

*Full Length Research Paper*

# **Constraints to banana (*Musa spp*) production in Beni territory of North-Kivu, Democratic Republic of Congo**

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The objective of this study was to characterize the banana production systems and to identify the constraints it faces. A questionnaire survey and field observations were carried out with banana producers. At the end of the surveys, three main banana production systems were found: Monoculture (10%), banana-food crops intercropping (7%) and agroforestry (83%). In addition, four types of banana (cooking banana, plantain, beer banana and dessert banana) are integrated into banana cultivation systems, with a varying planting density depending on the type of cultural association envisaged. On average, a banana farmer owns 140 banana plants or stools on an average area of 0.68 ha, ranging from 0.0625 to 2 ha. On average, banana grower's harvest 6 bunches per week with an estimated average weight of 12, 8.5 and 5.2 kg for plantain, cooking bananas and dessert banana, respectively. The weight estimate and marketing data for beer banana were not provided as it has not been sold in the market like other cultivars since the advent of BXW. The cultivation of bananas in Beni territory is constrained by diseases, mainly