's agricultural associations; trader and farmer from Nyabibwe.
[93] Focus group with farmers in Mukwidja
[94] Focus group with farmers in Nyabibwe

miners even steal cassava leaves. They are always coming into our fields to pick the leaves, and this causes an abnormally growth of our cassava[95]"

"*That's the way it is... if, for example, the maize or the cassava or the colocases reach their maturity in these fields, the miner who spends the night in this mining quarry, because he spends the night there, he will come and harvest [steal] even during the night and bring the harvest to his house... that's the way it is here...*[96]".

Given that social conflicts were difficult to capture, this study focused on land conflicts. Indeed, some studies (such as Claessens (2017) and Mudinga (2017)) have already demonstrated that Kalehe territory is characterized by land conflicts reinforced by different forms of land grabbing. Also, as I mentioned in the first chapter, access to land is often a problem for many rural households and can sometimes be the basis of land conflicts. Thus, even in the absence of artisanal mining, farmers can face various forms of land conflicts.

To capture this variable, I analysed land prices. In effect, studies such as those of Aragón and Rud (2012), Ocansey (2013) and Sahu and Dash (2011) assert that the presence of minerals creates land competition and therefore negatively impacts land prices which vary upwards; a variation that may be at the root of land conflicts. The hypothesis is formulated as follows:

- *Artisanal mining is likely to increase the prices of agricultural land*

3.3.5. Artisanal mining substitutes for agriculture

In line with what was stressed in the literature review, the pilot survey revealed that the relatively high income offered by artisanal mining attracts many farmers who abandon farming in favour of artisanal mining. This abandonment may be total (farmers abandon farming completely) or partial (farmers practice artisanal mining during certain periods of the year).

"*Here in Nyabibwe, many farmers are abandoning their farming activities in favour of mining activities. What attracts them is the income; they have understood that with mining, someone working on his own account can find 5 kg or 10 kg of cassiterite every day, which gives him some money to support his household*[97]"

"*Here in Mukwidja these situations occur mostly during the dry season. Not everyone can mine during the rainy season, only those who are experienced. During this period,*

[95] Focus group with farmers in Nyabibwe
[96] Focus group with miners in Nyabibwe
[97] Interview with the chief of Mbinga Nord groupement

everyone is looking for money in agriculture but as soon as the dry season starts, around July and August everyone will go to the mining quarries...[98]"

"*If the production is good in the mining quarry, everybody goes there because that's where they can make money. There, we [farmers] suffer because we have no more labour*[99]"

As stated in these quotes, the main consequence of this abandonment is the shortage of agricultural labour, which also has negative effects on agricultural production. Thus, I postulate that:

- *Artisanal mining is likely to reduce the number of agricultural workers used by households*

To sum up, the arguments developed in this section contribute to an understanding of the rootedness of artisanal mining in agricultural livelihoods. While these arguments call on policy makers to maintain and support artisanal mining, as its absence is believed to be at the root of the resurgence of social conflicts, they also recognized artisanal mining as contributing to farm households' livelihoods by helping them to meet needs that could not be met by agricultural income alone. The section also raised some other negative aspects of artisanal mining to farm-based livelihood. However, it is still unclear to what extent these positives and negatives aspects of artisanal mining affect farm households. In the following section, I present the method I used to try to fill this gap.

3.4. Overview of the Propensity Score Matching (PSM) method

To determine the effects of artisanal mining on agriculture-based livelihoods, I should normally compare the situation of farm households when they have no connection with artisanal mining and their situation when they interact with artisanal mining. However, these two situations cannot be observed at the same time for the same household. I therefore resorted to the PSM method. Widely applied when experimental approaches are not feasible, this method involves constructing a statistical comparison group (counterfactual) based on a probability model of participating in artisanal mining (treatment). This probability model allows to determine propensity scores. A propensity score is defined as a "single summary measure of the observed characteristics that can be used to determine the extent to which one person is similar to another" (Bamanyaki, 2017, p. 246). Each farm household that interacts

[98] Interview with the head of SOLFAP/Mukwidja
[99] Focus group with farmers in Mukwidja

with artisanal mining is then matched to one or more farm households that have no connection with artisanal mining, on the basis of these propensity scores (PS). The average difference in outcomes across the two groups is compared to get the effect of artisanal mining (Verhofstadt & Maertens, 2014; Chabé-Ferret, Dupont-Courtade, & Treich, 2017; Bamanyaki, 2017).

When the treatment variable is binary, PS can be calculated using a *probit* or a *logit* model. In my case, this model determines the probability of participating in artisanal mining (T) for a farm household in the sample given the observable factors (X).

$$PS = Prob\ (T = 1 \setminus X) \qquad (1)$$

There are different methods through which treated units and control units can be matched. These methods provide relatively similar results and are chosen based on the quality of the PS (Caliendo & Kopeinig, 2005). The single (or multiple) *nearest neighbour matching* method matches a treated unit to a control unit (or to several control units) with the closest PS. With the *caliper or radius matching method*, a threshold on the maximum PS distance between treated and matched control is set. Through the *stratification or interval matching method*, the common support is divided into different strata and the treatment effect is calculated within each stratum as a mean difference in outcome between treated and control. Then, the weighted average of these stratum impact estimates gives the overall program impact. As for the *Kernel matching method*, a weighted average of all control units is used to construct a counterfactual match for each treatment unit. Finally, when the PS of control observations are distributed asymmetrically around the treated observations, *local linear matching* is used to avoid bias. Comparable with Kernel matching, the local linear matching uses an additional linear term in the weighting function.

On the basis of the matching, the average treatment effect (ATE) can be calculated. Considering Y as the outcome variable, the ATE is a mean difference in outcome variables between the treatment group Y(1) and the control group Y(0), which will be interpreted here as the effect of the presence of artisanal mining on the outcome variable:

$$ATE = E[Y(1) - Y(0)] = E[Y(1)] - E[Y(0)] \qquad (2)$$

In this study, I applied the "treatment-effects propensity score matching (*teffect psmatch*)" command in Stata 15.0 to evaluate the effect of artisanal mining on different outcome variables of farm households. The six nearest neighbour matching method is used to match control and treated units. A robustness check is conducted by using the *psmatch2* command with Kernel matching methods (Khandker, Koolwal, & Samad, 2010; Bamanyaki, 2017).

3.4.1. Variable description

3.4.1.1. *Treatment variable (T)*

The treatment variable is here represented by the participation of farm households in artisanal mining. This participation can be direct when for example, one or more members of the farm household are directly involved in artisanal mining. It can be indirect when, although not directly working in the sector, the farm household is exposed to artisanal mining effects because they evolve in the same area. It is therefore a dummy variable that takes the value of 1 if the farm household resides in a village where agriculture and artisanal mining coexist (Kabulu II village in this study) and 0 if the farm household resides in a village without artisanal mining and/or its influence (Bubale I village in this study).

3.4.1.2. *Covariates (X)*

The covariates used to match respondents in the treatment village to similar respondents in the control village are observable characteristics that are expected to influence the direct or indirect participation of farm households in artisanal mining (treatment), but which are not affected by artisanal mining. While authors have divergent views on the choice of these variables, Caliendo and Kopeinig (2005) propose the reliance on economic theory, knowledge of previous research, and the institutional framework in which the research takes place. Nevertheless, the researcher must ensure to include only those variables that simultaneously influence the decision to participate and which are not affected by participation (or anticipation of participation).

Based on theory (e.g. (Beyene, 2008; Yesuf, 2013; Shenu & Abubakar, 2015; Iqbal, Ping, Ahmed, & Nazir, 2015)) and common sense, depending on the outcome variable and respecting the conditional independence assumption, the following variables (Table 3.1) were used as covariates (X):

Table 3.1 Covariates (X) used to calculate propensity scores

Covariates	**Description of covariates**
Age	Age of the household head
Age square	The square age of the household head
The household head matrimonial status	Whether or not the household head lives with partner(s)
The household head low level of education	Whether or not the household head holds a state diploma (primary + secondary school)
The household size	The number of people in the household

Ethnicity	Non-Havu households
Membership in an association	Whether or not the household head is a member of an association
Distance to the nearest market	Distance from the farm to the nearest market

Source: Author's conception

3.4.1.3. *Outcome variables (Y)*

The outcome variables reflect the hypotheses that this study seeks to test. These hypotheses were presented in the previous section and are summarised in the Table 3.2 below.

Table 3.2 Outcome variables and the expected effect of artisanal mining

Hypotheses	**Outcome variables**
Artisanal mining is likely to have a positive effect on off-farm income	Off-farm income
In the presence of artisanal mining, the household is likely to sell a large part of its production	Share of sold production over total production
Artisanal mining is likely to increase the price of agricultural products	Price of agricultural product
Artisanal mining is likely to increase the number of livestock owned by farm households	Livestock ownership quintile
Artisanal mining is likely to increase the number of agricultural tools used by the household	Agricultural equipment ownership quintile
Artisanal mining is likely to increase the number of agricultural lands owned by the household	Number of agricultural plots owned by the household
Artisanal mining is likely to increase the number of paid external labour used by the household	Number of paid agricultural labour used
Artisanal mining is likely to increase the prices of agricultural land	Price of agricultural land

Artisanal mining is likely to reduce the number of agricultural workers used by households	Ratio non-family labour/land size

Source: Author's conception

To measure ***off-farm income***, I analysed the number of income sources that contribute to the household income and the contribution of each income source to the total household income. The contributions of non-farm sources were summed to obtain the total income from off-farm activities. Income from most of these non-farm activities is difficult to estimate by farm households, as they do not keep records of their income. I therefore asked respondents to estimate the contribution of each activity carried out in the household to total household income, in the week preceding the survey, in a normal (average) week[100] and in in a week in which this activity produces a higher income (high production week[101]). For the econometric analyses, I focused on income in a normal week because not only do I not know the situation in which the household was in the week preceding the survey (normal or high production), but also, respondents stated that high production in these activities is not frequent. However, I used the income from these two periods (last week and high production week) to check the robustness of the results. Off-farm income distribution being skewed to the right, I normalized it by using its logarithm.

With regard to the ***share of sold production***, I planned to calculate the share of production sold as a proportion of the total production and the average price at which the sale took place. However, as the respondents do not keep records of all transactions, I have relied on estimates. Respondents were asked the following question: "*If this total quantity harvested is represented by these 10 beads (10 fingers), how many of these 10 beads (10 fingers) represent the quantity: (1) Sold; (2) Self-consumed; (3) Stored; (4) Donated; (5) Lost*[102]*?*". I made a distinction between sales during the lean season (hunger season) and sales during the harvest period. The idea was that during the lean season, not all households have production to sell, whereas during the harvest period all households can sell. For instance, only 50 households (11% of respondents) sold during the lean season and 169 (35.7%) during the harvest period. To facilitate understanding of the results, analyses will focus on cassava. On the one hand, in contrast to other common crops, it had already been harvested by a large proportion of

[100] Week during which all activities are running normally and in which there are no situations that influence upward or downward the income
[101] Week during which there are situations that influence upward the income from the activity
[102] These options were developed based on responses to this question in our 2017 pilot survey.

respondents at the time of the survey[103]. For instance, it has been sold by 41 households out of the 50 households that sold during the lean season and 148 households out of the 169 households that sold during the harvest period. On the other hand, as I mentioned in the general introduction, cassava is the staple crop in Kalehe and in all the other territories of the South Kivu province. To get the ***price of agricultural product*** (here the price of cassava), since respondents could not recall the exact prices, I asked them to report the total amount of money they received from the sale. I then reported the total amount from the sale out of the total quantity sold to get what a unit sold yielded.

Since ***livestock owned*** as well as ***agricultural tools*** owned are of several kinds, these variables were captured using indexes. To construct these indexes, I used Principal Component Analysis (PCA). For the livestock, the index includes all different cattle raised in the two villages namely, cows, goats, pigs, sheep, hens, ducks, turkey, rabbits and guinea pigs. On the other hand, for the agricultural tools index, I took into consideration the various farming tools used in the field, such as pickaxes, hoes, shovels, machetes, sprayers, trident, *muhamba*[104] and rakes. Based on the index, I classified the respondents into quintiles ranging from the least (1) to the most (5) affluent.

Regarding the ***price of agricultural land***, two kinds of prices have been analysed, namely: the (hypothetical) selling price, which has been captured by the price at which the owner of the land would be willing to sell it, and the renting price, which represents the average price paid by the tenant to the landowner in the fixed renting contract[105].

Finally, I calculated the ***ratio agricultural labour/ agricultural land size*** in order to estimate the number of people a household relies on to cultivate a given size of land (a hectare in this case). Calculations will focus on non-family (paid and unpaid) labour. This is because, while family labour is often an obligation for household members, recourse to non-family labour often intervenes when family labour is unable to cover all the work that needs to be done. Also, when family labour moves into artisanal mining, it was mentioned earlier, that sometimes part of the income they earn is used to pay for hired labour. I suppose this can compensate for the work they had to do. In this case, the labour shortage will refer more to hired labour.

[103] Taking all the products would create problems related to the size on the one hand because only a minority sold the other products (which are not cassava) and this may make it difficult to interpret the statistical results. Also, measures of quantities sold are expressed in different units and their prices are sometimes not even comparable.
[104] A small tool resembling the hoe used to weed the field
[105] The analyses focus on the first most important field farmed by the household in the 2017/2018 crop year.

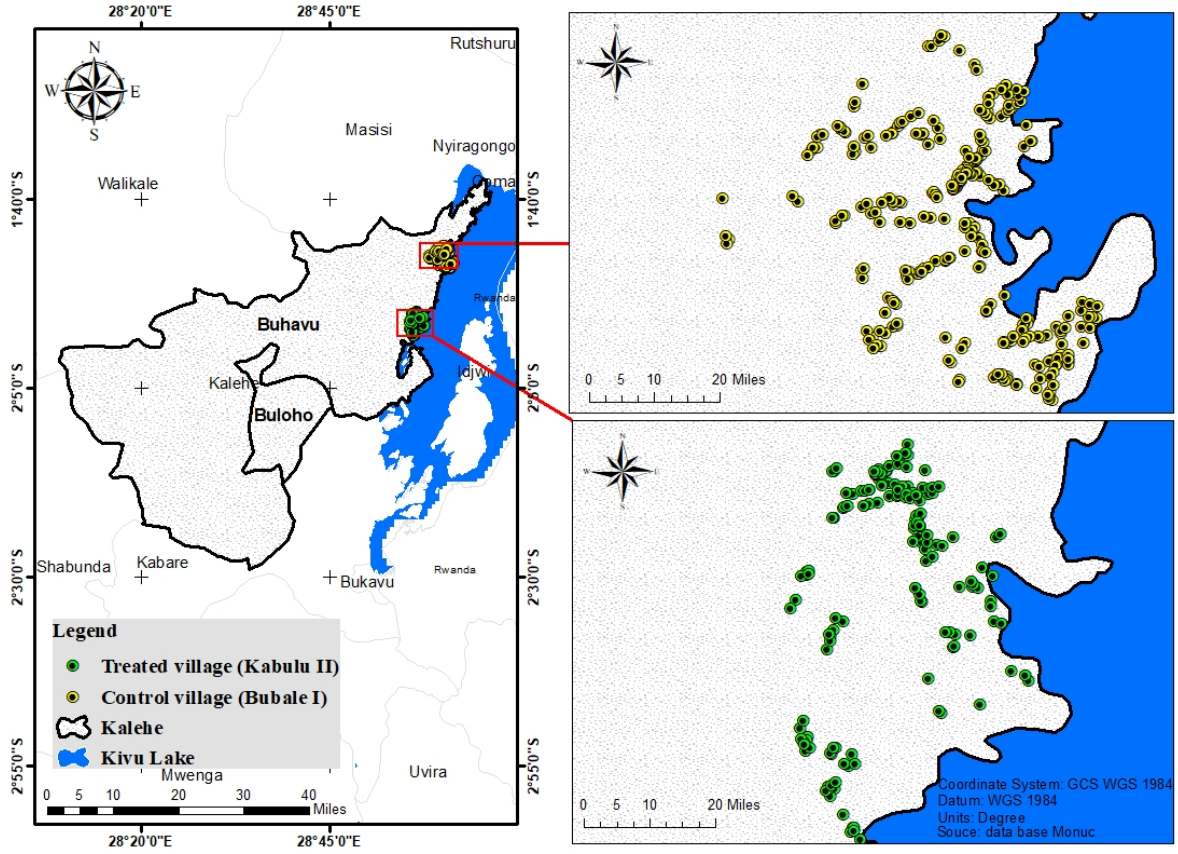
3.4.2. Validity of the propensity score matching results and limitations of the counterfactual

For the PSM method to be valid, two conditions must be fulfilled, namely, the *common support (CS) or overlap* and the *conditional independence (CI)* assumptions (Khandker, Koolwal, & Samad, 2010). According to the common support assumption, there should be sufficient overlap in propensity scores across the treated and control samples. Therefore, treatment observations must have comparison observations "nearby" in the propensity score distribution. To verify the overlap hypothesis and the region of common support between the treated group and the control group, I visualized and analysed the distribution of propensity score densities in the two groups (Caliendo & Kopeinig, 2005), eliminated the units that were outside the 'common support'[106] (Khandker, Koolwal, & Samad, 2010) and only used observations in the common support region. I also checked the balancing properties of covariables in treated and control groups before and after the matching. Normally, I expect similarity or no significant differences in covariates after matching between the two groups (Verhofstadt & Maertens, 2014).

On the other hand, the conditional independence assumption, also called 'unconfoundedness' maintains that given a set of observable covariates X, potential outcomes Y are independent of treatment assignment T. Thus, belonging to a treated or control group should depend entirely on observed characteristics. This assumption is violated if X includes variables that themselves are affected by the treatment. To ensure that this condition is met, I have tried to carefully select the X covariates. Moreover, I carefully selected the control village (counterfactual) with almost the same observable characteristics as the treated village, except that artisanal mining is present in the latter. As shown in Figure 3.1 below, the village without artisanal mining, Bubale I is remote from the village with artisanal mining, Kabulu II. Through the pilot survey, I tried to ensure that spillover effects between the two villages were limited. For example, of all the individual interviews and focus groups I had in the control village, when asked what links this village had with artisanal mining, participants attested to having no direct or indirect connection with artisanal mining, yet not knowing the purpose of this question.

[106] The area of common support is defined as the area where the propensity scores of the control units is not lower than the minimum PS of the treated units and the PS of the treated units is not higher than the maximum PS of the control units (Bamanyaki, 2017)

Figure 3.1 Surveyed households in the control and treated village



Source: Author's conception

This choice has, nevertheless, an important shortcoming that may weaken the credibility of the counterfactual. Indeed, with a sample of only two villages where all treated households are located in one and all control households in the other, treatment may be collinear with location. Thus, the estimated effects of participating to artisanal mining on agriculture could be completely confounded and simply capture other differences between the two villages (e.g., village leadership, governance, access to infrastructure) rather than or in addition to access to mining. This could be avoided if I had several control villages, which would allow me to make a comparison. However, due to budget and time constraints, this was not possible.

To test the robustness of my results to this limitation, I re-run the calculations by considering as treated households only those directly involved in artisanal mining (those whose artisanal mining contributes directly to household income) and, the counterfactual or control household those with no direct links to artisanal mining (whether they are residents of the village with or without artisanal mining). Of course, this is not a perfect counterfactual free from endogeneity bias. In this one, the endogeneity bias does not come from confounding factors at the village level, but rather, from unobserved characteristics that may lead to (self) selection into mining activities.

In the following section I present some key characteristics of the respondents before analysing the mean differences (ATE) in the outcome variables presented previously.

3.5. Presenting the results

3.5.1. Some key characteristics of respondents

3.5.1.1. Socio-demographic characteristics

As mentioned in the general introduction, the sample consists of 496 farm households. Of these 496 farm households, 195 are from Kabulu II village where artisanal mining and agriculture coexist (referred to here as treated households) and 301 from Bubale I village where artisanal mining does not exist (referred to here as control households). According to their socio-demographic characteristics (see Table 3.11, Appendices), the average age of the household head is 42 years, with the treated households having a relatively older household head. More households are headed by men in Bubale I (74%) than in Kabulu II (57%). One of the explanations for this situation may be related to what was raised in the previous section. Indeed, as noted above, once he finds money at the mining site, the husband tends to take several wives, thus abandoning his family. I assume that, due to his new wife, the husband may become unable to fully performing his family duties as he did before. In this case, there is a strong likelihood that he will no longer be considered the head of the household. Unfortunately, the data in my possession do not allow to verify this hypothesis. Overall, about 87% of the household heads live with partners, about 90.9% do not hold a state diploma (bac.), 64% have more than 5 kids and 99% were born in a rural area (village). The average household size is 8 people in both villages. Protestantism is the dominant religion. However, there are more Catholics in Bubale I and more Adventists in Kabulu II. Havu is the dominant ethnic group in both villages, but there are more Hutus in the Kabulu II village and more Shis in the Bubale I village. Membership in an association is higher in Kabulu II than in Bubale I even though this difference is not statistically significant.

3.5.1.2. Economic characteristics

Regarding their economic characteristics, more activities contribute to the household income in the presence of artisanal mining (Kabulu II) as compared to its absence (Bubale I) (1.6 activities/household on average against 1.5 activities/household on average) with a maximum of 4 activities and a minimum of 1 activity in both villages (see Figure 3.4 Appendices). Artisanal mining makes the difference because when not considered, the number of economic activities that contribute to the household income is on average the same in both villages. I

also notice that the number of off-farm activities performed in the household is higher in Kabulu II as compared to Bubale I. On average, three household members participated to the household's economic activities and 5 members did not participate. The average dependency ratio of 2 means that each household member who participates covers on average 2 members who do not. In 87% of households the head has agriculture as his/her main activity, and he/she has already spent an average of 25 years there. Besides, in 96% of households at least one of the head's parents is (has been) a farmer. It is worth noting, however, that these figures are higher in the Bubale I as compared to Kabulu II (see Table 3.12 Appendices).

The total income (from all the activities performed in the household) is higher in the village with artisanal mining (Kabulu II) than in the village without artisanal mining (Bubale I). Thus, for the week preceding the survey, the household economic activities produced on average 15 US$ in Kabulu II compared to 12.6 US$ in Bubale I. They usually produce on average 25 US$ against 16.9 US$ in a normal (average) week and 72.1 US$ against 39.1 US$ in a week of high production. Whether in the week preceding the survey, in the normal week or in the high production week, apart from the farming's contribution to the household's income, on average, artisanal mining's contribution outnumbers the contribution of other activities in Kabulu II and fishing's contribution stands out in Bubale I (see Figure 3.5, Appendices).

3.5.1.3. Agricultural characteristics

Households exploited an average of 2 fields during the 2017-2018 cropping season. This figure is significantly higher in in the presence of artisanal mining (Kabulu II) compared to its absence (Bubale I) (2.3 versus 2.1). As presented in Table 3.13 (Appendices), 64% of respondents exploited more than one field, the proportion being significantly higher in Kabulu II (68.6%) compared to Bubale I (61.1%). These are small plots of land of less than 0.5 ha, often located in the same village as the household at a walking distance of about 3 hours to reach the nearest market. For about 50% of the respondents, the field exploited belongs to the household. When this is not the case, the exploitation was done either under a rental contract (6.5%) or - in the vast majority of cases - under a sharecropping contract (38.9%). Comparing the two villages, I notice that the proportion of households having farmed under a rental contract is significantly higher in Kabulu II while those having farmed under sharecropping is significantly higher in Bubale I. To exploit these fields, households use either family or non-family labour (paid or unpaid). The use of family labour is more pronounced in the control households while more treated households use paid labour compared to control households.

Regarding the crops grown (see table 3.14 Appendices), as noted in the general introduction, this study was limited to food crops. It turned out that the two most important[107] food crops grown by 96.2% of the population are cassava and beans (Figure 3.6 Appendices). At the time of the survey, the harvest of these important crops had already been completed in 71.1% of households in Bubale I and 48.7% of those in Kabulu II. For households that had not yet completed harvesting, on average 45% of the cultivated area had not yet been harvested. It should be noted, however, that these figures differ depending on the crop (see Figures 3.7 and 3.8, Appendices). Considering the two most important crops (cassava and beans), on average, the households had already harvested 181.8 kg of cassava and 37 kg of beans, with small differences depending on whether this concerns the control or the treated households. Its production is sold either directly to consumers (40.2% of households) or to intermediaries (57.4% of households) who supply it to consumers.

Regarding the share of production sold over total production[108], descriptive results show that both in the presence and absence of artisanal mining, a large proportion of production is used for self-consumption (see Figure 3.9 Appendices). In effect, beans are more grown for self-consumption while other crops (like potatoes, taro, etc.) are grown for sale, especially in the control village where 82% of their harvest is sold. A significant part of the beans production is kept as seed for the next growing season and another part is distributed as a donation in the context of solidarity. The loss is very often related either to roaming animals or to post-harvest losses[109].

Looking at these key characteristics, it is apparent that farm households living close to artisanal mining enjoy certain privileges that their counterparts do not. For example, they participate in more off-farm activities, have a higher total income, use more paid labour, and when farming under the land contract, they make more use of the fixed rental contract and less use of the sharecropping contract compared to their counterparts. In addition, the fact that more of the households living close to the mining operation than their counterparts have their cultivated land located in a village other than the village of residence may already point to the scarcity of land in the villages where artisanal mining is taking place. This may have as corollary high land prices and/or more land conflicts. Are the differences between these two groups of farm households due to the presence of artisanal mining?

[107] "Important" here refers to the vital crops which are part of the local food habits and without which the local population may suffer.
[108] As a reminder, this is an estimate. Respondents were asked the following question: "*If this total quantity harvested is represented by these 10 beads (10 fingers), how many of these 10 beads (10 fingers) represent the quantity: (1) Sold; (2) Self-consumed; (3) Stored; (4) Donated; (5) Lost?*".
[109] Pilot survey 2017

3.5.2. Implications of access to artisanal mining

In this section, based on the outcome variables presented above, I check whether farm households who benefit from artisanal mining differ from those who do not. In addition, using the PSM method I try to estimate what the effect of artisanal mining might be if differences are observed. As a reminder, treated households here are those agricultural households living in the village where artisanal mining is taking place, whether they are directly or indirectly involved in it. Control households are those agricultural households living in the village where artisanal mining is not present.

Figure 3.10 in the appendices depicts the density distribution of the estimated propensity scores for treated and control households for each outcome variable. It shows sufficient overlap in the propensity score distribution between treated and control observations. Moreover, balancing tests for each outcome variable presented in Table 3.15 in the appendices show that there are no significant differences in observable characteristics between treated and matched control observations. In view of the above, I have therefore calculated the ATE for the different outcome variables presented in Table 3.3 below.

Table 3.3 Estimated average treatment effects (ATE) of involvement (direct and indirect) in artisanal mining

Outcome variables	ATE of Direct + Indirect involvement		
	Untreated on-support (U); Treated on-support (T)	Six Nearest neighbours matching	Kernel matching
Log (off-farm income Last week)	U=81; T=76	0.58* (0.14)	0.55
Log (off-farm income average week)	U=112; T=107	0.50*** (0.13)	0.49
Log (off-farm income High production week)	U=114; T=108	0.69*** (0.14)	0.70
Share of the harvest sold	U=168; T=91	-11.38*** (4.09)	-11.04
Log (Monetary gain/1kg of cassava sold)	U=93; T=45	0.34*** (0.11)	0.32
Number of owned arable fields	U=298; T=186	0.36** (0.17)	0.33
Experience of land conflict		-0.05 (0.04)	-0.06
- Robust standard errors in parenthesis; ***p<0.01 **p<0.05. -*psmatch2* command does not display neither standard errors nor significant level for ATE			

3.5.2.1. Artisanal mining and off-farm income

The first hypothesis of this study is that the presence of artisanal mining is likely to increase off-farm household income. At first glance, this seems obvious because, as noted in Table 3.4 below, descriptive statistics indicate that whether in the week preceding the survey (referred to here as last week), the normal (average) week or the week of high production, off-farm income is higher in the presence of artisanal mining (treated households). However, as I noted earlier, households in the village with artisanal mining perform more non-farm activities than those in the village without artisanal mining. In effect, the literature review pointed out that artisanal mining sites give way to market exchanges and can therefore spur the development of other activities. What, then, is the extent of artisanal mining in these observed differences?

The results (Table 3.3 above) reveal a positive and statistically significant ($p<0.01$) average treatment effect (ATE) of artisanal mining on off-farm income. These results are consistent across the different matching methods used as robustness check. On average, living in a village with artisanal mining increases off-farm income for farm households by 49-50% in a normal/average week and by 69-70% in a week of high production (the increase ranged from 55-58% in the week before the survey).

Table 3.4 Income from off-farm activities

				Number of respondents		
	Total	**Treated**	**Control**	Treated	Control	Total
Income from off-farm activities (in USD)						
Last Week[a]	7.3	9.4	5.4***	110	120	230
	(11.2)	(13.4)	(8.4)			
In an average Week[b]	14.4	18.0	11.1**	114	121	235
	(25.7)	(29.7)	(20.7)			
In a week of high production[c]	31.9	44.5	20.1***	113	122	235
	(65.8)	(86.9)	(33.0)			

****p<0.01 **p<0.05*
Standard deviations in parenthesis
[a] Off-farm income perceived by households the week prior to the survey
[b] Off-farm income perceived by households in an average week i.e. a week where activities are working normally
[c] Off-farm income received by households in a week when activities are exceptionally good and bring in more income
Source: Own conception based on household survey data collected in 2018

3.5.2.2. *Artisanal mining and the marketing and price of agricultural products*

Given that farm households living in the mining site stated that the presence of artisanal mining facilitates the sale of agricultural produce at a relatively high price, I hypothesized that artisanal mining is likely to increase the share of production sold out of total production as well as the selling price of agricultural produce. As a reminder, this study focuses only on food crops and analyses are based on cassava production.

While it is expected that the share of the quantity sold will be higher in the presence of artisanal mining than in its absence, the opposite is observed (see table 3.5 below). In effect, on average 39% of the harvested quantity of cassava is sold in the village with no connection to artisanal mining compared to only 28% in the village connected to artisanal mining.

Table 3.5 Allocation of Cassava harvest in %[110]

	Total	Treated	Control	Number of respondents Treated	Control	Total
Sold	35.1	28.2	39.1***	100	173	273
	(32.9)	(27.7)	(35.0)			
Self-consumed	49.6	54.4	46.8*	100	173	273
	(33.3)	(32.4)	(33.7)			
Stored	3.8	6.5	2.3***	100	173	273
	(11.5)	(15.1)	(8.4)			
Donated	8.1	9.4	7.4	99	173	272
	(14.8)	(13.8)	(15.4)			
Lost	3.5	1.7	4.6*	96	164	260
	(12.0)	(7.5)	(13.9)			

****P<0.01 *p<0.1*
Standard deviations calculated in the t-test in parenthesis
Source: Own conception based on household survey data collected in 2018

Analysing the extent of artisanal mining in this observed difference, results (Table 3.3 above) show that on average, living in a village with artisanal mining decreases the share of the harvest allocated to sale by 11.04-11.38 percentage points. This result is statistically significant and consistent across the different matching methods used as consistency check. One explanation behind this may be the relatively high presence of off-farm activities induced by artisanal mining. As developed above, these activities generate more income and may help to meet non-food needs and/or purchase imported food. In the absence of artisanal mining however, off-farm activities may be limited, increasing the incentive of farm households to sell large part of their production to cover their non-food needs. Also, with large off-farm job opportunities the farmer may be divided between agricultural and non-agricultural work, therefore, he/she may not have enough time to allocate to agriculture, thus preferring to favour self-consumption-oriented agriculture[111] where only the surplus is sold after his/her own consumption needs are met.

Regarding the selling prices[112], results show that they are significantly higher in the presence of artisanal mining than in its absence during the harvest season (Table 3.6). During the

[110] This is an estimate made by farmers who had already harvested all or part of the cassava sown during the growing season 2017/2018. The question was worded as follows: "*If this total quantity harvested is represented by these 10 beads (10 fingers), how many of these 10 beads (10 fingers) represent the quantity: (1) Sold; (2) Self-consumed; (3) Stored; (4) Donated; (5) Lost*". Responses have been converted into percentages
[111] For instance, the quantity of cassava allocated to self-consumption is higher in the presence of AM (54.4%) than in its absence (46.8%).
[112] Here represented by the monetary gain that one kilogram of cassava sold yields to the household.

hunger season 1kg of cassava sold yields 0.4USD in the presence of artisanal mining compared to 0.3USD in its absence and, 0.3USD compared to 0.2USD during the harvest period.

Table 3.6 Sale of Cassava during hunger and harvest seasons

	Total	**Treated**	**Control**	**Number of respondents** Treated	Control	Total
Hunger season Unit price (in USD)[a]	0.32 (0.19)	0.37 (0.19)	0.30 (0.18)	13	28	41
Harvest season Monetary gain/ 1kg sold (in USD)[a]	0.27 (0.23)	0.31 (0.24)	0.25* (0.23)	49	95	144

**p<0.1*
Standard deviation calculated in the t-test in parenthesis
[a] *Since respondents could not recall the exact prices, I asked them to report the total amount of money they received from the sale. I then reported the total amount from the sale out of the total quantity sold to get what a unit (here a kg) sold yielded*
Source: Own conception based on household survey data collected in 2018

In view of these results (Table 3.6), a hasty conclusion would lead to affirm the hypothesis according to which artisanal mining is likely to increase the price of agricultural products. However, since the objective of the study is to verify whether the observed differences are related to the existence of artisanal mining, this conclusion deserves a second reflection. In effect, existing studies (see, for example Matsane & Oyekale (2014); Mufungizi (2016); Karani & Wanjoy (2017); etc.) raise several other factors that influence the sale (marketing) of agricultural production. These include, for example, access to storage and market infrastructures, access to market information, etc. As only a few farmers certified that they had sold during the lean season (41 respondents), I analysed only sales during the harvest period.

It appears from the results (Table 3.3 above), that living in the village with artisanal mining increases the monetary gain a farm household makes from the sale of its agricultural production by 32% to 34%. This result is statistically significant ($p<0.01$) and consistent across the different matching methods used as robustness check.

3.5.2.3. Artisanal mining and agricultural investments by farm households

From what has been reported by respondents during the pilot survey (reinforced by the literature review), artisanal mining helps farm households to invest and further secure their incomes through the purchasing of agricultural land, paying external labour for farm work, purchasing other farm inputs and assets such as livestock and houses. Given that these investments can be made by households even in the absence of artisanal mining, I was keen to ascertain whether the presence of artisanal mining makes a difference, i.e., whether farm households invest less (or more) in these items in the presence of artisanal mining. Based on this, I postulated that artisanal mining is likely to increase the amount of agricultural land, the number of agricultural tools, the number of livestock owned by the household as well as the number of paid external labour used by the household.

Results (Table 3.7 below) show that livestock ownership does not depend on the presence of artisanal mining since on average households are in the same quintile even in its absence. On the other hand, while I was expecting the contrary, I found that households own more agricultural equipment in the absence of artisanal mining than in its presence although the difference is not statistically significant. This may be due to the fact that in the absence of artisanal mining, households have little opportunity for diversification and concentrate more on agriculture which is their main source of income. Thus, they are more incentivized to invest in the purchase of agricultural equipment in order to improve their production (which in turn improves their income). With regard to the ownership of agricultural land, results show (table 3.7) that the proportion of households that have already purchased agricultural land is higher in the presence of artisanal mining than in its absence even though the difference is not statistically significant. Also, the number of agricultural plots owned by the household is significantly higher in the presence of artisanal mining than in its absence. Regarding the use of paid farm labour[113], in the presence of artisanal mining, households use more paid farm labour than in its absence[114] although the difference is not statistically significant.

[113] Here I consider paid labour used on the most important field of the household

[114] It would be fairer to compare the paid labour used with the size of the field, however, the use of external labour is not only a function of the size, but also depends on other factors such as the stage of production, the crop grown, the various tasks to be carried out, etc.

Table 3.7 Investment in agriculture

	Total	Treated	Control	Number of respondents Treated	Control	Total
Livestock ownership quintile[a]	2.6 (1.6)	2.6 (1.6)	2.6 (1.7)	194	301	495
Agricultural equipment ownership quintile[b]	2.9 (1.4)	2.8 (1.5)	3.0 (1.4)	185	286	471
The hh has already bought a field (%)	23.8	26.7	21.9	195	301	496
Number of agricultural plots owned by the hh	1.4 (1.6)	1.6 (1.8)	1.3* (1.4)	195	301	496
Number of paid agricultural labour used	6.9 (6.3)	7.9 (8.0)	6.1 (4.8)	43	64	107

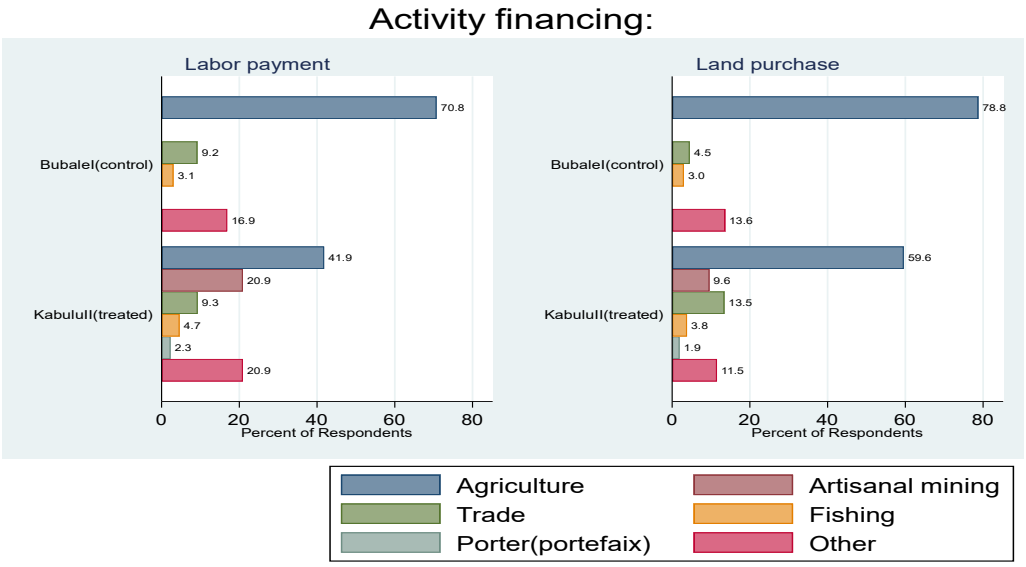
**P<0.1*
Standard deviations calculated in the t-test in parenthesis
[a] Classification of respondents into quintiles ranging from the least (1) to the most (5) affluent based on the livestock ownership index. To construct this index, I used Principal Component Analysis (PCA) and included all different cattle raised in the two villages namely, cows, goats, pigs, sheep, hens, ducks, turkey, rabbits and guinea pigs.
[b] Classification of respondents into quintiles ranging from the least (1) to the most (5) affluent based on the equipment ownership index. To construct the index, I used Principal Component Analysis (PCA) and included the various farming tools used in the field, such as pickaxes, hoes, shovels, machetes, sprayers, trident, muhamba and rakes.
Source: Own conception based on household survey data collected in 2018

Given these results, I tend to assert that farm households invest more in the purchase of agricultural land in the presence of artisanal mining than in its absence[115]. However, so far, I cannot say that this observed difference is a consequence of the presence of artisanal mining. As presented in Table 3.3 above, results show that living in a village with artisanal mining increases the amount of owned agricultural land by 0.33-0.36 points. This result is statistically significant ($p<0.05$) and consistent across the different matching methods used as robustness check.

A follow-up question was asked to specify the activity(ies) that typically fund(s) some of the respondents' investments. As can be seen in the Figure 3.2 below, a non-negligible share of households resorts to artisanal mining to finance the purchase of agricultural land and the payment of agricultural labour.

[115] Differences observed for other assets are not statistically significant, therefore, I did not estimate the effect of artisanal mining on them.

Figure 3.2 Activities financing some investments in agriculture



Source: Own conception based on household survey data collected in 2018

3.5.2.4. Artisanal mining and the price of agricultural land

The pilot survey (reinforced by the literature) argued that the presence of artisanal mining is at the root of different forms of conflict. I opted to analyse the relation between land conflicts and the presence of artisanal mining, using land prices as a proxy. Based on the existing literature, I hypothesized that the presence of artisanal mining is likely to increase land prices. Thus, I analysed two kinds of land prices namely, the (hypothetical) selling price, which has been captured by the price at which the owner of the land would be willing to sell it, and the renting price, which represents the average price paid by the tenant to the landowner in the renting contract.

From the results (see Table 3.8), it appears that hypothetical selling prices as well as land rental prices are slightly higher in the presence of artisanal mining than in its absence. However, these differences are not statistically significant; therefore, I did not estimate the effect of artisanal mining on them.

Table 3.8 Land prices and land issues

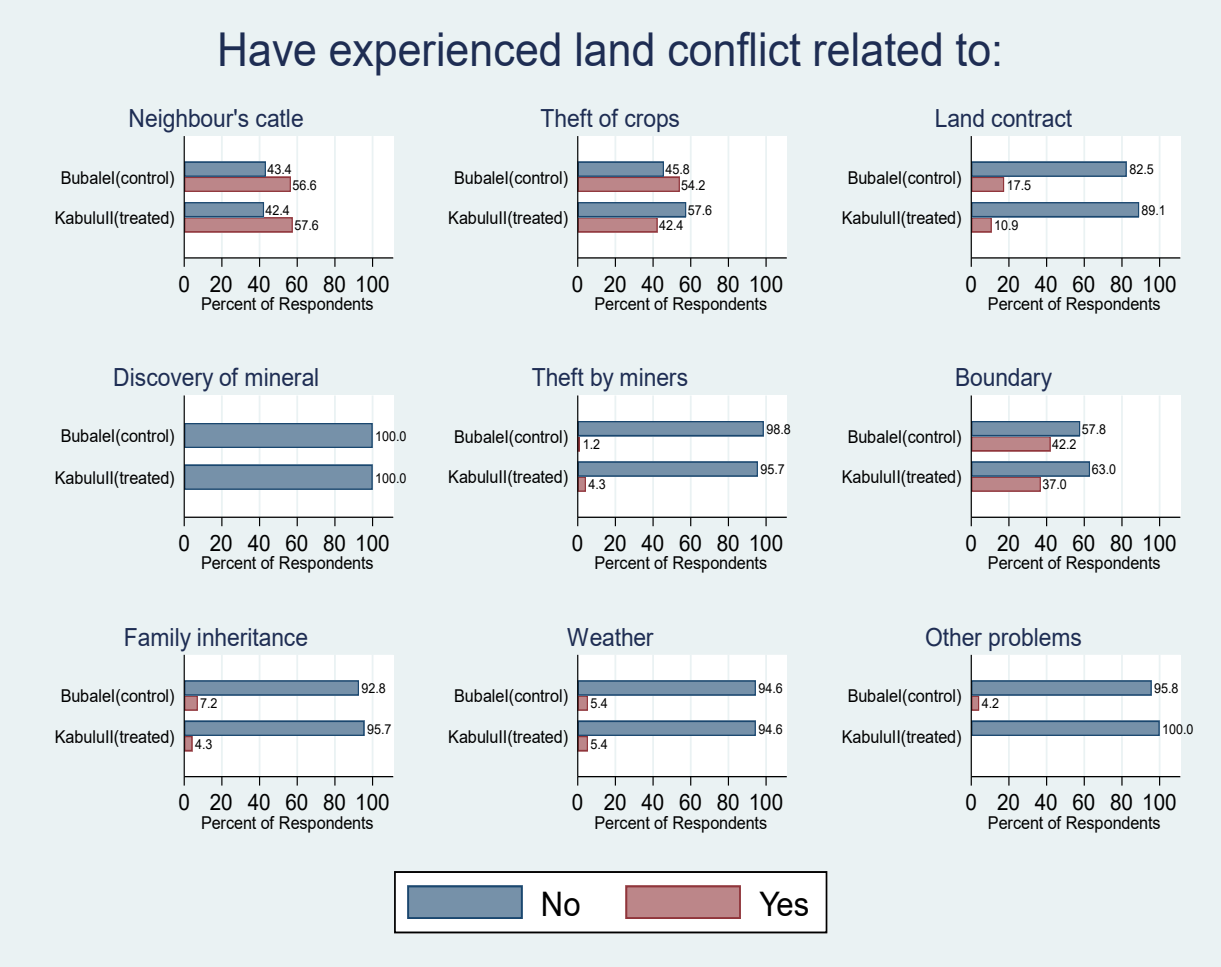
	Total	Treated	Control		Number of respondents Treated	Control	Total
Hypothetical selling the price (USD)	1249.5 (1890.0)	1258.9 (2219.8)	1243.0 (1633.4)		101	147	248
Rental price (USD)	52.9 (42.0)	61.5 (51.0)	43.0 (27.3)		17	15	32
Have had land issues (%)	52.0	47.2	55.1	*	195	301	496

**P<0.1*
Standard deviations calculated in the t-test in parenthesis
Source: Own conception based on household survey data collected in 2018

To better grasp this question, I asked respondents if they had ever experienced a land problem of any kind with their neighbours. While I was expecting the opposite, I find that (Table 3.8) more households in the village with no connection to artisanal mining (55% of respondents) responded positively compared to those in the village connected to artisanal mining (47% of respondents). Based on this assertion, I am tempted to say that the presence of artisanal mining is likely to decrease land conflict. However, I cannot so far say that this observed difference is the result of the presence of artisanal mining. As shown in the Table 3.3 above, the estimated average effect of artisanal mining on the experience of land conflict(s) is consistently negligible and statistically insignificant across the different matching methods used as robustness check.

I asked a follow-up question to those who said that they had already experienced a land problem in order to find out what kind of conflict they have experienced. As presented in the Figure 3.3 below, very few of the respondents stated that they had ever experienced land conflicts related to the existence of artisanal mining. The most recurrent land conflicts are rather related to the neighbour's cattle ravaging crops in the fields, crop theft in the fields, disputes around boundaries and land contracts that have gone wrong. While the land tenure problems faced by farm households in Kalehe were mentioned in the first chapter, these results (Figure 3.3) show the extent to which such problems can lead to disputes and conflicts.

Figure 3.3 Different kinds of land conflict



3.5.2.5. Artisanal mining and the number of available agricultural workers

Artisanal mining is considered as leading to the abandonment of agriculture due to the relatively high and quick income it offers. Based on this, I hypothesized that artisanal mining is likely to reduce the number of agricultural workers used by households. The analysis focuses on non-family labour (see Table 3.9 below) because, very often, family labour working in the family field only fulfils their family obligation regardless of their other activities.

Table 3.9 Agricultural labour

	Total	Treated	Control	Number of respondents Treated	Control	Total
Size of the field (ha)	0.3 (0.7)	0.4 (0.6)	0.3 (0.7)	183	298	481
Nr of family labour used	3.2 (1.8)	3.0 (1.7)	3.2 (1.9)	152	271	423
Nr of non-family labour (paid + unpaid)	7.0 (7.3)	7.9 (8.9)	6.4 (5.8)	83	112	195
Ratio non-family labour/size	95.2 (234.7)	86.2 (218.8)	101.7 (246.2)	79	110	189

Standard deviations calculated in the t-test in parenthesis
Source: Own conception based on household survey data collected in 2018

In terms of numbers, although the difference is not statistically significant, it appears that households use more non-family labour in the presence of artisanal mining than in its absence. This result seems obvious since the average farm size is also higher in the first case. This leads to the analysis of the ratio non-family labour used/field size to get the number of non-family labour used per 1ha exploited. Based on this ratio, it appears that in the absence of artisanal mining, farm households use less non-family labour per ha exploited than in its presence (see Table 3.9 above), however, the difference is not statistically significant.

3.5.2.6. Limitation of these results

While providing some insight into the contribution of artisanal mining to the livelihoods of farm households, these results have to be taken with care because of the aforementioned limitations of identifying a valid counterfactual. Indeed, as already mentioned, having only one village as a counterfactual weakens the credibility of the results because the estimated effects may be confounded and possibly capture the difference between the two villages in terms, for example, of village leadership or governance rather than or in addition to access to artisanal mining.

As previously announced, unable to counteract this problem because of budget and time constraints, I tried to recalculate the effects of artisanal mining by considering as counterfactual all households without direct linkages with artisanal mining, whether they are residents of the village with or without artisanal mining. The problem with this strategy was the small sub-sample size for the treated group. Only 38 out of 496 households in the sample were directly involved in artisanal mining. For some outcome variables this number is even lower as only some households provided data for these variables. This is the case, for instance,

for the variable price at which the production was sold (see Log (Monetary gain/1kg of cassava sold)) of which only 144 households provided data. Of these 144 households, only 7 are directly involved in artisanal mining. As this number is small, there was a problem of collinearity for two covariates making it impossible to calculate the ATE[116].

Nevertheless, for other outcome variables, the results show almost the same trend. For example, as indicated in Table 3.10 below, there is a positive and statistically significant effect of farm households' direct involvement in artisanal mining on off-farm income. Being directly involved in artisanal mining increases off-farm income for farm households by 45-47% in a normal/average week and by 88-100% in a week of high production (the increase ranged from 59-64% in the week before the survey). Likewise, as with the first case (village without artisanal mining as a counterfactual), there is a negative effect on the share of production sold although this effect is not statistically significant (see Table 3.10 below).

[116] It would be desirable to compare respondents in the 'mining' village only i.e. a comparison between those who are and are not involved in artisanal mining within the village where artisanal mining is present. With my data, I tried to do so but I encountered the same problems: Not only does the sample size become very small, but also the differences between the two matching methods increase. However, even with these weaknesses, the effect of artisanal mining on non-farm income remains positive and significant (during the normal/average week: 17-20% with $p<0.1$; during the high production week: 58-74% with $p<0.01$) and its effect on the share of production sold remains negative.

Table 3.10 Estimated average effects (ATE) of direct involvement in artisanal mining

	ATE of only direct involvement (Robustness check)		
Outcome variables	Untreated on-support (U); Treated on-support (T)	Six Nearest neighbours matching	Kernel matching
Log (off-farm income Last week)	U=78 T=21	0.64** (0.27)	0.59
Log (off-farm income average week)	U=180 T=34	0.45** (0.22)	0.47
Log (off-farm income High production week)	U=145 T=32	0.88*** (0.18)	1.04
Share of the harvest sold	U=234 T=15	-10.33 (7.6)	-8.71
Log (Monetary gain/1kg of cassava sold)	U=68 T=7	-	-
Number of owned arable fields	U=442 T=35	-0.02 (0.25)	-0.03
- Standard deviation in parenthesis; ***p<0.01 **p<0.05. -*psmatch2* command does not display neither standard errors nor significant level for ATE			

3.6. Discussion & conclusion

To document the entrenchment and indispensability of artisanal mining, this chapter analysed its contribution to the livelihoods of Kalehe peasants. Drawing on the existing literature on the links between artisanal mining and agriculture which generally describes the relationship between these two sectors in terms of competition and complementarity, five hypotheses were formulated and tested throughout the chapter. The propensity score matching method was used to compare farm households connected to artisanal mining with those living in the village where artisanal mining is not present. Provided that the observed effect is the result of household involvement in artisanal mining and not of other differences that may exist between these two villages, some conclusions can be drawn from the findings.

First, I assumed that artisanal mining is likely to increase the non-farm income of farm households. This assumption was confirmed. Indeed, according to the results, farm households living in the village where artisanal mining is present have a weekly off-farm income 49 to 50% higher than their counterpart during an average (normal) week. Thus, in a context where agriculture fails to provide sufficient income, artisanal mining appears to be complicit in maintaining the survival of farm households. Engaging (directly or indirectly) in artisanal mining as part of the livelihoods strategy can therefore, as the Sustainable Livelihoods Framework (SLF) claims, improve the ability of farm households to cope with shocks/stresses encountered in the agricultural sector.

The complicity between these two sectors, as I mentioned in the first chapter, is not only direct. It is also indirect in that artisanal mining helps to stimulate the creation of other non-farm activities. As evidence of this, my results have shown that in the presence of artisanal mining, farm households participate in more non-farm activities than in its absence. However, while this may have a positive effect on off-farm income, it can also affect agricultural production. On the one hand, in case of high availability of off-farm activities, farmers may not have enough time to devote to agriculture, thus preferring to farm for self-consumption or, in the worst case, abandoning farming in favour of imported food. Although my database does not allow for a comparison of the extent of food imports in the presence and absence of artisanal mining, the data I do have reveals that in the presence of artisanal mining, farm households allocate much of their production to self-consumption. On the other hand, limited off-farm activities may induce farm households to sell much of their production to cover their non-food needs. In this regard, while the literature argues that the presence of mining is likely to increase the share of agricultural production sold, I observed the opposite. The results show that living in the vicinity of artisanal mining reduces by 11.04-11.38 percentage points the share of the production that farm households allocate to sale. This may be because, in the absence of artisanal mining, households with few non-agricultural opportunities need to rely on their agricultural production to meet their non-food needs.

Another indirect contribution of artisanal mining is revealed by its positive effect on the prices of agricultural products (or at least on the monetary gain that farm households receive from the sale of their agricultural products). Indeed, consistent with the assumption according to which artisanal mining is likely to increase the price of agricultural products, results show that farm households evolving close to artisanal mining gain 32 to 34% higher from the sale of their agricultural harvest as compared to farm household living in a village where artisanal mining is not present. In the existing literature mentioned previously, this gain is explained

by the fact that the presence of artisanal mining is likely to increase the number of consumers of agricultural products whose purchasing power is relatively high. Thus, in an environment where demand for agricultural products is low, artisanal mining appears to be a provider of consumers of these products, and thus a stimulus for increased agricultural production.

Second, the predatory nature that the existing literature attributes to artisanal mining in its interaction with agriculture is reportedly explained, among other things, by its negative effect on the price of agricultural land and on agricultural labour. Accordingly, I hypothesized that the presence of artisanal mining is likely to increase land prices and to reduce the number of agricultural workers used by households. On the one hand, I analysed the hypothetical selling price and the rental price, which represents the average price paid by the tenant to the landowner in the renting contract. Though the differences were not statistically significant, I found that the hypothetical selling prices as well as land rental prices are slightly higher in the presence of artisanal mining than in its absence. Curiously, despite these high land prices, more farm households use their own land (or have already bought a land) in the presence of artisanal mining than in its absence. Moreover, when farming under land contract, they make more use of fixed rental contract and less use of sharecropping contract than their counterparts. On the other hand, I calculated the ratio non-family labour used/field size to get the number of non-family labour used per 1ha exploited. Here, while I expected the opposite, even though the difference was not statistically significant, I found that farm households use more non-family labour per ha exploited in the presence of artisanal mining than in its absence. Are these results due to the presence or absence of artisanal mining? On the one hand, results show that living close to an artisanal mining site increases by 0.33 to 0.36 points the amount of agricultural land owned by farm households. On the other hand, existing literature as well as qualitative data from the pilot survey highlighted the fact that income from mining is allegedly invested in the purchase of agricultural land and the payment of agricultural labour. Thus, artisanal mining may well have a predatory effect by driving up land prices and reducing available farm labour, but this effect would also be countered by the income it generates. This income may enable farm households to buy farmland despite high prices or to pay for farm labour if family labour becomes insufficient.

Finally, in parallel with the existing literature, this chapter sheds more lights on the rootedness and indispensability of artisanal mining on agriculture-based livelihood. In accordance with the SLF, it documents how engaging in artisanal mining in the frame of livelihood strategy can not only increase the household's capability to cope with shocks and changes or to manage stress, but also, can affect the resilience and stability of natural resources. Given that it enables

farm households to meet their needs that cannot be met by agricultural income alone, artisanal mining deserves attention from policy makers. Instead of discouraging or prohibiting it as is often the case (Hilson, 2016b), policy makers should develop supportive policies to limit the negative effects that artisanal mining can have. For example, they could consider policies to channel the income generated by artisanal mining into productive investments which can support the agricultural sector. They could also develop policies to improve farm incomes to support mutualism between the two sectors in order to enable the agricultural sector to stand on its own feet if artisanal mining becomes impossible anyway. These policies are discussed in the fifth chapter (conclusion) of this thesis.

Appendices III

Table 3.11 Socio-demographic characteristics of farm households

	Total (496)	**Treated (195)**	**Control (301)**	
Household demographic characteristics				
Age of the household head (year)	42.2	40.7	43.2	*
	(14.4)	(14.5)	(14.3)	
Household size (nr)	7.9	7.8	8.1	
	(3.0)	(3.0)	(3.0)	
Male headed households	67.9%	57.9%	74.4%	***
The hhh does not have a state diploma	90.9%	91.2%	90.6%	
The hhh lives with a partner	86.9%	86.2%	87.4%	
The hhh have more than 5 children	64.5%	66.2%	63.5%	
The hhh was born in rural area (village)	99.0%	99.0%	99.0%	
Household social characteristics				
Ethnicity (%)				
Havu	61.5	64.6	59.5	
Hutu	9.9	14.4	7.0	***
Shi	13.3	7.2	17.3	***
Other	15.3	13.8	16.3	
Religion (%)				
Catholic	23.8	9.2	33.2	***
Protestant	48.2	55.9	43.2	***
Adventist	11.5	19.5	6.3	***
No religion	2.0	2.6	1.7	
Others	14.5	12.8	15.6	
Membership in an association (%)				
No	52.8	49.7	54.8	
Yes	47.2	50.3	45.2	

****p<0.01 ; *p<0.1*
Standard deviations calculated in the t-test table in parenthesis
Source: Own conception based on household survey data collected in 2018

Table 3.12 Economic characteristics of farm households

	Total	Treated	Control		Number of respondents Treated	Control	Total
Household economic characteristics							
Economic activities (nr)							
Nr of economic activities in the household	1.5 (0.6)	1.6 (0.6)	1.4 (0.6)	***	195	301	496
Nr of off farm activities	0.6 (0.6)	0.7 (0.6)	0.5 (0.6)	***	195	301	496
Nr of non AM activities	1.5 (0.6)	1.5 (0.6)	1.5 (0.6)		195	301	496
Participation to the household economic activities (nr)							
Nr of participants	3.2 (1.9)	3.1 (1.7)	3.2 (1.9)		195	301	496
Nr of non-participants	5.2 (2.5)	5.3 (2.6)	5.1 (2.5)		187	273	460
Dependency ratio	2.1 (1.8)	2.2 (1.8)	2.1 (1.9)		195	301	496
Total income (from all activities of the hh in USD)							
Last week	13.5 (21.5)	15.0 (22.1)	12.6 (21.1)		189	295	484
In a normal week	20.1 (31.0)	25.0 (36.2)	16.9 (26.7)	***	194	300	494
In a week of high production	52.3 (76.0)	72.1 (98.7)	39.1 (53.0)	***	194	300	494
Agricultural experience of the hh							
Agriculture as the main activity of the hhh (%)	85.7	80.0	89.4	***	195	301	496
Years the hhh spent in agriculture	25.4 (14.8)	25.0 (14.2)	25.6 (15.1)		156	268	424
At least one of the parents is(was) a farmer (%)	96.4	94.9	97.3		195	301	496

****p<0.01 ;*

Standard deviations calculated in the t-test table in parenthesis

Source: Own conception based on household survey data collected in 2018

Table 3.13 Characteristics of the most important field exploited by the household during the 2017-2018 crop year

	Total	Treated	Control		Number of respondents Treated	Control	Total
Nr of fields used during 2017/2018 crop year	2.2 (1.2)	2.3 (1.3)	2.1 (1.2)	*	195	301	496
Characteristics of the most important field							
Size of the field (ha)	0.3 (0.7)	0.4 (0.6)	0.3 (0.7)		183	298	481
Field located in the same village (%)	94.7	89.6	98.0	***	192	301	493
Ownership of the field (%)							
owned	53.5	55.7	52.2		192	301	493
rented	6.5	8.9	5.0	*	192	301	493
sharecropping	38.9	34.4	41.9	*	192	301	493
other	1.0	1.0	1.0		192	301	493
Kind of labour used on this field (%)							
Family	85.8	79.2	90.0	***	192	301	493
Paid non-family	21.9	22.4	21.6		192	301	493
Unpaid non-family	22.7	25.5	20.9		192	301	493
Distance to the nearest market (in minutes)	99.0 (72.3)	92.3 (63.8)	103.2 (77.0)		189	299	488

****P<0.01 **p<0.05 *p<0.1*

Standard deviation calculated in the t-test table in parentheses

Source: Own conception based on household survey data collected in 2018

Table 3.14 Characteristics of important food crops grown

	Total	Treated	Control		Number of respondents Treated	Control	Total
The most important of the food crops grown is (%)							
Cassava	77.2	82.6	73.8	**	195	301	496
Beans	19.0	12.3	23.3	***	195	301	496
Other	3.8	5.1	3.0		195	301	496
Have finished harvesting the crop (%)	62.3	48.7	71.1	***	195	301	496
Quantity already harvested							
Cassava (kg)	181.8 (296.4)	161.1 (272.1)	196.6 (312.3)		158	221	379
Beans (kg)	37 (57.5)	32 (50.2)	38.7 (60.0)		24	70	94
The household sells its production to (%)							
Consumers	40.2	41.8	39.5		55	114	169
Intermediaries	57.4	54.5	58.8		55	114	169
Miners	0.0	1.8	0.6		55	114	169
Other	1.8	1.8	1.8		55	114	169

****P<0.01 **p<0.05*
Standard deviation calculated in the t-test table in parentheses
Source: Source: Own conception based on household survey data collected in 2018

Table 3.15 Balancing properties of covariates for Kernel matching on propensity scores (For all the significant outcome variables)

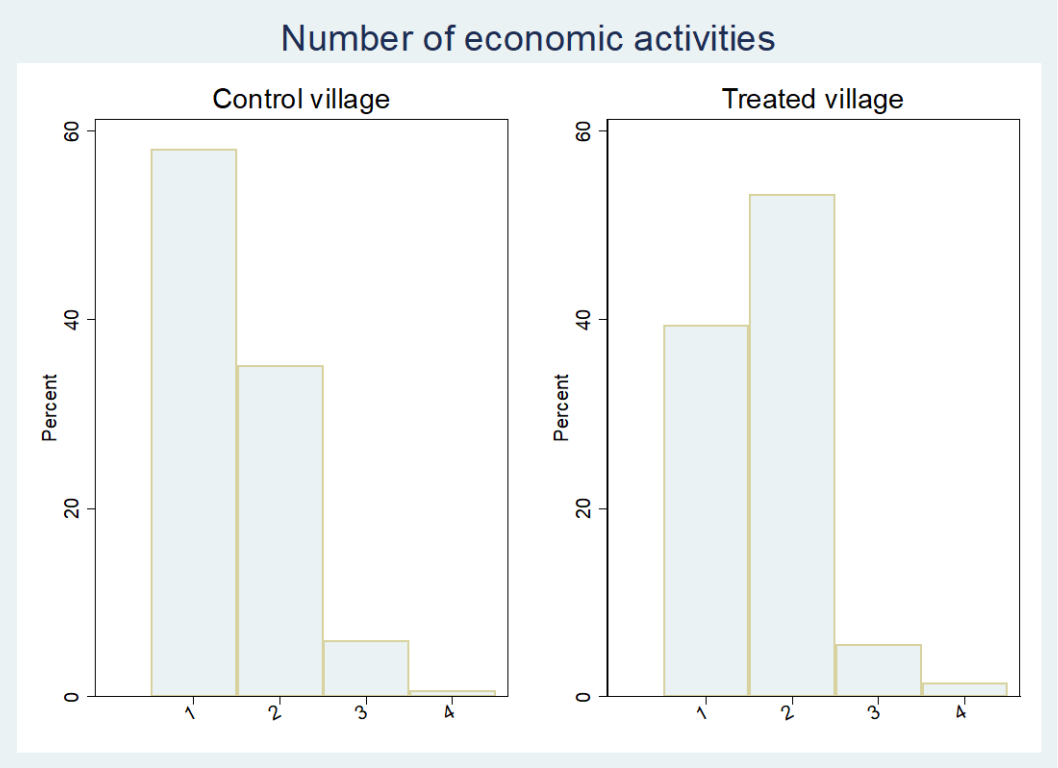
Variables	Sample	Mean Treated units	Mean Control units	% Bias between treated and control	% Reduction Bias	t-Test Mean Treated =Mean Control
Off-farm income during the average week						
Age hhh	Unmatched	38.964	40.053	-8.8		-0.66
	Matched	39.178	39.419	-1.9	77.9	-0.14
Age square hhh	Unmatched	1689.8	1739.4	-4.6		-0.34
	Matched	1694.6	1716.7	-2.0	55.4	-0.14
Matrimonial status hhh	Unmatched	0.9009	0.9292	-10.1		-0.76
	Matched	0.90654	0.92763	-7.5	25.5	-0.56
Hhh low level of education	Unmatched	0.89189	0.85841	10.1		0.76
	Matched	0.88785	0.89231	-1.3	86.7	-0.10
Hh size	Unmatched	8.0721	8.0973	-1.0		-0.07
	Matched	8.028	8.0597	-1.2	-25.2	-0.09
Hhh non-havu ethnicity	Unmatched	0.36036	0.38938	-6.0		-0.45
	Matched	0.36449	0.37287	-1.7	71.1	-0.13
membership association	Unmatched	0.53153	0.52212	1.9		0.14
	Matched	0.52336	0.53214	-1.8	6.7	-0.13
Distance nearest market	Unmatched	85.333	99.69	-21.6		-1.62
	Matched	86.187	86.466	-0.4	98.1	-0.03
Share of the harvest sold						
Age hhh	Unmatched	39.909	44.263	-30.3		-2.37**
	Matched	40.736	40.87	-0.9	96.9	-0.06
Age square hhh	Unmatched	1775.9	2185.9	-30.2		-2.33**
	Matched	1847.9	1864.8	-1.2	95.9	-0.09
Matrimonial status hhh	Unmatched	0.83838	0.89474	-16.6		-1.34
	Matched	0.91209	0.8825	8.7	47.5	0.65
Hhh low level of education	Unmatched	0.90909	0.88889	6.7		0.52
	Matched	0.9011	0.90189	-0.3	96.1	-0.02
Hh size	Unmatched	8.0909	7.9474	4.6		0.37
	Matched	8.1538	8.0251	4.1	10.3	0.28

Hhh non-havu ethnicity	Unmatched	0.29293	0.44444	-31.7		-2.48 **
	Matched	0.31868	0.35156	-6.9	78.3	-0.47
membership association	Unmatched	0.49495	0.50292	-1.6		-0.13
	Matched	0.49451	0.493	0.3	81.1	0.02
Distance nearest market	Unmatched	87.949	90.088	-3.4		-0.27
	Matched	86.89	88.757	-3.0	12.7	-0.20
Monetary gain per 1kg of cassava sold						
Age hhh	Unmatched	40.5	42.404	-14.3		-0.78
	Matched	40.267	40.573	-2.3	83.9	-0.12
Age square hhh	Unmatched	1779.8	2010.3	-18.5		-1.00
	Matched	1767.7	1797.5	-2.4	87.1	-0.13
Matrimonial status hhh	Unmatched	0.89583	0.92553	-10.3		-0.60
	Matched	0.91111	0.88425	9.4	9.6	0.42
Hhh low level of education	Unmatched	0.97917	0.91489	28.8		1.49
	Matched	0.97778	0.97159	2.8	90.4	0.18
Hh size	Unmatched	9.0208	8.1277	28.7		1.68*
	Matched	8.6222	8.6694	-1.5	94.7	-0.08
Hhh non-havu ethnicity	Unmatched	0.375	0.44681	-14.5		-0.82
	Matched	0.35556	0.38834	-6.6	54.3	-0.32
membership association	Unmatched	0.5	0.44681	10.6		0.60
	Matched	0.51111	0.50906	0.4	96.1	0.02
Distance nearest market	Unmatched	103.23	87.287	23.9		1.39
	Matched	97.444	97.757	-0.5	98.0	-0.02
Number of owned arable fields owned by the household						
Age hhh	Unmatched	40.905	43.237	-16.1		-1.74*
	Matched	41.188	41.611	-2.9	81.9	-0.28
Age square hhh	Unmatched	1887.6	2073.7	-13.5		-1.46
	Matched	1909	1947.1	-2.8	79.6	-0.26
Matrimonial status hhh	Unmatched	0.86772	0.87625	-2.5		-0.28
	Matched	0.86559	0.8721	-1.9	23.7	-0.19
Hhh low level of education	Unmatched	0.91534	0.90635	3.1		0.34
	Matched	0.91398	0.91655	-0.9	71.4	-0.09
Hh size	Unmatched	8.2063	7.893	10.3		1.11

Hhh non-havu ethnicity	Matched	8.1183	8.1353	-0.6	94.6	-0.05
	Unmatched	0.35979	0 .40134	-8.5		-0.92
membership association	Matched	0.36022	0.37002	-2.0	76.4	-0.20
	Unmatched	0.50265	0.45485	9.6		1.03
Distance nearest market	Matched	0.49462	0.49608	-0.3	97.0	-0.03
	Unmatched	92.339	103.24	-15.4		-1.63
	Matched	92.78	93.202	-0.6	96.1	-0.06

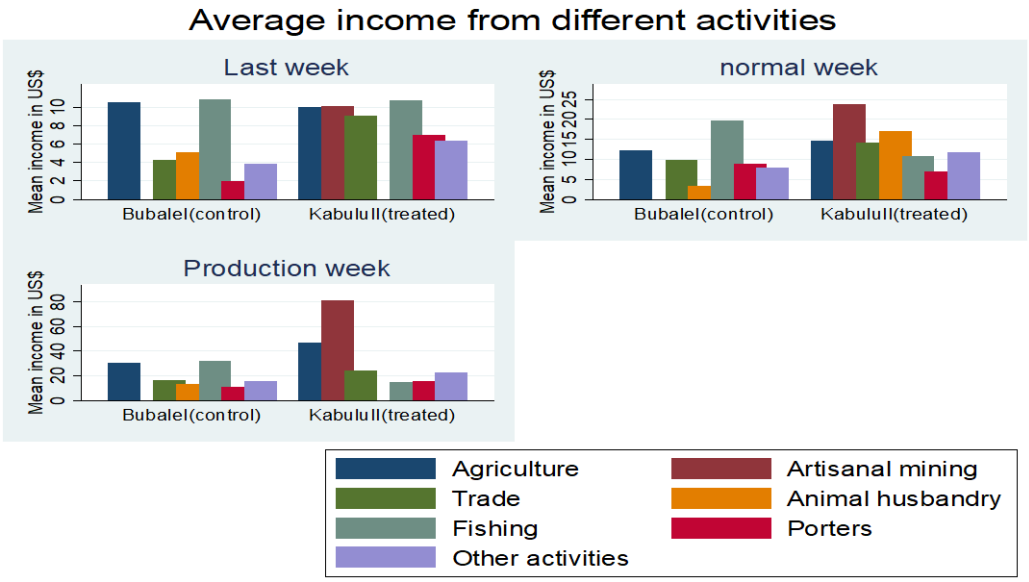
Hh= Household; Hhh= Household head; *p<0.1 **p<0.05.

Figure 3.4 Number of economic activities which contribute to the household income



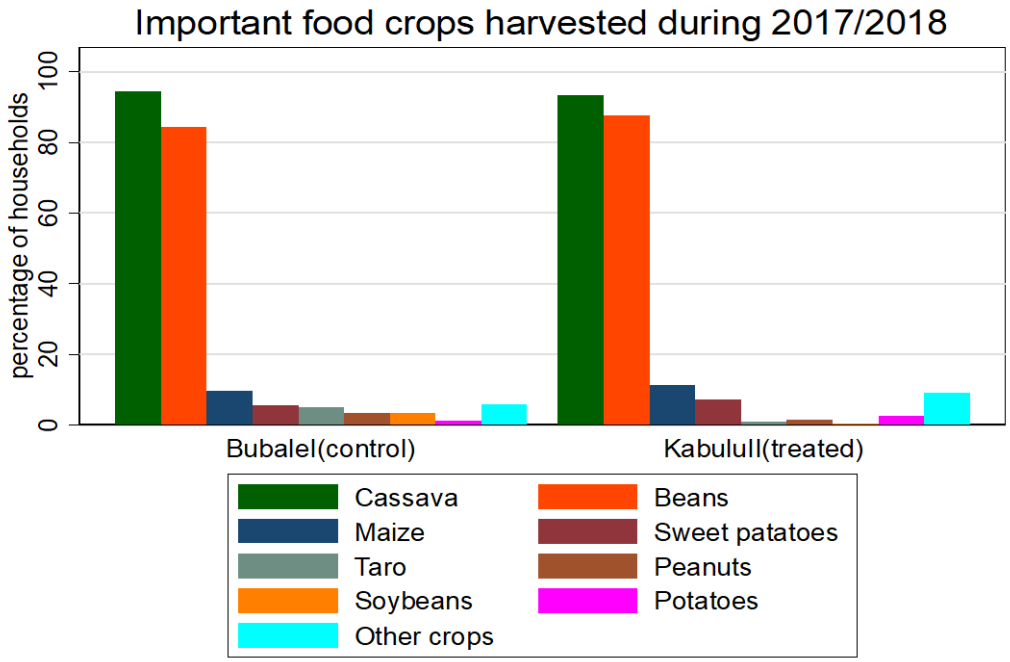
Source: Own conception based on household survey data collected in 2018

Figure 3.5 Average income from different activities



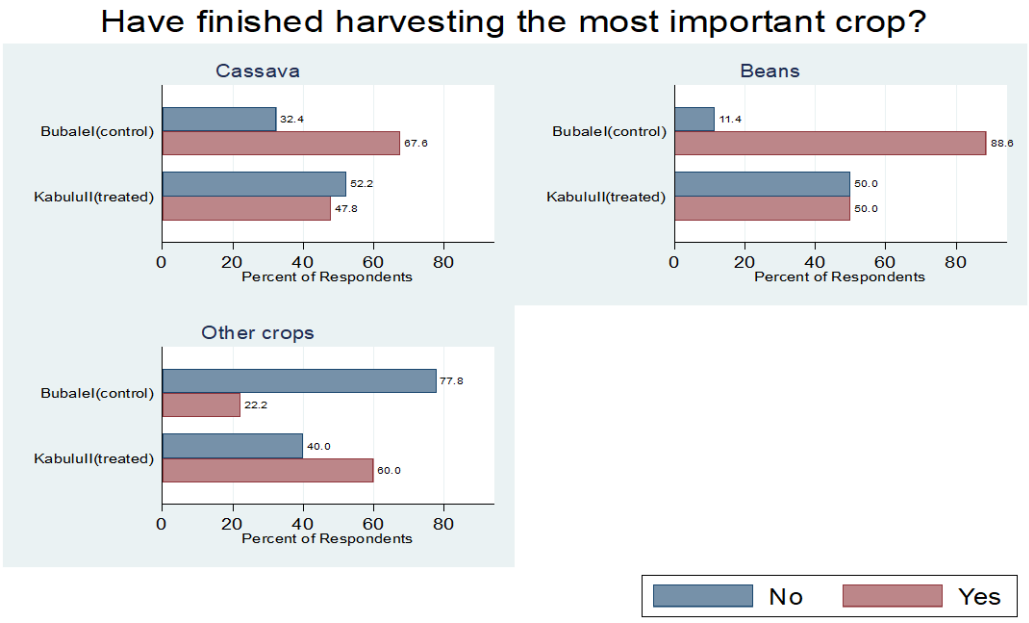
Source: Own conception based on household survey data collected in 2018

Figure 3.6 Important food crops harvested during 2017-2018 crop year



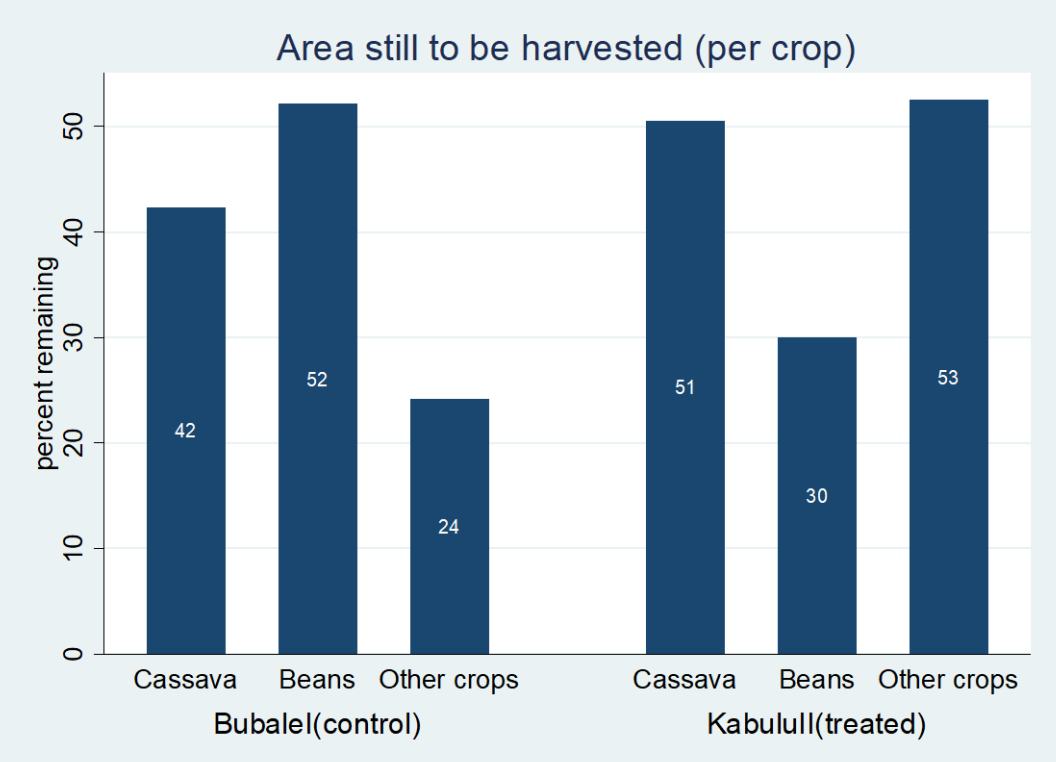
Source: Own conception based on household survey data collected in 2018

Figure 3.7 The household has finished harvesting the most important crop



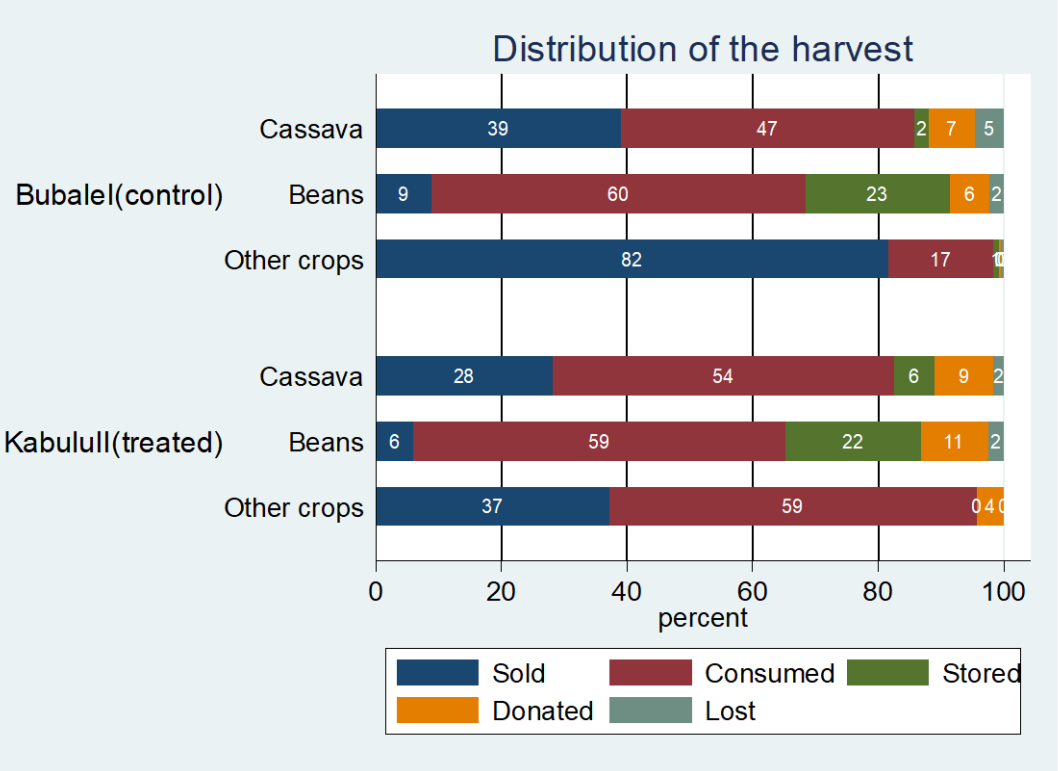
Source: Own conception based on household survey data collected in 2018

Figure 3.8 Area still to be harvested



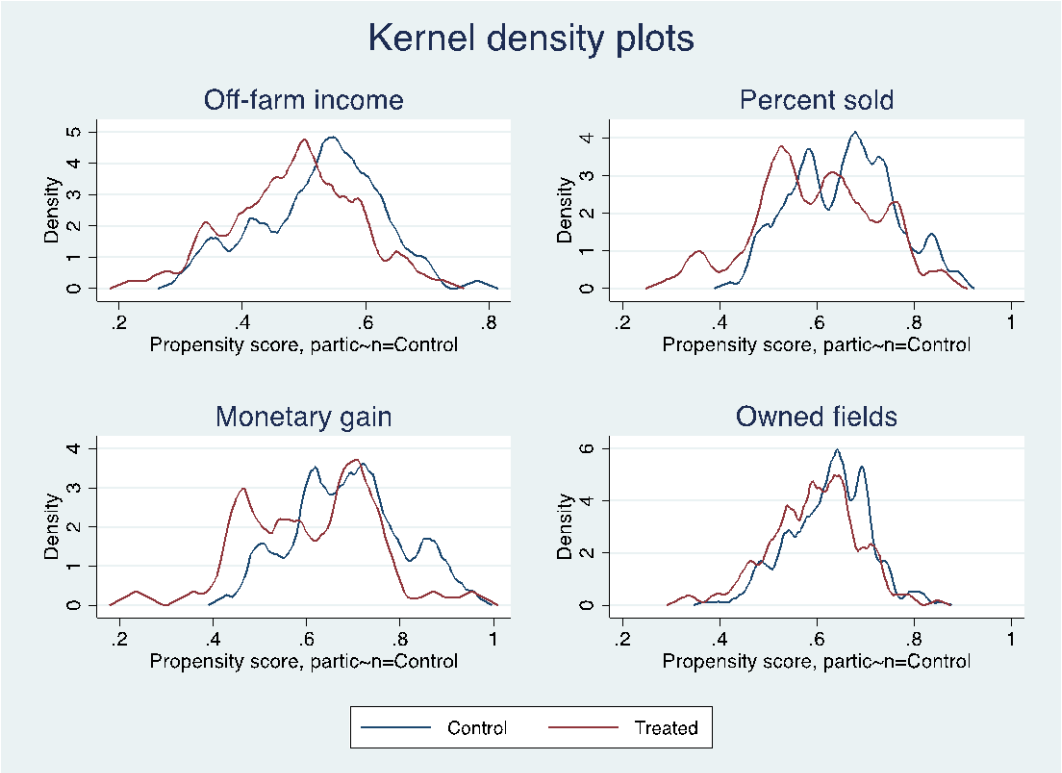
Source: Own conception based on household survey data collected in 2018

Figure 3.9 Distribution of the harvest quantity



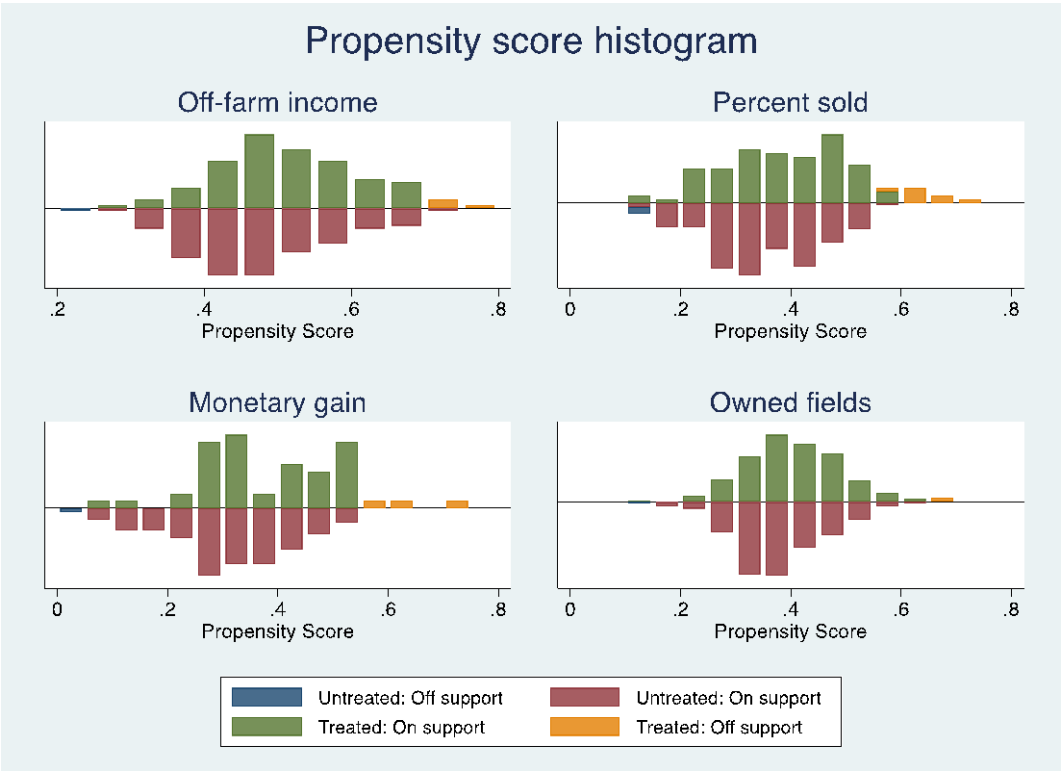
Source: Own conception based on household survey data collected in 2018

Figure 3.10 Kernel density plots



Source: Own conception based on household survey data collected in 2018

Figure 3.11 Propensity score histogram



Source: Own conception based on household survey data collected in 2018

Chapter IV: Place of agriculture in the imagined future of artisanal miners of Kalimbi mine in Kalehe

4.1. Introduction

In the previous two chapters, artisanal mining has been presented as a key livelihood activity in the diversified livelihood portfolios of farming households. However, this activity is sometimes threatened because, like other extractive activities, artisanal mining is inevitably exhaustive and, like other rural livelihood activities, it faces shocks/stresses, leading artisanal miners to adapt their livelihood strategies. Deposits may become out of reach because of technical or geological difficulties, like mounting groundwater, or hard to break rocks. Moreover, governments may want to put an end to artisanal mining because they hand the concessions over to industrial companies (Siegel & Veiga, 2010; Stoop, Verpoorten, & Buraye, 2016) or because they fight 'illegal' mining and/or the destructive environmental impact of artisanal mining (as happened for instance in the DRC: see Geenen, Kamundala, & Mukotanyi, 2011; and in Ghana: see Adonteng-Kissi & Adonteng-Kissi, 2018; Mabe, Owusu-Sekyere, & Adeosun, 2021). The former refers to a geological reason why artisanal mining will inevitably come to an end in a particular place – and why the artisanal mining frontier advances by "technological deepening and geographical widening" (Verbrugge & Geenen, 2019; 2020). The latter refers to political reasons to end artisanal mining, or confine it to particular demarcated spaces, or to particular production modes.

Although farmers get involved in artisanal mining to support the insufficient income offered by agriculture (see Chapter II), when the end of artisanal mining and the future direction of artisanal miners is imagined by policy makers, agriculture often comes to the forefront of alternative livelihood options (Banchirigah, 2008; Aubynn, 2009; Bush, 2009; Cartier, 2009; Hilson & Banchirigah, 2009; Adonteng-Kissi & Adonteng-Kissi, 2018; Prescott, et al., 2020). Only few studies have a positive opinion on this option. This is the case of Hinton, Veiga, & Veiga, (2003) who find a positive example in the Tapajós region of Brazil where the end of the artisanal exploitation of gold has led small entrepreneurs to invest in cattle breeding, palm and coconut production. This attraction was made possible by the construction and / or rehabilitation of agricultural feeder roads that were impassable at the time of mining. Another example comes from Cartier (2009) who emphasizes that the most realistic livelihood for artisanal miners is agriculture provided that they are willing to voluntarily return to and exploit their ancestral lands. Similarly, Mabe et al. (2021) described agriculture as the most dominant

alternative activity adopted by artisanal miners rendered unemployed by the ban on *galamsey*[117] and artisanal mining in Ghana.

Other studies, however, consider this choice as a top-down decision and portrays agriculture as an unattractive option which does not take into account needs and wishes of artisanal miners (Banchirigah, 2008; Hilson & Banchirigah, 2009; Bush, 2009; Jønsson and Fold 2011; Perks, 2011; Stoop, Verpoorten, & Buraye, 2016; Adonteng-Kissi & Adonteng-Kissi, 2018). For instance, Jønsson & Fold (2011), maintain that agriculture is not attractive to artisanal miners because despite the uncertainty and risk of artisanal mining, the income it provides is significantly higher than that offered by agriculture. Also, as stated by Perks (2011), earning schedules in agriculture are not attractive. In effect, while artisanal mining can provide a daily income, farm income depends on the harvest period. That is why people abandon farming to engage in artisanal mining where they hope to earn more income (Jønsson and Fold 2011, Perks 2011). These studies therefore recommend that artisanal miners are more actively involved in decisions about their future, so as to come to policy solutions that better suit their needs (Bush, 2009; Hilson & Banchirigah, 2009; Hinton, Veiga, & Veiga, 2003; Adonteng-Kissi & Adonteng-Kissi, 2018; Prescott, et al., 2020).

Following this recommendation, existing analyses are often limited to presenting activities perceived as attractive by artisanal miners. They would be more informative if they specified to what extent and for which category of artisanal miners a given activity is more attractive. Furthermore, although agriculture is often seen by policy makers as an ultimate alternative to artisanal mining, very limited studies have attempted to analyse to what extent and for which category of artisanal miners it would be attractive. Based on a case study from Kalehe territory in South Kivu, this chapter attempts to fill these gaps and complement the existing literature. In line with the previous two chapters (chapter II & III), it recognises that artisanal mining is one of the activities co-constituting rural households' livelihoods and that an artisanal miner may at the same time engage in agriculture as an income diversification strategy (either himself/hersefl or through a member of his/her household). However, unlike these two chapters, in which artisanal mining is analysed as a livelihood strategy for farm households when faced with shocks and stresses in agriculture, this chapter analyses whether, when faced with shocks and stresses in artisanal mining, agriculture can also be considered as a livelihood strategy by artisanal miners. I intend to answer the following questions: *If artisanal mining is no longer possible, to what extent is agriculture an interesting option? What category of artisanal miners would consider agriculture as an option?* This could then serve as a basis on

[117] Illegal mining

which policy makers can reflect when imagining and planning for the future of artisanal miners. The findings will not only complement the existing literature on possible post-mining activities, but will also help policy makers to identify the categories and characteristics of artisanal miners for whom they can propose farming as a post-mining option.

Very limited studies have addressed the issue of alternative activities to artisanal mining from this particular angle in the context of the South Kivu. A first attempt was made by Stoop, Buraye and Verpoorten (2016). Based on a case study of Kamituga in Mwenga territory, their study analysed alternative activities which can be chosen by artisanal miners who are threatened by the expansion of large-scale mining. From their findings, only few of artisanal miners would be interested in agriculture, while activities such as car mechanic and employment in large scale mining are very appealing to them. However, as argued by Geenen and Byemba (2009), Kamituga has a long history of artisanal mining. In addition, because farmlands are not located near mining sites (Stoop et al., 2016), artisanal miners in Kamituga may have less information on the functioning of farming activities. Therefore, Stoop et al.'s findings may be somewhat particular, as Kamituga's inhabitants have depended on mining for a long time, and have consequently neglected farming. This situation may explain the lack of interest in agricultural activities.

The historical trajectory is different in Kalehe territory, where mining activities have started more recently, and people have since long relied more heavily on agriculture. In this territory where the Kalimbi mine is located, Buraye (2018) analysed the intentions of artisanal miners to leave the Kalimbi mine as a result of the traceability mechanism, and the activities towards which they can orient. With the traceability mechanism, minerals produced at Kalimbi mine should be labelled and their trade route should be tracked. Buraye (2018) considered this mechanism to be an exogenous force that threatens the survival of miners because of its local commercial requirements: on the one hand, the mechanism restricts artisanal miners to sell their products only to declared buyers at the quarry level, and on the other hand, it creates additional bureaucratic costs for the miners, negatively impacting their earnings from the activity. For Buraye (2018), this reduction in earnings would be an incentive for artisanal miners to move to alternative activities or to move to other mining sites where this mechanism is not yet in place. In this context, the author found that commercial activities are more preferred by artisanal miners who intend to leave artisanal mining and move into alternative activities. Agriculture only comes fourth.

These two studies (Stoop et al., 2016 and Buraye, 2018) have in common the fact that respondents are already facing a (imminent) shock as a result of a political decision (the

revival of the industrial mining in the first case and the traceability system in the second case). Their choices may have been influenced by these shocks[118]. If miners had to choose alternative options because artisanal mining becomes impossible for geological reasons or because they voluntarily decide to abandon the sector, their answers might have been different. For example, when interviewing former miners who left the Kalimbi mine and moved into other activities, Buraye (2018) found that 74% had moved into agriculture, 10% were miners at other sites and only 8% had moved into commercial activities, although this was the most interesting activity for those intending to leave the sector because of the traceability mechanism.

Largely based on the methodology used by these two studies and inspired by the Sustainable Livelihoods Framework (SLF) presented in the first chapter, this chapter contributes to the understanding of the choice of alternative livelihoods by artisanal miners in South Kivu when faced with shocks/stress in artisanal mining. In contrast to these two studies, my analyses do not envisage the choice of alternative activities as a result of a political decision, but rather calls on artisanal miners to imagine the impracticability of artisanal mining due to geological reasons and to choose activities to which they can orient as a result of this shock (impracticability). Moreover, in addition to identifying possible alternatives as the two studies did, I put more emphasis on the choice of agriculture by analysing to what extent and by which category of artisanal miners it can be chosen. This is to fill the gap in the existing literature and to inform policy makers about the kind of people to whom they can offer farming as an option. This would prevent them from considering farming as an option for all artisanal miners as they often do.

My empirical analyses are based on the information from 268 artisanal miners of the Kalimbi mine in Kalehe territory located in South Kivu, the eastern DRC. Qualitative data collected from farmers and miners in Kalehe are also used. Kalimbi mining site and the data collection procedure have been presented in the general introduction. Data were analysed using a mixed approach. First, using qualitative data, I analysed different narratives about agriculture in order to understand how artisanal miners perceive agricultural activities. Next, I assessed and analysed the activities artisanal miners would like to move into if mining is no longer possible. To do so, I relied on survey instruments developed by Stoop, Verpoorten, and Buraye (2016) and Buraye (2018). Indeed, for their study, Stoop, Verpoorten, and Buraye (2016) developed a survey instrument in which existing livelihood activities (possible alternatives activities)

[118] For example, they may have thought that such a question was asked because there was already a plan to reorient them towards alternative activities.

were represented by images. Relying on this survey instrument, Buraye (2018) has added other activities adapted to the Kalimbi context. For my study, these images (see example in Figure 4.7, Appendices) were presented to artisanal miners who indicated which ones are of interest to them if mining is no longer possible. Through descriptive statistics I evaluate the choice of each activity and how interesting it is for artisanal miners. To understand which categories of miners may consider farming as an option, I did a comparison between those for whom agriculture is an option with those for whom it is not, based on certain characteristics. Using an econometric model, I assessed the determinants of the choice of agriculture as a post-mining option.

This chapter proceeds as follows. The first reviews the literature on the factors that influence the choice of a livelihood activity. The second analyses the dominant narratives on agriculture in Kalehe. As will be discussed below, these narratives are likely to influence artisanal miners to choose agriculture as an alternative livelihood option. In the third section, I analyse different activities which artisanal miners may prefer to engage in if artisanal mining is no longer possible. The fourth section analyses the determinants of farming as a post-mining option and the fifth section presents some concluding notes.

4.2. Literature review: Influencing factors in the choice of livelihood activities and the fictional expectation theory

Various empirical studies have identified factors that determine the choice of economic activities in the context of livelihood diversification (Schwarze, 2004; Rahman & Akter, 2014; Mackenzie, 2017; Belay, Recha, Woldeamanuel, & Morton, 2017; Alemayehu & Bewket, 2017; Gebru, Ichoku, & Phil-Eze, 2018; Agyei-Manu, Nimoh, Owusu-Peprah, & Kyerematen, 2020; Mandishekwa & Mutenheri, 2021). Recent studies include Mandishekwa and Mutenheri (2021) who analysed the choice of economic activities of households migrating to mining areas; Agyei-Manu et al. (2020) who studied the choice of alternative livelihoods by cocoa farmers to cope with the negative impacts of mining activities on cocoa production; Gebru et al. (2018); Alemayehu and Bewket (2017); Belay et al. (2017), who evaluated the choice of livelihood activities to cope with climate change in Ethiopia. From these studies, the choice of economic activity(ies) depends on institutional factors, the individual abilities and aptitudes as well as the individual socio-economic characteristics.

The majority of these studies focus on the factors that make an individual or a household decide to diversify into agricultural activities, non-agricultural activities or a combination of both (Mackenzie, 2017; Schwarze, 2004; Rahman and Akter, 2014; Gebru et al, 2018;

Alemayehu and Bewket, 2017; Belay et al., 2017). Studies on the factors that influence the choice of a particular activity as a result of a given livelihood shock are rather limited. A recent study in such context includes Andaregie & Astatkie (2021) who analysed the factors that determine beekeeping adoption by smallholder rural households in Northwest Ethiopia. Their study uses a binary logistic regression model on cross-sectional data collected from 369 rural households. Results revealed that beekeeping adoption is significantly determined by sex, marital status, household size, the educational status of the household head, number of extension visits, membership in a farmers' association, and access to credit.

Studies on the determinant of the choice of alternative activities by artisanal miners due to a shock in the mining sector are almost non-existent. A recent contribution comes from Mabe et al. (2021). Using cross-sectional data from 156 miners deprived of their livelihoods as a result of the mining ban in Ghana, the authors performed a multivariate probit model to determine the factors influencing these miners to adopt agriculture, trade or labour supply as a coping strategy. Overall, results show that the uptake of these activities is influenced by institutional factors, personal characteristics and location-specific factors. In this study, artisanal miners made their choice knowing that mining was momentarily suspended and could be re-authorised after a period of time (after the ban). Their choices might have been different if artisanal mining was permanently suspended and/or mining became permanently impossible.

The present study explored this second option in a different context. On the one hand, miners are required to choose desired alternative activities, not because artisanal mining has been (or will be) temporarily suspended as a result of a political decision, but rather, in a context where mining becomes permanently impossible due to geological reasons. On the other hand, miners' choice is made in the context of an uncertain economic environment. Indeed, defined as something that "is not fixed, not determined, vague, subject to change, ambiguous, or dependent on unpredictable factors" (Geenen, 2018, p. 31), uncertainty is one of the characteristics of my study area. Kalehe, like all other territories in the DRC, is characterized by uncertainty in the political, economic and security spheres, manifested, for example, by the continued presence of armed groups, shaky political coalitions and inflation (Geenen, 2018; Makutu & Tshimanga, 2014). In the mining sector, besides the price instability, the long-term expropriation and the ruin of social resources by militarized groups, conflicts surrounding mining have increased uncertainty and produced what James H. Smith called "a social world that is extremely confusing and in which it is impossible to know what is going to happen from one day to the next" (Smith, 2011, p. 22).

However, according to Beckert (2013), uncertainty complicates decision-making about the future. For this author, choices in an uncertain environment are based on the mental representations of future states (Beckert, 2011; Beckert, 2013; Beckert, 2016). Thus, making a choice involves evaluating possible courses of action with reference to a desired future state. In this case, an intentionally rational actor[119] relies on fiction, that is, "images of some future state of the world or course of events that are cognitively accessible in the present through mental representation" (Beckert, 2013, p. 220). These mental representations of future states are referred to as "fictional expectations".

Fictions are constructed as narratives coming either from stories, theories or speeches which have a temporal orientation and are able to influence the future (Beckert, 2011; Beckert, 2013; Beckert, 2016). For instance, based on the investment market, Beckert explains how stories influence the future because they have an effect on the investor's confidence. Relying on Akerlof and Shiller (2009) he argues that inspirational stories, stories about new business initiatives, and tales of how others are getting rich tend to increase confidence and thus to encourage more investment (Beckert, 2013; Beckert, 2011).

Based on this fictional expectation theory, I assume in this chapter that the choice of agriculture as an alternative by artisanal miners might, in addition to the socio-economic-institutional factors raised above, be influenced by the dominant narratives about agriculture-based livelihoods. By enabling miners to project what they would be like if they were farmers, these narratives would influence or discourage them from choosing farming as an alternative option.

In the following section, narratives about agriculture livelihood in Kalehe are analysed from two perspectives. On the one hand, the place (consideration) that the population of Kalehe gives to agriculture in relation to other activities is analysed. On the other hand, artisanal miners are led to compare their living standards and working conditions with those of farmers. These perspectives will help to understand the mental representation of artisanal miners on agriculture.

4.3. Dominant narratives about agriculture livelihood in Kalehe

In this section I analyse the views on agriculture in relation to other activities in Kalehe. I draw on qualitative data from 23 individual interviews and 13 focus groups with the community of Kalehe. These are different categories of miners (those extracting rocks, those

[119] Beckert defines an intentionally rational actor as the one who needs to increase his/her utility but is perplexed as to the strategy to adopt in order to achieve his/her goal (Beckert, 2013).

supervising the work, those processing the ore, and so on), farmers, service providers, and community leaders. I also draw on quantitative data collected from 268 artisanal miners.

4.3.1. Agriculture is an important but low-income activity as compared to artisanal mining

Participants in the individual interviews and focus groups were asked to list the activities that are practised in their community, to rank them in terms of importance and to justify this ranking. Overall, agriculture was often ranked first. From this classification, I noted four dominant sets of narratives on agriculture in relation to other activities in Kalehe. While the first three can encourage the choice of agriculture, the last one is rather sceptical.

First, agriculture is perceived as a traditional activity that should never be neglected because it is the basis for investment in other activities. As noted in the quotes below, its traditional nature is justified by its consideration as the main activity which has been practised by the ancestors and handed down from generation to generation. The soil of the area being favourable for agriculture, the latter is perceived as having spurred the emergence of other economic activities.

> "*Our soil has a high fertility which is favourable to all crops. Our ancestors only lived from agriculture, especially bananas and cassava, and we have continued like this and it has become our economy […]. Every tradesman comes from agriculture [...]. In fact, agriculture is the basis of all the activities that are practised here. That's why you will find that the people who have big houses here, they started in agriculture. If we look for persons with better life today, we will find out that they are tradesman! But, if you look closer, you will find that agriculture is at the basis of their trade activity.*[120]"

The excerpt from the life story of this farmer who is also a pit owner illustrates how income from agriculture can facilitate the emergence of other activities.

> "*That's how I started [artisanal mining]: I harvested cassava in my field. The income from this harvest is what got me started. [with this income] I first started by buying cassiterite waste which I washed and extracted some cassiterite from it. This inspired me to buy my own pit. I used this money to buy a pit, buy the artisanal miner card and the SAESSCAM card. And until today I am a pit owner*[121]".

[120] Focus group with farmers in Minova
[121] Interview with a lady, farmer and pits manager in Kalimbi

Within this first view, the importance of agriculture is also justified by its capacity to favour investments. Many respondents attested to having been able to invest income from farming in schooling for children and paying for health care, as well as in the purchase of various assets such as livestock.

> "*For example, me! I am a farmer. It is in agriculture that I find the money to pay for the children's schooling and the food for the whole family. It is thanks to agriculture that I bought a goat for the first time and it is still thanks to agriculture that I managed to buy a cow"*[122].

Second, in comparison with other activities practiced in Kalehe (and more specifically artisanal mining), agriculture is described as offering a degree of independence to its practitioners. As can be noted from the quotes below, this independence is justified by the fact that farmers are seen as their own bosses who are not accountable to anyone and who know the exact time of the harvest when they can get money. Miners on the other hand, not knowing when they will reach the production phase, resort to debt to support their activity and thus become dependent on their lenders.

> "*If you are a farmer or herder, you cannot quarrel with someone saying: 'you did this... you did that...', no; whether you succeed or fail, you know that you depend on yourself. People in some other activities [referring to mining and trading] sometimes get into debt and go bankrupt! They are forced to sell their houses, putting all their families in trouble.*[123]"

> "*[...] They [farmers] are not like miners; miners go to the quarry but they don't know when they will find the minerals. In contrast, once they sow, farmers only wait for the day when they will harvest. That day can be after 3 months or even after a year. The farmer knows the time he will harvest, while a miner does not know the day when he will find minerals [...] It depends on luck.*[124]"

While justifying the independent nature of agricultural activities, these narratives also highlight the uncertain nature of mining and farming activities. Artisanal mining is described here as more uncertain because miners do not know exactly when they will hit the mother lode. However, even though farming is unpredictable due to climatic and/or weather

[122] Interview with the chief of the Nyabibwe Centre (*Chef de centre de Nyabibwe*)
[123] Focus group with farmers (cassava producers) in Nyabibwe
[124] Focus group with transporters in Nyabibwe

disturbances (see below, fourth set of narratives), farmers are described as knowing exactly when they will harvest and adjust their actions and consumption accordingly.

A third narrative describes agriculture as an important food provider, which is unavoidable because it ensures the household survival more than other income-generating activities. One reason for this is that it produces food. Even without income from other activities, a farm household cannot starve because it can always consume its agricultural produce. This is reflected in statements such as:

> "*Agriculture is the backbone*[125]"; "*Even a trader cannot work without eating*[126]"; "*You can produce even 10 tons of cassiterite but you will never eat it [whereas farmers can eat their produce]*[127]"; "*Even a herder cannot keep his livestock without eating [...] so there is no activity that can evolve without agriculture*[128]"; "*Everyone lives on food*[129]". "*A farmer can lack money but he cannot lack food; while those who do other activities if they don't have money, they can starve*[130]."

The fourth set of narratives describes agriculture as producing a relatively low and irregular income which cannot support the household throughout the year. Irregularity here refers to the time lag between sowing and harvesting, period during which farmers get almost no income from the field. However, being aware of such situation, farmers develop strategies to maintain their livelihood. As noted from the quotes below, diversifying into other income generating activities is one of such strategies (see Chapter II as well).

> "*Even if you cultivate, if you don't do petty trade, it's nothing! because you don't harvest in the same year that you cultivated. That's why we are in several activities to support the household all year round*[131]."

> "*We cannot put all our trust in agriculture only because you don't harvest the day you sow. We have to have a small business that will allow us to survive while waiting for the harvest*[132]."

While these quotes describe the diversification of income sources as a strategy to cope with the time lag between planting and harvesting, they also highlight the uncertainty this time lag

[125] Focus group with farmers in Minova
[126] Interview with the chief of the Nyabibwe Centre (*Chef de centre de Nyabibwe*
[127] Focus group with landowners in Nyabibwe and Mukwidja
[128] Focus group with farmers in Nyabibwe
[129] Interview with a herder from Nyabibwe
[130] Focus group with farmers (potato producers) in Nyabibwe
[131] Interview with a lady, farmer and pits manager in Kalimbi
[132] Focus group with leaders of women's associations in Nyabibwe

creates for farming activities. In fact, the unavoidable dependence of agricultural activities on the natural environment[133] which is the basis of this time lag, renders agricultural activities financially risky and uncertain. On the one hand, in the production process, inputs have to be committed well in advance. When farmers discover that production is (or will be) lower than expected or that its value is lower than it was supposed to be, they have little or no possibility to reverse input decisions. They might therefore incur higher expenses for a low production. On the other hand, in the marketing process, farmers have little flexibility to avoid marketing their production in times of low demand. Indeed, dependence on the natural environment and the timing it imposes on agricultural production means that harvesting takes place at the same time for almost all farmers. This can result in high supply and low demand during the harvest period, leading to low prices and income for farmers. Farmers can only avoid marketing their produce in times of low demand if they have access to storage facilities (see chapter II). And even if storage is possible, it always comes at an additional cost. Thus, although farmers know exactly when the harvest will take place, farming activities remain uncertain because events or situations that may occur between the sowing and harvesting period are uncontrollable and often irreversible.

This relatively low and uncertain income leads some artisanal miners in Kalehe to debate what was mentioned in the first set of narratives. Even though they recognize the ability of agriculture to favour investment, they argue that due to its low income, this should take a long time as compared to artisanal mining.

> "*Thanks to mining, you can buy a field or a house, but as far as I know, to buy a vehicle or a motorbike thanks to agriculture, it really takes a lot of time*[134]."

Some even go so far as to mock farmers by saying that they work hard for nothing because they will never become rich on farm income. The efforts they make working in the fields are considered to be worthless. They are therefore compared to someone who buries his feet while alive, that is, who gets stuck in an activity knowing that it will not help him to move forward.

> "*We who use the hoe [referring to cultivator] are mocked, [saying:] 'when will this one become rich?'. They say that we bury our feet while we are still alive*[135]!".

In the existing literature, opinions about agriculture are raised either when analysing its linkages with artisanal mining or when agriculture is analysed as an alternative to artisanal

[133] The vegetative cycle of many crops is defined by the natural cycle of daylight and temperature which is often beyond human control
[134] Focus group with artisanal miners of Kalimbi
[135] Focus group with farmers (cassava producers) in Nyabibwe

mining. While this literature describes farming as a complement to artisanal mining in terms of food provision (see chapter III), it also sees farm income as low and irregular, not allowing farmers to make ends meet (see for example Perks, 2011a; Banchirigah & Hilson, 2010; Aizawa, 2016; Prescott, et al., 2020). The analysis of my qualitative data confirms this literature and provide a more nuanced or detailed categorization of these opinions.

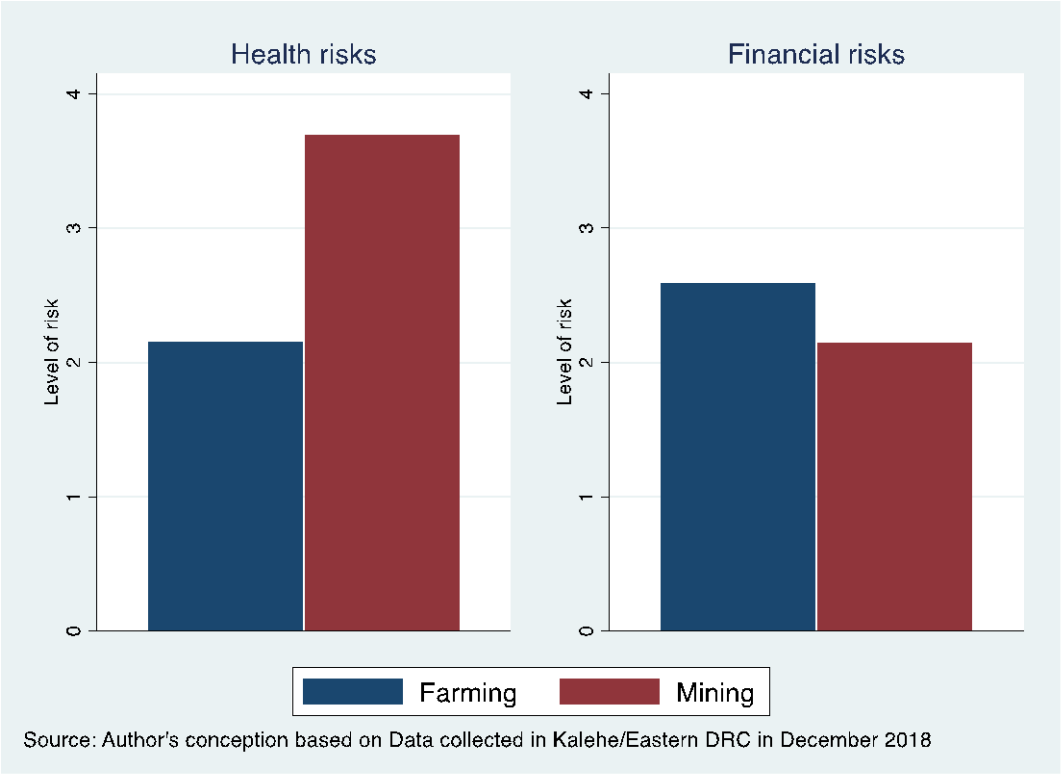
The first three sets of dominant narratives that I have just illustrated extol the importance of agriculture as a basis for investing in other activities, a food provider and an independent activity. These are the narratives that may bring artisanal miners to imagine themselves as farmers if they ever abandoned mining. On the contrary, the last set of narratives are rather discouraging. They fall in the explanations of Perks (2011) according to which *"[r]emuneration and earning schedules are commonly cited as key considerations by artisanal miners with which smallholder agriculture in most instances cannot compete*" (Perks, 2011a, p. 1121), or of James Smith who noted that in the Kivus people choose to abandon agriculture in favour of artisanal mining because "*they need money quickly and cannot wait six months to a year for the harvest to come to fruition*" (Smith, 2011, p. 29). These narratives also highlight that both agriculture and artisanal mining are characterised by uncertainty and can therefore be risky[136]. In the following sub-section, I analyse the views of artisanal miners on the health and financial risks associated with farming compared to artisanal mining.

4.3.2. Agriculture is a less health risky but more financial risky activity as compared to artisanal mining

To deepen my understanding of the consideration given by artisanal miners to agriculture and thus understand how they might imagine themselves as farmers, artisanal miners were asked to rate, on a scale of five[137], the health and financial risk associated with agriculture and artisanal mining. Artisanal miners believe that their activity presents more health risks than agriculture while the latter presents more financial risks than artisanal mining (see Figure 4.1 below).

[136] Geenen (2018) clearly distinguished between risk and uncertainty. The former is described as something that can be controlled and mitigated while the latter cannot be controlled.
[137] No risk, Very few risk, Little risk, A little more risk, A lot of risk

Figure 4.1 Level of health and financial risks associated with farming and mining



0= No risk
1= Very few risk
2= Little risk
3= A little more risk
4= A lot of risk

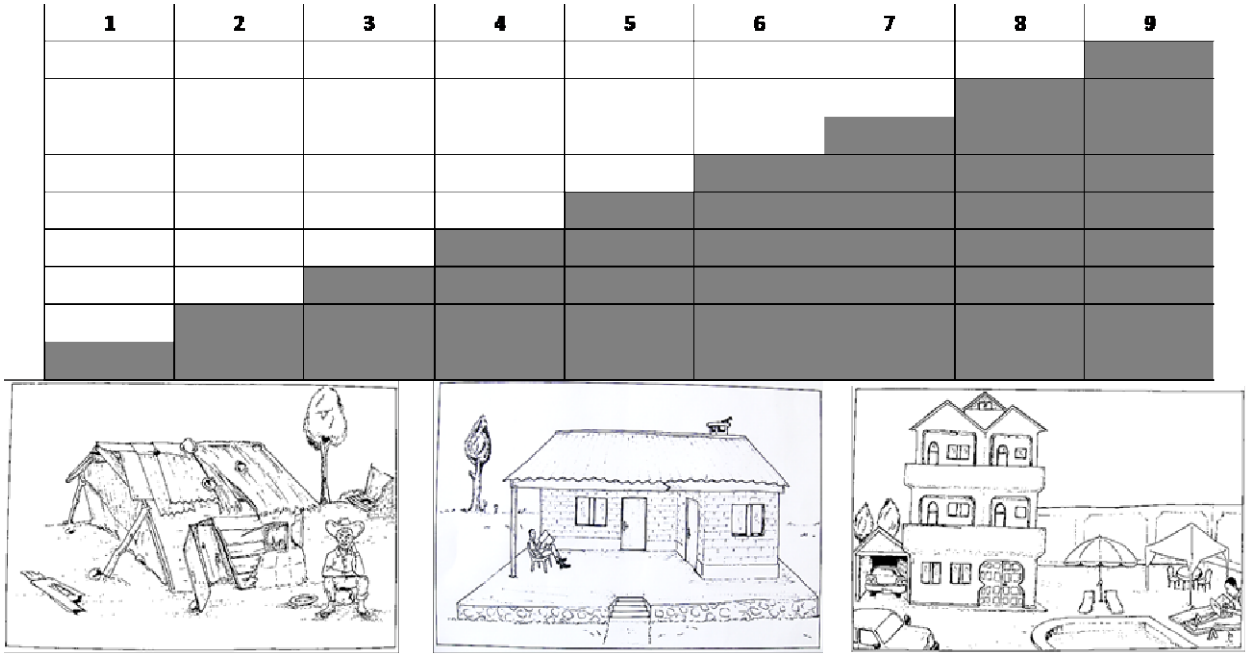
It appears that artisanal miners are aware of the health risks that their activity can present. Indeed, unlike farming, artisanal mining is often described as unsafe, characterized by many injuries and fatal accidents due to shaft collapses, landslides, poor ventilation and inadequate work space, exposure to dust, mercury, fumes, child labour and lack of gender awareness (see for example: Perks, 2011b; Aizawa, 2016; Verbrugge and Besmanos, 2016; Nkuba, Bervoets, and Geenen, 2019). On the other hand, considering that agriculture presents more financial risks is in line with the fourth set of narratives presented above. It could therefore be explained by the fear of unpredictable events that can occur during the important time lag between sowing and harvesting. This does not mean, however, that artisanal mining does not present financial risks. For instance, as I mentioned in the previous lines, artisanal miners are often heavily indebted in the hope of achieving better production to pay off their debts. This is also risky because they cannot predict or specify the day when they will reach the production

phase. Also, they are price-taker[138], relying on the international price which can fluctuate any time (Perks, 2011a).

4.3.3. "Farmers are persevering than us": comparing the living standard

Artisanal miners were also asked to compare their living standard[139] with that of farmers. To do so, they had to situate farmers on an image representing the ladder of life with three standards of living subdivided into nine levels (see Figure 4.2 below). The first to the third levels represented the first standard or the poverty level, the fourth to the sixth level represented the average level and the seventh to the ninth level represented the high level or the richest level. Artisanal miners then had to say what level they think most farmers are at, the minimum level or the level below which farmers cannot be found, and the maximum level or the level beyond which farmers cannot be located. This exercise was also done for themselves, i.e., the level at which most artisanal miners find themselves, their minimum level and their maximum level.

Figure 4.2 Presentation of the ladder of life



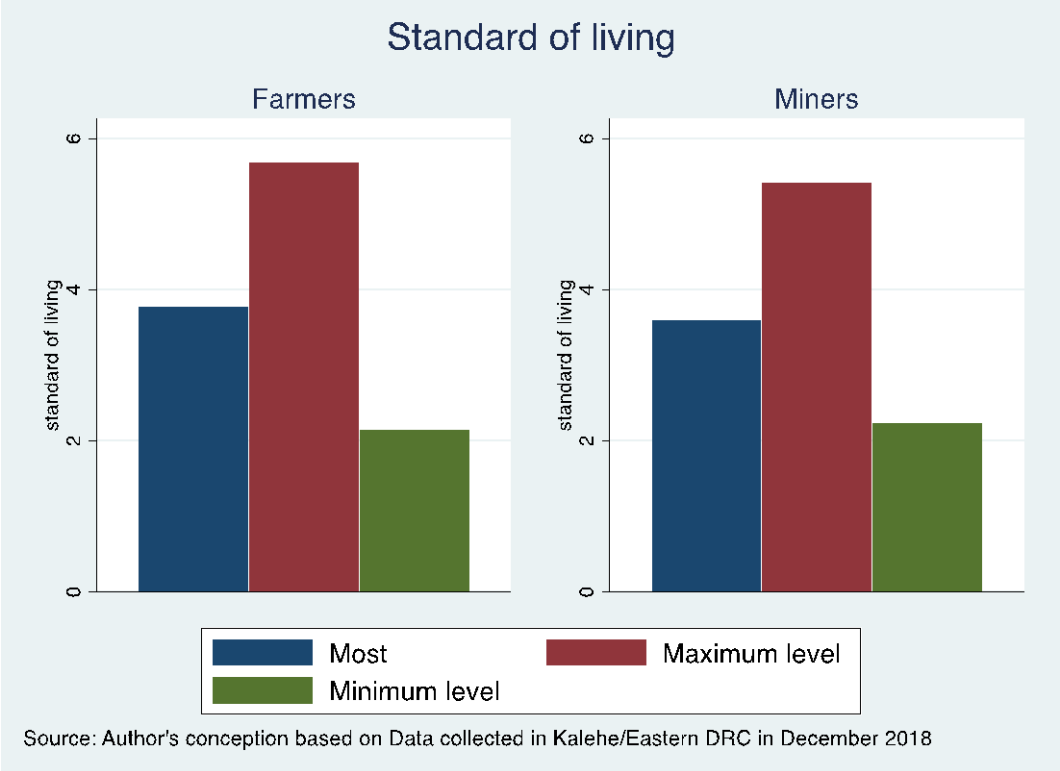
Source : Stoop et al. (2016)

A closer look at Figure 4.3 below shows that artisanal miners tend to attribute a slightly higher

[138] They have no influence on international pricing
[139] Standard of living here was taken in its proper sense as defined by the Oxford Languages as "the quality of housing, material comfort and wealth enjoyed by an individual or group".

standard of living to farmers than their own. On average, most farmers are considered to be located at level 3.7 and most miners at level 3.6. Likewise, the highest level that can be achieved by farmers is reported to be 5.6, while it is 5.5 for artisanal miners. Thus, artisanal miners believe that both farmers and miners cannot reach the richest level (seventh to ninth). However, it is estimated that farmers may be poorer than artisanal miners because the minimum level they can reach is slightly lower than that which can be reached by artisanal miners (2.1 compared to 2.2 on average).

Figure 4.3 Comparing the living standard of farmers and miners



Source: Author's conception based on Data collected in Kalehe/Eastern DRC in December 2018

Considering that farmers have a high living standard than artisanal miners is surprising. It seems to contradict what has been developed in the fourth set of narratives, where farmers were considered to be stuck in an activity that will not help them to move forward. To explain this surprising result, artisanal miners refer to their pattern of spending. As presented in the quotes below, although artisanal miners recognized their ability to invest more, they highlight the fact that they do not invest because they misspend their income in the hope to earn daily. In contrast, farmers are described as persevering people who have a low income but save and invest more:

> "*Mining brings fast money, and artisanal miners expect a daily income, therefore he has to consume everything he has earned today because he will still earn in the evening or tomorrow [...] miners only think about eating and drinking but never about*

investment [...] miners earn more money than farmers but they live in straw houses... farmers are smarter because they suffer to get their money but plan deeply its allocation[140]."

"*If we look at their income, we can say that farmers are trying very hard. They earn a little, but they do more. In general, many of them live in metal sheet houses (...) and they don't drink; I, for example, if I earn 100 USD in the morning, in the evening I won't even have 10 CDF, I know I'll come back tomorrow to get another 100 USD*[141]."

"*He (the miner) only plans what he will eat, what he will drink, but he does not think about the investment*[142]"

These quotes describe the phenomenon of "hot money" or "bitter money" already identified for artisanal mining elsewhere in Africa (Walsh, 2003; Geenen, 2016; Mkodzongi & Spiegel, 2019). While money from agriculture is seen as more sustainable, the phenomenon of 'hot or bitter money' refers to the situation where, rather than being invested in sustainable assets or serious activities, artisanal mining money is consumed in 'bold' ways to satisfy immediate needs. That is why in Kalimbi, farmers are considered to mostly have beautiful houses, educate their children and give the impression of earning more than artisanal miners.

Artisanal miners noted that all living standards can be found in both groups. This may be due to the strong heterogeneity within the group. Within the artisanal miners' group, there are categories that are predisposed to having a higher income and higher living standard than others. For instance, as presented in the Table 4.1 below, while team leaders and supervisors earn more (123.32USD and 71.0USD respectively in an average week) than ordinary miners (54.8USD in an average week), they also feel they have a higher standard of living (5.0 and 4.0 respectively) than ordinary miners (3.5). Similar results were found by Geenen, Stoop, & Verpoorten (2021) for the case of Kamituga in Mwenga territory where the pit managers, right hand miners and experts earn more and have a higher standard of living than the *pelleteur* (see Table 4.1 below). Within the farmers' group, as mentioned in chapter II, there are on the one hand landowners and on the other hand landless smallholder farmers. Their initial predispositions are such that income and investments in the two groups cannot be the same[143].

[140] Focus group with artisanal miners_2 of Kalimbi
[141] Focus group with artisanal miners_1 of Kalimbi
[142] Focus group with artisanal miners_2 of Kalimbi
[143] See, for example, factors that negatively impact farm income when landless smallholder farmers resort to land contract in chapter I

This is why the former can reach the third level while the latter are in majority at the first and the second level[144].

Table 4.1 Artisanal miners' earnings (USD) and the estimated living standard, by function

Kalimbi/Kalehe						Kamituga/Mwenga					
Function	Obs	Mean	Sd	Min	Max	Function	Obs	Mean	Sd	Min	Max
Artisanal miners' earnings in a normal (average) week											
Team leaders	31	123.2	142.2	9	500	Pit Manager	42	191	195	15	717
Supervisors	59	71.0	92.3	0	438	Right hand	77	92	88	7	500
Miners	143	54.8	65.1	0	438	Expert	133	52	51	7	167
Other	11	67.6	85.9	9	300	Pelleteur	201	24	26	1	167
Estimation of own living standard (position on the ladder of life 1-9)											
Team leaders	31	5.0	1.60	1	9	Pit Manager	42	4.8	1.6	2	9
Supervisors	66	4.0	1.38	1	7	Right hand	77	4.0	1.0	2	7
Miners	160	3.5	1.24	1	8	Expert	133	3.4	1.0	2	6
Other	11	4.4	1.91	2	9	Pelleteur	201	2.9	1.2	1	7

Source : For Kalimbi, author's data collected in Kalehe; For Kamituga, Geenen et al. (2021)

To sum up, the objective of this section was to present and analyse the dominant narratives about agriculture in order to understand how artisanal miners may imagine it in their future (their fictional expectations). According to the analyses above, while some narratives are encouraging, others are more sceptical and may hinder the choice of agriculture as a post-mining alternative option. In the imagination of artisanal miners, agriculture is depicted as an activity that presents more financial risk and less health risk. For them, it is true that farmers have a low income; but, being persevering and smart, they may have a slightly higher standard of living than theirs. With these fictions, can artisanal miners imagine themselves as farmers if artisanal mining becomes impossible? In the next section I analyse the different livelihood activities which artisanal miners may prefer to engage in if artisanal mining is no longer possible.

4.4. In what activities do artisanal miners imagine themselves in a future without artisanal mining?

As pointed out in the data analysis strategy section, to answer this question I have used images designed by Stoop et al (2016) and readapted by Buraye (2018), which include the different possible alternatives. I first asked the respondent to choose all the activities he/she thinks he/she can do in the absence of artisanal mining and to put them aside. I then asked, if he/she

[144] Focus group with artisanal miners_1 and artisanal miners_2 of Kalimbi

must choose only 3 of these activities, which ones he/she would choose, ranking them according to their importance. I explained that the first choice should be the most important for him/her, followed by the second choice which he/she can undertake if the first is not available and, the third choice if his/her first two choices are not available.

With this method, my results likely suffer from the hypothetical bias. This is because the method rather presents the stated preferences of artisanal miners instead of their real choices. Indeed, as the empirical evidence suggests, stated preferences are mostly hypothetical, as individuals give preferences that they do not necessarily choose in a real situation (Stevens, Tabatabaei, & Lass, 2013). This is even demonstrated by the aforementioned study by Buraye (2018), in which commercial activities were the preference of most miners, whereas when faced with a real choice, they overwhelmingly chose agriculture.

According to the results (see Table 4.2 below), commercial activities seem to be more appealing as first (38.7% of respondents), second (41.3%) and third choice (44.2%). These activities include opening a small shop, selling products in the market, becoming a street vendor, opening a pharmacy, a bar (bistrot) or a restaurant.

Table 4.2 Choice of alternative livelihood activities (% of respondents)

Activities	Choices		
	1st	2nd	3rd
Small shop	16.79	15.67	9.32
Market activities	16.04	13.05	11.19
Street vendor	1.86	1.11	4.1
Pharmacy	1.86	2.61	2.23
Bar (Bistrot)	1.49	2.23	1.86
Restaurant	0.74	6.71	4.47
Total commercial activities	**38.78**	**41.38**	**33.17**
Farming	15.67	11.94	11.94
Animal husbandry	11.1	11.19	10.82
Fishing	0.74	2.23	1.49
Total agriculture-based activities	**27.51**	**25.36**	**24.25**
Taxi-moto	8.2	9.7	12.68
Car mechanic	8.2	6.71	5.97
Construction worker	1.86	2.61	5.59
Carpenter	1.11	4.1	2.98
Tailor	1.11	2.23	1.49
Barber	1.11	1.11	1.49
Welder	0.37	1.86	0.37
Porter	0.37	0	0
Charcoal making	0	0.37	0.37
Total technical activities	**22.33**	**28.69**	**30.94**
Worker at iTSci	5.97	2.61	6.71
School	4.85	1.86	4.1
Rebel	0.37	0	0.74

Source: Author's conception based on data collected in Kalehe/Eastern DRC in December 2018

In the focus groups, some artisanal miners reported that commercial activities are interesting because, like artisanal mining, they produce a daily income. For them, the only obstacle would be the start-up capital. But, if this were available, the best alternative would be trading.

> "*The alternative par excellence is trade. It is trade that can bring us frequent income like mining. We can't wait for the time it takes for agriculture to produce an income. It's only because we don't have the start-up capital, otherwise trade is better*[145]".

This quote documents how the fourth set of narratives on agriculture discussed above can discourage the choice of agriculture as an alternative: some artisanal miners are not perceptive enough to endure the time lag between sowing and harvesting to get the agricultural income.

[145] Focus group with artisanal miners_2 of Kalimbi

The quote also confirms Perks' (2011) analysis that the earning schedule in agriculture is one of the barriers that lead artisanal miners to consider supplier businesses and trade as appealing alternatives.

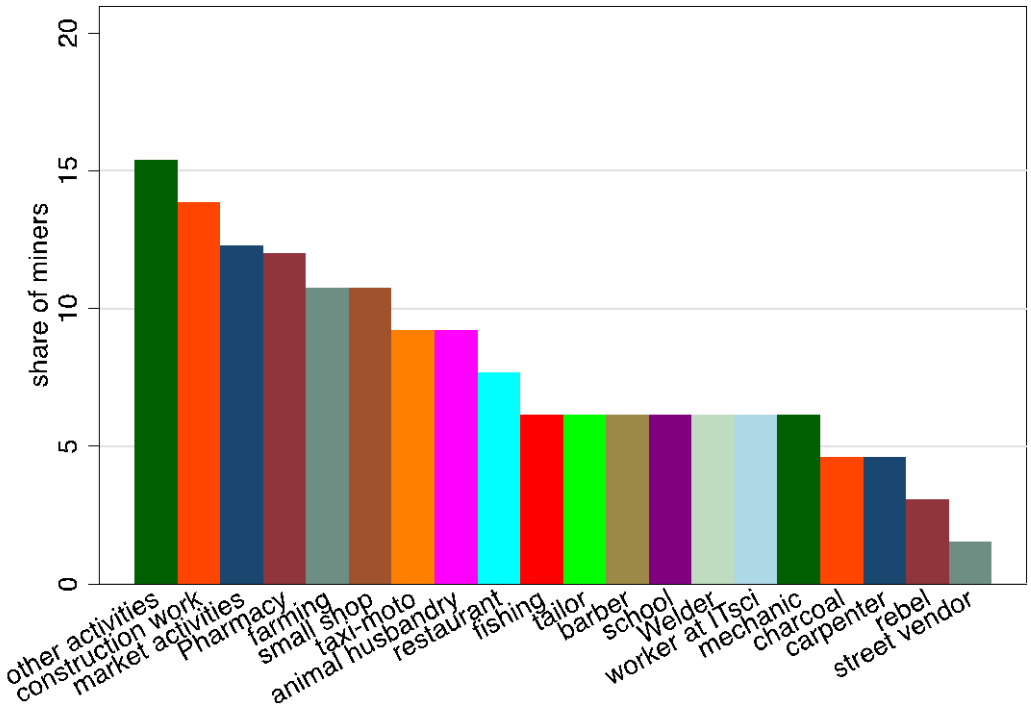
Technical activities also seem to attract artisanal miners as first (22.3%), second (28.6%) or third (30.9%) choice. In line with the results of Stoop et al. (2016) and Buraye (2018), motorbike taxis and car mechanics are the most preferred technical activities. In the context of Ghana, Tschakert (2009) cited taxi driving, car fitting, masonry and carpentry among the favourite alternative options for artisanal miners. A report by Mime Consult Ltd (2002) analysing the preference of artisanal miners towards alternative activities in Ghana, also noted that miners would be interested in acquiring skills in technical activities such as carpentry, driving and tailoring. In Kamituga, Geenen (2016), citing one of her respondents, noted that motorbike taxi is perceived as a prestigious activity by young artisanal miners because it helps to attract girls. At this time, bikers' earning was estimated between 50USD and 100USD per day. Thus, girls were attracted by bikers and thought that "marrying a biker is the supreme good" (Geenen, 2016, p. 99). In analysing the Kalimbi data, indeed, the results show that artisanal miners who choose the motorbike taxi activity as an option are significantly younger than those for whom this activity is not an option. The average age of the former is 35 years, while the latter have an average age of 39 years. The difference is statistically significant ($p<0.05$).

Agriculture-based activities are attractive for a certain number of artisanal miners. These activities include farming, animal husbandry and fishing. As first, second or third choice, agriculture-based activities can be an option for 27.5%, 25.3% and 24.2% of artisanal miners respectively. This is consistent with the results by Tschakert (2009) and Mabe et al. (2021) in the context of Ghana. While Tschakert (2009) mentioned poultry farming and palm oil farming as the most popular options for artisanal miners, Mabe et al. (2021) identified farming as the major alternative livelihood coping strategy for miners faced with the mining ban. In South Kivu, while the results of Stoop et al. (2016) and Buraye (2018) ranked agriculture as the sixth and fourth most interesting activities for artisanal miners respectively, my results show that if miners have to abandon artisanal mining because it becomes permanently impractical, farming is ranked third among the most appealing activities (15.6% of respondents) after small shop (16.7%) and market activities (16%) (see Table 4.2 above).

A part from these three choices, I also asked respondents if there are other activities that he/she could consider performing among those he/she has set aside or even those that were not on the images. Thus, 24% of respondents specified a fourth choice. While construction activities,

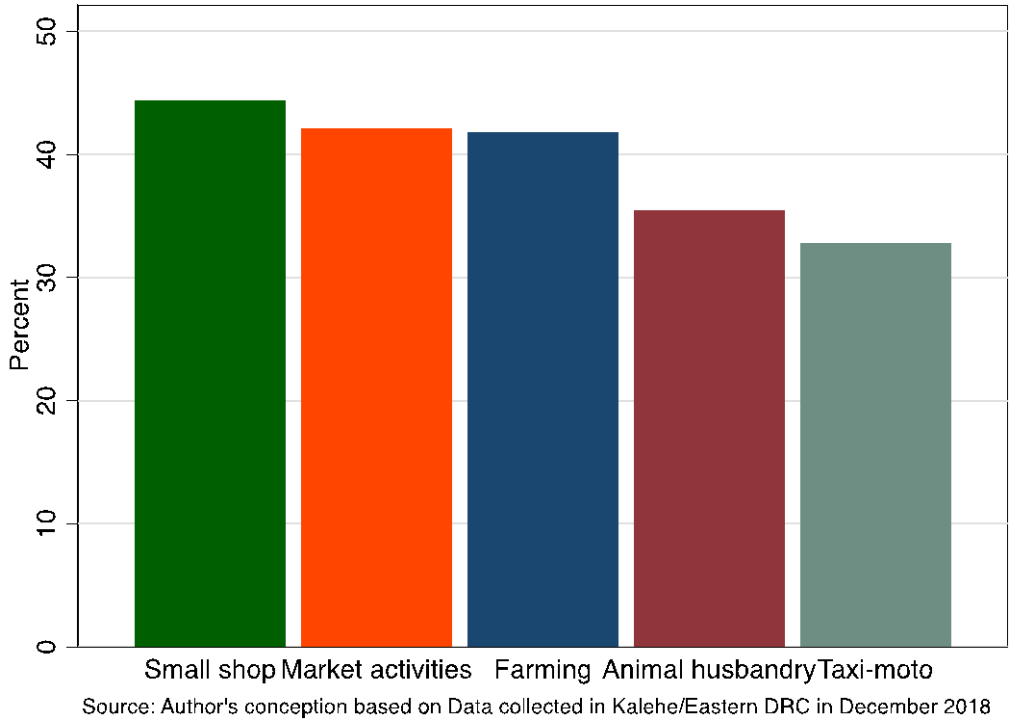
market activities and opening a pharmacy were more mentioned, agriculture and small shop were cited by 21.54% of them to the extent of 10.77% each (see Figure 4.4 below).

Figure 4.4 Selected activities in the fourth round (only 24% of respondents)



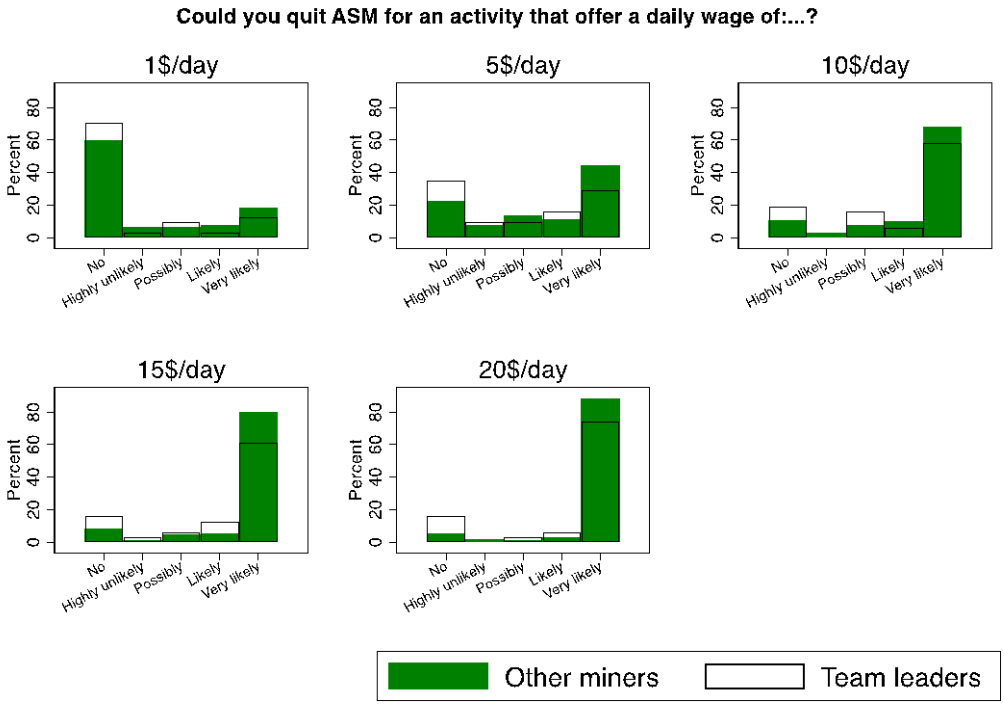
To sum up, if we take into account the first, second, third and fourth choices, it appears that the five most interesting option are small shop (44% of respondents), market activities (42.1%), farming (41.7%), animal husbandry (35%) and taxi-moto (32%). These are activities that can be an option (whether first, second, third or fourth choice) for more than 30% of respondents (see Figure 4.5 below).

Figure 4.5 Five most interesting alternative options



Wanting to know what salary artisanal miners would expect in these different activities, I tried to analyse their reservation wages. This is the "the minimum wage needed to make an artisanal miner switch from artisanal mining to another economic activity" (Stoop, Verpoorten, & Buraye, 2016). To the question: "*Could you quit ASM for an activity that offer a daily wage of ...*", my results (see Figure 4.6 below) show that unsurprisingly team leaders are more demanding than other miners. In effect, an activity that offers $1 a day is very likely to attract only 13% of the team leaders and 18% of the other miners. As the amount increases, so does the proportion of miners who are likely to be attracted. Thus, for an activity that offers $20/day, up to 89% of other miners and 74% of team leaders are very likely to be attracted.

Figure 4.6 The reservation wages



Source: Author's conception based on Data collected in Kalehe/Eastern DRC in December 2018

In view of these results, if the reservation wage were the only determinant of the choice of activities, many activities would not be an option because they offer a low wage. Indeed, the 1-2-3 survey in the DRC estimated the monthly income of the agricultural sector at USD17, USD20 for informal business, USD62 for formal business and USD25 for public administration[146] (Mukotanyi, 2012, p. 53), amounts that are much lower than the reservation wage of artisanal miners.

To remain within the objectives of this chapter, in the following section I analyse the choice of agriculture as one of the options (first, second, third or fourth choice). Based on certain characteristics, a comparison is made between artisanal miners for whom agriculture is an option and those for whom it is not. Then, using a *probit* regression model, I analyse the factors that are likely to influence the choice of agriculture as an option.

4.5. Choosing agriculture as an alternative livelihood: characteristics and determinants

From the above, we have just seen that agriculture can be considered as an option by 41.7% of respondents. In the focus group discussions with artisanal miners, three main arguments are put forward to justify this choice. Firstly, as pointed out by this artisanal miner, many of them are artisanal miners and farmers at the same time. If one of the activities is no longer

[146] Data from Ministère du Plan (2008), 1-2-3 Survey (2004-2005)

possible, they would find it easy to concentrate on the other. This shows, as discussed previously, how artisanal mining is part of rural livelihoods activities.

> "*Many of us are miners and farmers at the same time […] if one activity doesn't work, they stay in the one that works [...]".*

Secondly, consistent with the second set of narratives developed above, artisanal miners recognized that agriculture is important because it provides food for the entire population. Thus, some miners have argued that for the survival of their households they can only return to agriculture:

> "*Someone who has ten or fifteen children, how is he going to feed them? it is only by cultivating [...] agriculture is the basis, it is the 'mother activity'*[147]*. [With agriculture] you can lack everything except food. That is why we can only choose agriculture*."

Lastly, for some artisanal miners, the presence of artisanal mining is the main reason why agriculture is neglected; therefore, its absence will lead people to undertake agriculture.

Artisanal miners for whom farming is not an option cited low and irregular farm income as the main barriers to considering agriculture as an option[148]. This is in line with the fourth set of narratives as well as Perks' (2011) findings presented previously.

If I can formulate hypotheses based on these different arguments put forward by artisanal miners and the different set of narratives developed earlier, I can postulate that the choice of farming as an alternative option is likely to be positively influenced by: (1) the presence of agriculture among the activities practiced in the miner's household; (2) the miner's household size (more mouths to feed); and, (3) the level of income that an artisanal miner assumes that farmers earn. These three assumptions will constitute my variables of interest. In the following sub-section, I contrast the profile of artisanal miners for whom farming can be an option with those for whom it is not an option.

4.5.1. Comparing miners for whom farming is an option with miners for whom it is not an option

Regarding their socio-demographic characteristics, miners for whom farming is an option are significantly different from those for whom farming is not an option in terms of educational

[147] The term 'mother activity' is a French translation of '*activité-mère*' in reference to the '*alma mater*' or 'nurturing mother'. In everyday language, the word 'mother' is generally associated with an object to designate the starting point (e.g., mother-house, mother-school, ...) and to mean that whatever one becomes, one must always refer to this starting point.

[148] Focus group with artisanal miners_1 and artisanal miners_2 of Kalimbi

level, household size, the number of children, place of birth and ethnicity. In fact, as can be seen in the Table 4.3, the household size, the percentage of artisanal miners with more than 5 children, those born in rural areas and those belonging to the Hutu ethnic group[149], who are willing to choose agriculture as an option is significantly higher than the percentages of those for whom agriculture is not an option (8.2 vs 7.5; 60.7% *vs* 47.4%; 95.5% *vs* 87.2% and 51.8% *vs* 28.2%, respectively). There are no significant differences in their age, marital status, gender, and religion.

[149] Hutu is the dominant ethnic group in the area

Table 4.3 Comparing miners who consider farming as an option and those who don't

	option (n=112)	Not an option (n=156)	
Socio-demographic characteristics			
Age	38.1	37.9	
Male (%)	97.3	96.8	
Education level<secondary school diploma (%)	91.1	78.8	***
Live with a partner (%)	94.6	89.7	
Household size	8.2	7.5	*
The miner has more than 5 kids (%)	60.7	47.4	**
The miner was born in a rural area (%)	95.5	87.2	**
The miner is of Hutu ethnicity (%)	51.8	28.2	***
The miner is protestant (%)	41.1	41.0	
Household economic characteristics			
Dependency ratio	2.5	2.9	
Number of economic activities	2.2	2.0	**
Total hh income in a normal week (USD)	100	99	
Physical asset ownership quintile	2.8	3.1	*
Livestock ownership quintile	3.0	2.9	
Nr of owned arable fields	2.0	1.9	
Miner's experience in artisanal mining			
Years of experience in AM	11.5	9.7	*
Position (function) in the pit			
Team leader or PDG (%)	10.7	12.2	
Conducteur and supervisors (%)	29.4	21.1	
Miner (%)	56.2	62.1	
Other function (%)	3.5	4.4	
Production phase			
No production (period of suffering/*Kangumbu*)	53.6	46.2	
Small production	40.2	39.7	
High production	5.4	9.0	
Other	0.9	5.1	*
Working contract			
Know the term of their contract (%)	83.9	80.1	
Don't know the term of their contract (%)	16.1	19.9	
Contribution of AM to the hh income (USD)	64	71	
Miner's agricultural experience			
Agriculture in household activities (%)	74.1	50.6	***
At least one of the parents is(was) a farmer (%)	89.3	80.1	**
Fictions about agriculture			
Living standard of most farmers	3.8	3.8	
Agriculture carries no (or little) health risk (%)	62.5	57.7	
Agriculture carries no (or little) financial risk (%)	44.6	36.5	

*p<0.1, **p<0.05, ***p<0.01

Source: Author's conception based on Data collected in Kalehe/Eastern DRC in December 2018

In terms of their economic characteristics, it should be noted, that the number of economic activities carried out in the households of miners for whom farming is an option, is

significantly higher than for those for whom farming is not an option (2.2 vs 2.0 respectively). On the other hand, miners who imagine themselves as farmer in the future own fewer physical assets than their counterparts. Differences observed in other economic variables such as the dependency ratio, the household income, livestock and arable land ownership are not statistically significant.

As for their experience in artisanal mining, miners for whom agriculture is an option have significantly more years of experience in artisanal mining than their counterparts (11.5 compared to 9.7). The observed differences in the position they occupy at the mining site, knowledge of their employment contract, the phase of production they are at and the contribution of artisanal mining to their total household income are not statistically significant.

Regarding their agricultural experience, it is noted that having agriculture as one of the activities practiced in the artisanal miner's household and the fact that at least one of the miner's parents is (has been) a farmer tends to influence the choice of agriculture as their future option. Indeed, the percentage of miners who have agriculture as one of their household activities and those for whom at least one parent is (has been) a farmer is significantly higher for those miners who have chosen agriculture as an option compared to their counterparts (74.1% vs 50.6% and 89.3% vs 80.1% respectively).

Finally, concerning the way they imagine and consider farmers, even though the differences are not significant statistically, the percentage of artisanal miners who believe that farming involves less health and financial risk is higher in the group of miners who have chosen agriculture as an option.

In summary, the results presented in Table 4.3 above indicate that there are significant differences in some characteristics of artisanal miners who can choose agriculture as an option and the category of those for whom agriculture is not an option. However, these results are silent on the extent to which these characteristics affect the choice of agriculture as an option in the post-mining context. This is what I develop in the following sub-section.

4.5.2. Determinants of the choice of agriculture as an alternative livelihood option

Using a *probit* regression model, I evaluated factors that are likely to determine the choice of agriculture as an option. The aim was to evaluate the probability that a miner y chooses agriculture as an option. Thus, consider y_i^*, a latent variable denoting the choice of an artisanal miner i with:

$$y_i^* = \begin{cases} 0 \; if \; agriculture \; is \; not \; an \; option \; chosen \; by \; the \; artisanal \; miner \\ 1 \; if \; the \; artisanal \; miner \; chooses \; agriculture \; as \; an \; option \end{cases}$$

The probability of an artisanal miner i choosing agriculture as an option given a set of independent variables will be given by:

$$Prob(y_i^* = 1 \backslash X) = Prob(\beta_0 + \beta_i X_i + \varepsilon_i)$$

Where for any artisanal miner i, β_0 represents the constant, β_i represents the parameters to be estimated, X_i denotes the vector of explanatory variables and ε_i stands for the error term. The explanatory variables were chosen on the basis of the literature, the data collected during the qualitative survey and my prior knowledge of the study area (see Table 4.4).

In this subsection, before presenting and analysing the results, I first present the variables that were used.

4.5.2.1. Presentation of the model variables

The *choice made by the artisanal miner* is my dependent variable. It is a binary variable which takes the value 1 if agriculture is among the options chosen by the miner and 0 otherwise.

Based on the hypotheses presented above, the model includes four variables of interest. These are:

(1) *The presence of agriculture among the economic activities practised in the miner's household*. It is a binary variable that takes the value 1 if agriculture is among the activities practised in the miner's household and 0 if not. In fact, as noted above, to justify the choice of agriculture as a desired activity in the absence of artisanal mining, some artisanal miners cited the fact that agriculture is already practiced in their households as a reason. I therefore hypothesize that a miner whose household activities include agriculture is more likely to choose agriculture as an option.

(2) *Household size*. It is a continuous variable that includes the number of individuals sleeping under the same roof and sharing food together. In effect, it has been emphasised in the narratives above that agriculture is an important food provider and that, if artisanal mining is no longer possible, in order to ensure the survival of their households and meet their food needs, the miner may turn to agriculture. Assuming that a household with more individuals will have a greater need for food compared to a household with fewer individuals, I hypothesise that household size is likely to positively influence the choice of agriculture.

(3) *The standard of living attributed by artisanal miners to most farmers*. This variable stands for the fictional expectations of artisanal miners in relation to farm income. Ranging from 1 to 9, it captures the standard of living that the artisanal miner believes most farmers are at. The standard of living they attribute to farmers can therefore reflect the standard of living they would expect if they chose farming as an option. I therefore postulate a positive influence of this variable on the choice of agriculture as an option, i.e., a miner who thinks that farmers have a high standard of living is likely to choose farming as an option.

(4) The *financial risk that miners attribute to the agricultural activity* can also be used to capture the expected income in farming. It is a categorical variable which indicates the level of financial risk that an artisanal miner associates with agricultural activities: 0 if no risk, 1 if very little risk, 2 if a little risk, 3 if a little more risk and 4 if a lot of risk. I noted previously that some miners consider farming not a good choice because of the time lag between sowing and harvesting. Not only does this time lag explain the irregularity of farm income, but it also increases financial risks (both in the production and marketing processes) and negatively affect farm income. Therefore, perceiving farming as more financially risky is likely to discourage the artisanal miner from considering farming as an alternative.

In addition to these variables of interest, other control variables related to the socio-demographic characteristics of the miner (level of education, zone of birth and ethnicity) and the experience of the miner in artisanal mining (the function the miner holds in artisanal mining) were added to the model. These variables were chosen based on the literature review presented previously, the qualitative information analysed above and my prior knowledge of the study area.

Low level of education: The level of education is often presented as an explanatory variable for the choice of economic activities (Daw, et al., 2012; Kamitewoko, 2013; Stoop, Houssa, & Verpoorten, 2016; Andaregie & Astatkie, 2021; Mabe, Owusu-Sekyere, & Adeosun, 2021). It is argued that people with a higher level of education are better able to take advantage of opportunities in the non-agricultural sectors, while the agricultural sector is reserved for people with a low level of education, especially when it comes to subsistence agriculture (Barret, Reardon, & Webb, 2001). I therefore hypothesise that a low level of education is likely to have a positive influence on the choice of agriculture. To consider the low level of education, I set the threshold at the completion of secondary school. In fact, obtaining a secondary school diploma (BAC) is considered to be the key to accessing certain posts in the

public administration in the DRC (e.g., primary school teaching). Thus, this variable is dichotomous and takes the value 1 if the artisanal miner is less educated (has not studied until obtaining the secondary school diploma) and 0 otherwise.

Zone of birth of the artisanal miner: Since farming is one of the most common activities in rural areas, someone who was born and raised in a rural area is likely to have more skills and adaptability to farming (UNECE ; FAO ; OECED ; World Bank ; Eurostat, 2007). Based on this, I assume that miners who were born in rural areas are likely to choose farming as an option. This variable is dichotomous and takes the value 1 if the artisanal miner was born in a rural area and 0 if he was born in an urban area.

Ethnicity. Due to their history and traditions, some ethnic groups may be more interested in some particular activities (Stoop, Houssa, & Verpoorten, 2016). The most prevalent ethnic groups in my study area are Hutu (38% of respondents), Havu (29%) and Shi (15%). In the focus groups and individual interviews, the Hutu were described as the ethnic group most involved in agricultural activities. Belonging to the Hutu ethnic group would therefore increase the likelihood of choosing agriculture as an option. Havu ethnicity formed the base category.

The *function that the miner occupies* in artisanal mining stands for the miner's experience in artisanal mining[150]. Geenen et al. have argued that the function occupied in the mining pit is closely linked to the miner's experience in the sector. As the authors noted, "miners need experience in order to climb up the hierarchy of the mining pit" (Geenen, Stoop, & Verpoorten, 2021, p. 10). This is a categorical variable which takes the value 1 if the miner is a team leader, 2 if he/she is a supervisor/conductor, 3 if he/she is a simple miner and 4 if he/she holds another position. The team leader function formed the base category. Experience already accumulated in some activities is likely to influence the choice of economic activities (Daw, et al., 2012).

[150] Initially, I intended to use the number of years already spent in artisanal mining to capture the experience of the artisanal miner. However, not only was this variable not significant, but it was also significantly correlated with other variables such as household size (correlation of 25.99%), low level of education (20.55%), and function occupied in the mining (30.89%). I therefore decided to remove it from the model and stay with the variable related to the function in mining

Table 4.4 Description and codification of the variables used in the probit model

Variables	Description
Dependent variable	
Choice of agriculture as an option	Dummy = 1 if the miner chose agriculture as one of the options, 0 otherwise
Variables of interest	
Presence of agriculture within the household activities	Dummy = 1 if agriculture is among the activities practised in the miner's household and 0 if not
Household size	Continuous variable that includes the number of individuals sleeping under the same roof (same enclosure) and sharing food together
Standard of living of most farmers	Ranging from 1 to 9, this variable captures the standard of living that the artisanal miner believes most farmers are at
The level of financial risk attributed to farming	Categorical variable which takes the value of 0 if the miner associates no financial risk, 1 if very little risk, 2 if a little risk, 3 if a little more risk and 4 if a lot of risk.
Other control variables	
Low level of education	Dummy variable=1 if the artisanal miner is less educated (has not completed secondary school or has not studied until obtaining the secondary school diploma) and 0 otherwise
Zone of birth of the miner	Dummy = 1 if the artisanal miner was born in a rural area and 0 if he was born in an urban area
Ethnicity	Categorical variable which takes the value of 1 if the miner is of Havu ethnic group; 2 if he/she is Hutu; 3 if he/she is Shi and 4 if he/she belongs to another ethnic group. Havu is the base category
Function carried out in artisanal mining	Categorical variable which takes the value 1 if the miner is a team leader, 2 if he/she is a supervisor or driver, 3 if he/she is a simple miner and 4 if he/she holds another position. The team leader function formed the base category

Source: Author's conception based on the literature, the qualitative survey and her prior knowledge of the study area

The results are presented and discussed in the following subsection.

4.5.2.2. Presentation and analysis of results

I ran three different regression specifications (see Table 4.7, Appendices). I first started with a parsimonious model in which I included only the four variables of interest ((1) in Table 4.7). Then I ran another model including only the control variables ((2) in Table 4.7) to see how they behave without the variables of interest. Finally, I ran a model including all the variables (of interest and control, (3) in Table 4.7). The results of these three regression specifications are not significantly different. The Table 4.5 below presents the results of the third specification. It indicates five variables that significantly affect the probability of choosing agriculture as an option.

With regard to the variables of interest, it appears that having agriculture as one of the activities practiced in the household increases by 15.8% ($p<0.01$) the probability of choosing

agriculture as an option. This may be due to the fact that miners who have at least one member of their household in agriculture may somehow know how agriculture works. By being in close contact with farmers, they can therefore listen to some of their "positive" narratives about farming, thus enhancing their own fictional expectations about farming. This result therefore confirms one of the quotes presented above in which an artisanal miner attested that farming may be attractive because it is among the activities practiced in the miners' household.

Table 4.5 Probit regression results estimating the probability of choosing agriculture as an option

Variables	Marginal effects	Robust standard errors
Agriculture within the hh activities	0.158***	0.0596
Household size	0.00573	0.00886
Standard of living of most farmers	0.00894	0.0203
Financial risk farming (base=no risk)		
very few risk	0.000228	0.120
little risk	0.0534	0.114
a little more risk	-0.0314	0.109
a lot of risk	-0.0318	0.108
Low level of education	0.171**	0.0874
Zone of birth of the miner	0.214**	0.108
Ethnicity (base=Havu)		
Hutu	0.187***	0.0713
Shi	-0.0959	0.0871
Other	-0.000802	0.0869
Function in AM (base=team leader)		
Supervisor/conductor	0.199**	0.0962
Miner	-0.0125	0.0888
Other	0.0356	0.149
Pseudo R^2= 0.1278		
LR χ^2 (15)= 40.85		
Prob > χ^2= 0.0003		
Observations= 268		

Source: Estimations based on Data collected in Kalehe/Eastern DRC in December 2018

**hh=Household; AM= artisanal mining*

**** p<0.01, ** p<0.05*

The household size and the variables related to the fictional expectations of artisanal miners in relation to farm income (i.e., the living standard attributed to most farmer and the level of

financial risk attributed to farming activities) are not statistically significant. This is somehow surprising, especially as in the existing literature and some of the narratives of artisanal miners presented above (focus groups with artisanal miners), miners' perception of the low and irregular income from farming is presented as the main factors that make farming not a desired option. For the living standard attributed to most farmers, as explained in the previous section, some miners attributed a high standard of living to farmers, not because farming produces a high income, but because farmers are considered to be persevering and clever at investing the little income they get from farming. Thus, if miners see themselves as spendthrift and unable to be persevering like farmers, it is understandable that the perception they have on farmers' standard of living does not influence their choice of farming as an alternative option. On the other hand, if the financial risk associated with farming activities is related to the time lag between sowing and harvesting, then this should significantly influence the choice of farming. As this variable is not significant, it is questionable whether the time lag between sowing and harvesting - and the risk of a low and irregular income associated with it - really constitutes a barrier to the choice of agriculture as an alternative option, as advocated by the existing literature. This is even more pronounced when the hypothetical bias is taken into account. For instance, while many of the miners who intended to leave artisanal mining in Kalimbi as a result of the iTSci system presented commercial activities as their desire option, Buraye (2018) found that many of those who actually left the sector turned to agriculture instead. Similarly, while agriculture is presented as an undesirable option by artisanal miners, Mabe et al (2021) found that agriculture was dominant in the coping strategies adopted by artisanal miners in Ghana.

Regarding the other variables (control variables), low level of education, zone of birth, belonging to the Hutu ethnic group and working as a conductor/ supervisor positively and significantly influence the choice of agriculture as a post-mining option. Consistent with my hypothesis, not holding a secondary school diploma increases by 17.1 percentage points ($p<0.05$) the probability of choosing agriculture as an option. This result is also consistent with the literature I present above according to which a high level of education increases the likelihood of getting jobs in the non-farm sector, while people with low education level are more oriented towards subsistence farming.

Being born in a rural area increases by 21.4% ($p<0.05$) the probability of choosing agriculture as an option. This result confirms my hypothesis. Indeed, since agriculture is very often the main activity practiced in rural areas, miners who were born and evolved there may not find it difficult to easily adapt to it, and therefore to have it as an option.

Compared to Havu ethnic group, being of Hutu origin increases the likelihood of choosing agriculture as an option by 18.7 percentage points ($p<0.01$). Indeed, in the various interviews I had, Hutu were described as 'amateurs of farming'. In the quote below, they are described as strong and courageous people who are used to farming compared to their 'Havu' counterparts. This may explain this positive relationship with the choice of agriculture as a post-mining option.

> "*[...] Normally it is very rare to see Havu men going to farm. But our Hutu brothers who live in the high plateau, have the courage to cultivate because they are used to and like farming. But, we, the indigenous Havu!![are not like them] ...*[151]".

Finally, compared to team leaders, working at the artisanal mining site as a supervisor or "*conducteur*" increases by 19.9 percentage points ($p<0.05$) the likelihood of choosing farming as an option. The "*conducteurs*" and supervisors are responsible for the regular management of the pit on behalf of the team leader. Compared to other miners who move from pit to pit depending on the production phase, they are well aware of the daily expenses that team leaders incurred on the pits as well as the financial and health risks associated with artisanal mining. This may justify the choice of agriculture because, as mentioned in one of the previous sections, agriculture is perceived to present fewer health risks than artisanal mining.

To sum up, while the existing literature presents low and irregular income from farming as the ultimate factors that discourage artisanal miners from adopting farming as an option, my results show that this choice is rather influenced by the miner's experience with farming, the miner's socio-demographic characteristics, as well as the experience he or she has already accumulated in artisanal mining. The miner's perception of the standard of living of farmers and the financial risk involved in farming do not significantly influence the choice of farming as a post-mining option. Miners' choices are thus determined by their capabilities rather than by their estimates of the income/standard of living of farmers.

4.6. Conclusion

In order to extend the analysis of the linkages between artisanal mining and agriculture developed in Chapter II & chapter III, this chapter has raised questions about the future of artisanal miners in Kalehe. In effect, whenever the end of artisanal mining and the future direction of artisanal miners are imagined by policy makers, agriculture comes to the forefront as the best alternative livelihood or replacement activity. This choice is often criticized in the

[151] Interview with an agronomist instructor from Nyabibwe

literature as a top-down decision and therefore not effective because it does not take into account the needs and wishes of artisanal miners. This chapter contributed to this debate. It pursued two major objectives. First, to analyze to what extent agriculture is interesting for artisanal miners in the frame of livelihood strategies. Second, based on their characteristics, to compare artisanal miners who may be attracted by agriculture if artisanal mining becomes impossible with those who may not and, to assess the factors that may influence an artisanal miner to be interested by agriculture in his/her future.

After reviewing the existing literature on the determinants of choice of livelihood activities, I analyzed the dominant narratives on agriculture in Kalehe. These narratives, according to Beckert's fictional expectation theory, are likely to influence miners' choice. From these narratives, I noted that in Kalehe agriculture is seen as an important traditional activity that provides food and may encourage investment in other activities. On the other hand, it is described as offering a low and irregular income because of the time lag between the sowing and harvesting periods. This time lag leads miners to consider farming as more financially risky. Surprisingly, miners consider that farmers have a higher standard of living than their own. This, they argued, is not because farming provides a higher income than mining, but because farmers are persistent and know how to allocate their low income to productive investments, compared to artisanal miners. With all these considerations, can miners consider agriculture as a post-mining alternative?

My results show that if artisanal mining becomes impossible for geological reasons, the five activities that would be attractive to artisanal miners are small shop (44% of respondents), market activities (42.1%), farming (41.7%), animal husbandry (35%) and taxi-moto (32%). Comparing the 41.7% of respondents who can choose agriculture as an option with those for whom agriculture is not an option, I found that they differ significantly in terms of educational level, the household size, the number of children, place of birth, ethnicity, the number of economic activities carried out in the households and the number of years already spent in artisanal mining. As these observed differences do not allow me to establish a causal relationship with the choice of agriculture as an option, I have therefore analyzed the determinants of the choice of agriculture as an option. My results show that the choice of agriculture as a post-mining alternative is influenced by the miner's experience with farming, the miner's socio-demographic characteristics (level of schooling, zone of birth, ethnicity), as well as the experience he or she has already accumulated in artisanal mining. While the existing literature presents the low and irregular income from farming as the ultimate factors that discourage artisanal miners from adopting farming as an option, my results show that the

miner's perception of farming income does not significantly influence the choice of farming as a post-mining option. Some conclusions can be drawn from these results.

First, the proposal for alternatives to artisanal mining needs to be context specific and, the possibility of an hypothetical bias should be taken into account in the context analysis. Indeed, there is a difference in the choice of alternative activities, depending on whether miners make a choice for geological or political reasons (first case) or, whether they live in an area where agriculture is flourishing or not (second case). In the first case, while Buraye's (2018) analyses placed agriculture on the fourth position among the activities desired by artisanal miners to cope with the traceability mechanism, when these same miners are led to choose alternative activities because mining becomes impossible for geological reasons, agriculture comes in third position. In the same frame, when Buraye (2018) analyses the activities towards which those who have voluntarily left the mine have turned, agriculture comes in first position while it was at the 4th position for those who intend to leave artisanal mining as a result of political decision. In the second case, while agriculture is not very attractive as an alternative option in Kamituga where agriculture and mining do not coexist (or at least where their coexistence is not pronounced), it is a non-negligible option in Kalehe where agriculture and artisanal mining coexist. Moreover, my econometric results showed that having agriculture as an option in the household and being born in a rural area where agriculture is predominant positively and significantly increases the probability of choosing agriculture as an option. Thus, proposing agriculture as a post-mining alternative in a community where agriculture is less practiced is likely to be a failed policy.

Second, the argument that farming is an undesirable option for artisanal miners because of the low and irregular income it produces deserves a second thought. Capturing this variable by the level of financial risk that artisanal miners attribute to farming activities, my results showed that this does not significantly influence the choice of farming as a post-mining option. One of the options to explain this result would be to question the consistency between what artisanal miners say and what they actually do. Through the aforementioned results, where there is a consistent mismatch between the activities that artisanal miners actually engage in and the activities they have proposed as an option, Buraye (2018) provides a first example to inform this question. A second example is that of Mabe et al (2021) who found that while the literature present agriculture as a less-preferred activity, more miners engaged in agriculture (compared to those who engaged in trade or labor supply) to cope with the ban on artisanal mining. Another option to explain this result could simply be that the variable (financial risk associated to farming activities) did not capture all aspects of low and irregular

income related to agriculture. It would therefore be interesting to multiply studies on the determinants of the choice of agriculture as a post-mining option, differentially capturing miners' perceptions of low and irregular agricultural income, and comparing in different contexts, the activities proposed by miners and the activities in which they actually engage.

Finally, if it is true that farmers engage in artisanal mining to cope with the inadequate income offered by artisanal mining, and that policy makers believe that agriculture should be an alternative to artisanal mining if it comes to an end for whatever reason (political or geological), then they need to set up policies to improve farm income. In the next chapter I analyze the different policies that could improve farm income in Kalehe.

Appendices IV

Figure 4.7 Some alternative activities presented to artisanal miners

Source: Buraye (2018) adapted from Stoop et al. (2016)

Table 4.6 Correlation matrix between the variables used in the model

	Choice of agriculture	Agriculture in the household	Household size	Living standard most farmers	Financial risk farming	Low level of education	Zone of birth	Ethnicity	Function in AM
Choice of agriculture	1								
Agriculture in the household	0.2367 (0.0001)	1							
Household size	0.1137 (0.0631)	0.1885 (0.0019)	1						
Living standard most farmers	0.0176 (0.7744)	0.0650 (0.2888)	-0.0097 (0.8743)	1					
Financial risk farming	-0.0596 (0.3312)	-0.0353 (0.5647)	-0.0092 (0.8814)	-0.0848 (0.1663)	1				
Low level of education	0.1643 (0.0070)	0.2078 (0.0006)	0.1243 (0.0420)	-0.0279 (0.6495)	-0.0254 (0.6784)	1			
Zone of birth	0.1417 (0.0203)	0.1079 (0.0779)	0.0871 (0.1549)	-0.1319 (0.0308)	0.0328 (0.5925)	-0.0353 (0.5645)	1		
Ethnicity	-0.0853 (0.1640)	-0.1415 (0.0205)	-0.0213 (0.7284)	-0.0329 (0.5915)	0.0656 (0.2847)	-0.0567 (0.3548)	-0.1062 (0.0827)	1	
Function in Artisanal Mining	-0.0415 (0.4986)	0.1400 (0.0219)	-0.1643 (0.0070)	0.0181 (0.7676)	0.0692 (0.2592)	0.0982 (0.1086)	0.0015 (0.9809)	-0.0338 (0.5812)	1

Source: Author's conception based on Data collected in Kalehe/Eastern DRC in December 2018

Table 4.7 Three specifications Probit regression results estimating the probability of choosing agriculture as an option

Variables	Marginal effects (Robust standard errors)		
	(1)	(2)	(3)
Agriculture within the hh activities	0.215***		0.158***
	(0.0575)		(0.0596)
Household size	0.0111		0.00573
	(0.00888)		(0.00886)
Standard of living of most farmers	0.000531		0.00894
	(0.0217)		(0.0203)
Financial risk farming (base=no risk)			
very few risk	0.0654		0.000228
	(0.122)		(0.120)
little risk	0.115		0.0534
	(0.120)		(0.114)
a little more risk	0.0322		-0.0314
	(0.111)		(0.109)
a lot of risk	-0.0212		-0.0318
	(0.107)		(0.108)
Low level of education		0.221***	0.171**
		(0.0848)	(0.0874)
Zone of birth of the miner		0.256**	0.214**
		(0.107)	(0.108)
Ethnicity (base=Havu)			
Hutu		0.183**	0.187***
		(0.0736)	(0.0713)
Shi		-0.143*	-0.0959
		(0.0849)	(0.0871)
Other		-0.0246	-0.000802
		(0.0864)	(0.0869)
Function in AM (base=team leader)			
Supervisor/conductor		0.219**	0.199**
		(0.0964)	(0.0962)
Miner		0.00124	-0.0125
		(0.0863)	(0.0888)
Other		0.0620	0.0356
		(0.160)	(0.149)
Pseudo R2	0.0534	0.0993	0.1278
LR χ^2	(7)= 19.45	(8) = 31.28	(15)= 40.85
Prob > χ^2	0.0069	0.0002	0.0003
Observations	268	268	268

Source: Estimations based on Data collected in Kalehe/Eastern DRC in December 2018
**Hh=Household ;AM= artisanal mining ; *** p<0.01, ** p<0.05, * p<0.1*

Chapter V: General conclusion

Drawing on a case study from Kalehe territory in the Eastern Democratic Republic of Congo (DRC) where small-scale agriculture and artisanal mining coexist, this PhD dissertation complements existing analyses on the linkages between artisanal mining and subsistence agriculture. Using quantitative and qualitative methods based on both secondary and primary data collected in the field in 2017 and 2018, it aimed at: (1) studying the organisation of agriculture at the micro level in order to understand the factors behind its failure and how this failure drives farmers into artisanal mining; (2) examining the specifics of existing symbioses between agriculture and artisanal mining in order to highlight their impact on farmers' livelihoods; (3) analysing the circumstances under which, as well as the categories and characteristics of miners for whom farming may be an option in the after-mine context; (4) proposing and discussing some policies to support the farmer-miner interactions.

Structured around five chapters, the dissertation has theoretically drawn on the sustainable livelihoods framework (SLF) which aimed to explain how households fall into poverty and the opportunities they have to escape it. The starting point of this framework is the identification of the different assets that households can use to develop livelihood activities. This is followed by an analysis of the endogenous and exogenous factors that block or hinder households' access to these assets; the strategies that households adopt to counteract these blocking factors and gain livelihood; and the outcomes that they achieve after adopting a given livelihood strategy. These different stages of the SLF have been explored throughout the different chapters of this dissertation.

5.1. Some findings and Academic implications

In the second chapter, in order to answer the first research question, I analysed the livelihood opportunities available to farmers, the barriers that prevent them from taking advantage of these opportunities, and whether the coping strategies they adopt include artisanal mining. Results show that, although sometimes in insufficient quantity and quality, various assets on which Kalehe peasants can rely for their agricultural-based livelihood are available. However, peasants face different endogenous and exogenous factors that prevent them from taking full advantage of these assets and thus lead them to adopt certain strategies to maintain their survival. Diversification is the main adaptive strategy. They diversify in agriculture either by adopting the intercropping system or by creating outlets such as restaurants to absorb their surplus production. They also diversify away from agriculture by engaging in non-agricultural

activities, the first of which is petty trade, whose contribution to household income is recognized by more than 40% of households, while mining is recognized by 32% of households that diversify in the village where it is present. However, its indirect contribution may be even higher if one takes into account the linkages it creates with other sectors through its multiplier effects.

While the existing literature presents the failure of agriculture as one of the factors driving many farmers into artisanal mining, it attributes this failure to the wider global process (notably the changes brought about by the structural adjustment programme and neoliberal economic policies). By relying on local realities (micro approach), this chapter makes a better use of the sustainable livelihood framework in the explanation of the expansion of artisanal mining. It shows that in addition to the wider global process, the expansion of artisanal mining must also be attributed to the local process of inclusion and exclusion which negatively affects farm income and pushes farm households to replace the hoe with the hammer or to combine the two. Relying on local realities allows to 'kill two birds with one stone': it not only clarifies the factors behind farmers' involvement in artisanal mining, but also identifies opportunities that policy makers can build on and negative aspects that they can change to improve farm income.

In the third chapter, the linkages and multiplier effects of artisanal mining have been explored in order to provide an answer to the second research question of this dissertation. To analyse the outcome of farmers' (direct or indirect) adoption of artisanal mining as a livelihood strategy and, to evidence the embeddedness of artisanal mining in farmers' livelihoods, a comparison has been made between farm households living in the vicinity of an artisanal mining operation with those that have no connection to it. Results showed that living close to artisanal mining increases farm households' off-farm income, therefore, helping them to maintain their survival when agriculture fail to provide sufficient income. This is not only the result of the direct participation of farm households in artisanal mining, as is often argued in the literature. My analyses have indeed shown that in the presence of artisanal mining farm households participate in more off-farm activities than in its absence. Thus, as it promotes the emergence of other off-farm activities, artisanal mining can even positively affect the off-farm income of households who are not directly involved in artisanal mining. However, although this direct or indirect participation in artisanal mining positively affect off-farm income, it may negatively affect farming activities. This is because, in case of high availability of off-farm activities, farmers may not have enough time to devote to agriculture, thus

preferring to farm for self-consumption or, in the worst case, abandoning farming in favour of imported food.

A further implication of the findings in this second chapter is that the negative effects of artisanal mining on agricultural land prices, land conflicts and agricultural labour highlighted in the existing literature are questioned. On the one hand, while the existing literature argues that the presence of artisanal mining leads to upward pressure on land prices and decreases available farm labour, for these variables I did not find a statistically significant difference between farm households that benefit from the presence of artisanal mining and those that do not. In contrast, the results show that in the presence of artisanal mining, the number of farm households who farm their own land (who have already bought the farmland) is higher than in the absence of artisanal mining.

By answering the third research question, the fourth chapter of this dissertation brought me back to the analysis of livelihood strategies. However, unlike the second chapter in which I analysed the livelihood strategies adopted by agricultural households in response to shocks to agricultural income, in this fourth chapter I have analysed the choice by artisanal miners of agriculture as a livelihood strategy in response to the shock affecting artisanal mining. Indeed, for political or geological reasons, artisanal mining may end. This end constitutes a shock to the livelihoods already built around artisanal mining and, as the SLF advocates, calls on artisanal miners to reflect on strategies to maintain their livelihoods. The chapter not only identified the alternatives livelihood activity that are attractive to artisanal miners, but also assessed to what extent these activities are preferred, and for which category of miners agriculture is attractive as a livelihood strategy.

The academic implications of this chapter can be considered at three levels. First, with reference to the fictional expectation theory, according to which choices in an uncertain environment are based on the mental representation of future states, I assumed that choice of agriculture as an alternative option may, among other things be influenced by the opinion that artisanal miners have about agriculture. This involved analysing dominant narratives about farming-based livelihoods. By allowing the miners to project what they would be like if they were farmers, I hypothesised that these narratives might influence or discourage them from choosing farming as an alternative option. I have therefore provided a more nuanced and detailed categorisation of miners' views on agriculture-based livelihoods. Second, while the existing literature presents the low and irregular income from farming as the ultimate factors that discourage artisanal miners from adopting farming as an option, results from this chapter suggest that the miner's perception of farming income does not significantly influence his/her

choice of farming as post-mining alternative. Such a result warns of the existence of a hypothetical bias in this kind of analysis and calls into question the consistency between what artisanal miners say and what they actually do. Finally, while the proposal of alternative activities to artisanal mining is often done in a "one size fits all" approach, the analyses in this dissertation argue that miners' preference for alternative activities is context-specific. It varies according to the activities flourishing in the environment in which the artisanal miner operates as well as the capabilities of the artisanal miner rather than his or her estimates of the income of others or even his or her own desired options.

5.2. Some policy implications

Overall, the findings presented in this dissertation point to two main considerations for policy decision. Firstly, if farmers are adopting artisanal mining as a survival strategy because agricultural income is unable to cover their survival needs, then policy decisions to discourage or prohibit artisanal mining need to be thoroughly rethought. The study revealed that the direct or indirect involvement of farm households in artisanal mining allows them to meet needs that cannot be met by agricultural income alone. Regulating mining and increasing the income of artisanal miners will have an impact not only on agricultural activities but on all rural livelihood activities in general. Indeed, the results in Chapter III argue that the presence of artisanal mining creates an important market for other rural livelihood activities stimulating therefore their development. For example, it has been shown that in the presence of artisanal mining, farmers can sell their produce at a relatively higher price than in the absence of artisanal mining, traders can easily find customers for their goods, practitioners of other various professions (masonry, carpentry, tailoring...) find customers, etc. In addition, in Chapter II it was shown that when farmers choose the strategy of diversification of livelihood activities to compensate for low farm income, they do not only choose artisanal mining, they diversify into other livelihood activities developed in their areas. Similarly, if artisanal miners have to choose alternative activities, it was shown in Chapter IV that they do not necessarily choose agriculture, but also turn to other activities developed in their communities. These activities, as I have just said, are in turn stimulated by the presence of artisanal mining. Again, in Chapter II and Chapter IV, it was shown that one of the handicaps of the agricultural sector is the time lag between sowing and harvesting, during which farmers receive very little (or no) farm income. If artisanal mining stimulates the emergence of other activities, this will enable farmers to find income-generating activities they can be involved in to endure this low (or no) income period.

Thus, instead of prohibiting or discouraging artisanal mining as it is often the case, policymakers should develop supportive policies to limit the negative effects that artisanal mining can have. These include policies to facilitate access to technical and financial support, and laws and regulations to support the governance of artisanal mining.

Regarding artisanal miners' access to technical support, results presented in chapter IV demonstrated that artisanal mining is health risky characterized by many injuries and fatal accidents due to shaft collapses, landslides, poor ventilation, inadequate work space, and the like. The establishment of technical support measures to address these problems would enable artisanal miners to work safely and increase their income. With regard to financial support, analyses have shown that artisanal mining presents financial risks. One of the causes of these risks is indebtedness in search for ways to finance their activities when they have not yet reached the mining vein. Once they have reached the vein, they have to pay off their debts first, thus profiting less from their activity. In view of this, I therefore propose that artisanal mining be subsidised and that financial institutions facilitating access to low-interest loans be set up. For these policies to be effective, laws and institutions are needed to monitor and govern artisanal mining activities as a whole.

Secondly, if artisanal mining is to be stopped anyway for geological reasons or because policy makers are unable to monitor it, and if alternative options are to be considered, then policy makers should already be developing strategies to increase not only farm incomes but also to stimulate all possible rural livelihood activities. These include policies to facilitate access to production resources, access to inputs and output markets as well as the implementation of laws and regulations to monitor rural activities as a whole. In effect, results in chapter II have demonstrated that due to different endogenous and exogenous factors, Kalehe farm households face low farm income that push them to adopt some livelihood strategies (including engagement into artisanal mining). These endogenous and exogenous mediating factors are mainly related to low access to land as well as high costs in accessing inputs and outputs markets. These are the results of poor infrastructures, high taxation and harassments as well as ambiguous institutions regulating farm activities. Therefore, putting in place policies that will facilitate farmers' access to land and markets (for inputs and products) can help them increase their farm incomes and at the same time, can help control the expansion of artisanal mining.

In light of the above, I would like to propose to decision-makers two avenues of reflection for the concretisation of these different policies.

a. More focus on collective actions

By collective actions here I mainly refer to horizontal coordination whereby farmers or artisanal miners take collective action in the form of supply, production or marketing cooperatives and/or associations in order to reduce their transaction[152] costs and thus solve the problem of market failure they face (Pingali, Khwaja, & Meijer, 2007; Mason De Rada, 2015). Working collectively not only benefits small-scale producers but also benefits many buyers who prefer to work with producer groups (Shiferaw, Hellin, & Muricho, 2011). In effect, dealing with a group not only ensures a stable supply and quality products, but also helps them to reduce the transaction costs of attaining many small producers. If these cooperatives are well developed and functioning properly, it will make it easier for artisanal miners and/or small-scale farmers to access technology and financial services, to advocate to higher authorities and gain access to input and output markets than if they had to seek these services individually.

I must admit that I am not the first to consider cooperative organisation as one of the ways to improve the income of artisanal miners and farmers. However, despite the existence of cooperatives in Kalehe, my results have shown that these two sectors continue to face difficulties. A small observation I made in 2012 on the mining cooperatives of Kamituga (Mukotanyi F. I., 2012) and the discussions I had with the leaders of some agricultural and mining cooperatives in Kalehe, showed that the local reality in which the miners live plays a major role in the success of collective actions. The local reality here includes the level of trust between members, the problem of leadership, social belonging, ethnicity, the conditions set by law for the creation of a cooperative, etc. It is therefore time for policy makers to rethink the organisation of these cooperatives and to take into consideration the trade-off proposed in the existing literature when creating new cooperatives.

In this frame, existing literature identifies some trade-offs that need to be made for cooperatives to be beneficial to small-scale producers and allow them to reduce their transaction costs. These are related to the group characteristics, the governance system and institutional arrangements, and the external environment that influences collective action (Markelova, Meinzen-Dick, Hellin, & Dohrn, 2009; Shiferaw, Hellin, & Muricho, 2011). Regarding the characteristics of the group, even though large groups have the potential to

[152] Transaction cost is a catchall term which encompasses different "observable and unobservable costs associated with arranging and carrying out a transaction" (Alene, et al., 2008, p. 318). Broadly speaking, they are defined as the costs associated with making an exchange in an economy and encompass not only the costs incurred during the exchange (marketing) process but also the different costs associated with the (re)organization of the production process in order to produce enough for the market (Cuevas, 2014).

achieve economies of scale and thus gain advantages in the marketing process, small groups are considered as having higher internal cohesion and are easy to monitor. Larger groups may increase the transaction and managerial costs of cooperation, reducing therefore the incentive to act collectively (Shiferaw, Hellin, & Muricho, 2011). Federated organizations that combine small groups may be an option to maintain cohesion and gain from the economies of scale, provided they succeed to maintain the desire of collective action (Markelova, Meinzen-Dick, Hellin, & Dohrn, 2009). In addition, collective action between members who share norms and social capital, and who have experience of working together, is more likely to succeed than one based on external intervention pushing members together, even if they are less interested. Finally, a trusted and accountable leader with the skills to motivate members is an important ingredient that the group needs for successful collective action.

With regard to the governance system and institutional arrangements, clear, stable and centrally established rules, procedures and structures, ensure transparency and are important for successful collective action (Shiferaw, Hellin, & Muricho, 2011). Letting group members develop their own rules increases the likelihood that these rules will be understood and adapted to local conditions (Markelova, Meinzen-Dick, Hellin, & Dohrn, 2009; Shiferaw, Hellin, & Muricho, 2011).

Finally, the political environment in which collective action is undertaken and state interventions are also very crucial to the success or failure of horizontal coordination. Indeed, as Markelova, et al. (2009) noted, while good governance that ensures pro-poor legal and credit systems has the potential to increase economic opportunities for smallholders and encourage them to partner with others, state hostility and macroeconomic instability are likely to undermine the incentives for cooperation. In this regard, Shiferaw, et al., (2011) pointed out that many producer organisations are doomed to fail due to an unfavourable policy environment and undue government interference in the management and direction of their affairs. This interference often creates tensions, perpetuates dependency and diverts efforts from market orientation. Thus, while state interventions are important at times, they must be carefully balanced with the granting of greater autonomy in the management of collective actions (Penrose-Buckley, 2007; Shiferaw, Hellin, & Muricho, 2011).

b. The provision of public goods and institutional reforms

As pointed out previously, high transaction costs are the result of poor provision of public goods such as road infrastructures, market information, storage infrastructures, and the like. While the private sector can easily intervene in some areas such as the provision of storage

and marketing facilities or provision of some technical support to farmers/miners, public investment in improved transport, communication and market infrastructure can be a good accompanying measure to stimulate and sustain this private intervention (Pingali, Khwaja, & Meijer, 2007). The state must therefore intervene in the provision of these public goods, and in the creation of an attractive institutional framework in areas where the private sector can intervene.

For artisanal mining, in addition to road infrastructure, it is important to improve access for artisanal miners to appropriate machinery that can facilitate the reduction of health risks. As for farmers, our analyses have shown that they need transport and storage infrastructure, appropriate laws regulating access to land and appropriate institutions for monitoring climate hazards. In addition to infrastructure, investment in human capital through education can also have important positive effects. Such investment not only increases productivity through increased know-how of farmers and miners, but also increases their ability to obtain market information, thereby reducing their transaction costs (Cuevas, 2014). Furthermore, as noted by Pingali, et al. (2005 ; 2007), in a broader context, education should be considered a key policy priority. In addition to reducing research and monitoring costs, education stimulates the development of non-farm sectors and facilitates the movement of labour between sectors.

As for the institutional framework, enabling legal and policy frameworks are important in many areas (Omamo, 1998; Maltsoglou & Tanyeri-Abur, 2005; Stifel, Minten, & Dorosh, 2003; Renkow, Hallstroma, & Karanja, 2004; Alene, et al., 2008; Yousuf, 2017). These include but are not limited to, the development of laws and institutions that guarantee the proper functioning of the financial and insurance markets, the regulation of the functioning of horizontal coordination, the setting up of a system for monitoring prices and product quality, the development of the research and extension system for new technologies, the implementation of commercial policies that address the constraints faced by small producers, and the like.

Above all, good governance is the starting point. Indeed, to be successful in its role as a provider of public services and good institutions, the state needs conscious organisational bodies. The capacity and honesty of the civil servants responsible for carrying out any government intervention are important ingredients for a successful intervention (Cardenas, Stranlund, & Willis, 2000). Otherwise, government interventions may aggravate rather than correcting the problems faced by artisanal miners and farmers.

5.3. Study limits and avenues for future research

Like any scientific work, this study has several limitations which are outlined in the following lines and constitute avenues for future research.

Firstly, as mentioned in the general introduction, the DRC in general and the province of South Kivu in particular present contrasting realities depending on the area studied. Some territories are better endowed with agricultural land than others, the minerals exploited are sometimes different, local governance may differ, etc. However, this thesis has only explored the realities of one territory in South Kivu, namely the territory of Kalehe. A comparative study including territories with different characteristics would enhance the understanding of the linkages between artisanal mining and agriculture in the DRC.

Secondly, while the extent of agricultural and mining activities differs between the rainy and dry seasons, I used cross-sectional data collected during the rainy season. Collecting quantitative data in December, when the rainy season is at its peak, may have overlooked some realities. A study using data from both seasons might produce different results.

Thirdly, as mentioned in Chapter III, the use of the propensity scores matching method with a sample of only two villages where all treated households are located in one and all control households are located in the other means that my findings on the effects (impacts) of artisanal mining on agriculture-based livelihoods should be taken with caution. This is because, as such, treatment may be collinear and the estimated effects of artisanal mining may simply capture other differences between the two villages rather than or in addition to access to mining. Although I have conducted some tests to check the robustness of my results, I suggest a study with different counterfactuals to see if its results would be different.

Finally, although the sustainable livelihoods framework (SLF) used in this dissertation has some limitations discussed in chapter I, my analyses could not address them systematically. For example, to understand the process of marginalisation, dispossession, accumulation and differentiation in the access to livelihood opportunities, an analysis of power relations between different actors focusing on how livelihoods are structured by relations of class, gender, caste, ethnicity, etc. is recommended. While I have shown in chapter II how power relations negatively influence farmers' access to certain assets such as land, agricultural infrastructure, etc. thus negatively impacting their farm income, a study integrating, for example, gender and/or class differences in access to resources and livelihood strategies would contribute more to the understanding and/or documentation of the SLF.

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Samenvatting

Artisanale mijnbouw wordt vaak gezien als informeel, gevaarlijk en schadelijk voor het milieu en de gezondheid. De kritiek omwille van deze negatieve impact overschaduwt vaak het potentieel dat artisanale mijnbouw biedt aan een arme plattelandsbevolking. Door de connecties tussen artisanale mijnbouw en landbouw te analyseren, toont dit proefschrift aan dat mijnbouw – net als veeteelt, loonarbeid of andere economische activiteiten – een aanvulling vormt op het inkomen dat de plattelandsbevolking verwerft uit landbouw.

Dit onderzoek probeert inzicht te krijgen in de factoren die landbouwers ertoe aanzetten om aan artisanale mijnbouw te gaan doen, de impact van artisanale mijnbouw op hun bestaansmiddelen en de richting die zij kunnen inslaan als artisanale mijnbouw bedreigd wordt. Het is gebaseerd op een casestudy van Kalehe, een entiteit in het oosten van de Democratische Republiek Congo. Theoretisch maakt het onderzoek gebruik van het *sustainable livelihoods framework*, en methodologisch omvat het zowel kwantitatieve als kwalitatieve methoden.

Uit de bevindingen blijkt dat landbouwhuishoudens, geconfronteerd met endogene en exogene factoren die hun landbouwinkomen negatief beïnvloeden, strategieën opzetten om in hun levensonderhoud te voorzien, waaronder diversificatie naar artisanale mijnbouw. Dit helpt hen niet alleen om hun inkomen buiten de landbouw te verhogen, maar ook om investeringen te doen en zo andere economische activiteiten te ontwikkelen. Om politieke, technische en/of geologische redenen kunnen zich echter schokken voordoen in de strategieën die rond de artisanale mijnbouw zijn opgebouwd, waardoor de artisanale mijnwerkers zich moeten heroriënteren. De vijf activiteiten die hen het meest aantrekkelijk lijken, zijn kleine handel, marktactiviteiten, landbouw, veeteelt en motortaxi. De keuze voor landbouw hangt in dit geval af van de capaciteiten van de artisanale mijnwerkers en niet van hun inschatting van het inkomen of de levensstandaard van de landbouwers.

Kortom, als artisanale mijnbouw deel uitmaakt van de activiteiten die boeren op het platteland ontplooien om in hun levensonderhoud te voorzien omdat het inkomen uit de landbouw niet volstaat om in hun levensbehoeften te voorzien, dan moeten beleidsbeslissingen om artisanale mijnbouw te ontmoedigen en te verbieden grondig worden heroverwogen en moet ondersteunend beleid worden gevoerd om de negatieve effecten die artisanale mijnbouw kan hebben, te beperken. Bovendien, als de artisanale mijnbouw om geologische of politieke redenen toch moet worden stopgezet en alternatieve opties moeten worden overwogen, dan moeten beleidsmakers nu al strategieën ontwikkelen om niet alleen het inkomen van boeren te verhogen, maar om alle mogelijke activiteiten voor het levensonderhoud op het platteland te

stimuleren. In de conclusie van dit proefschrift worden enkele denkpistes voor dit soort beleid voorgesteld.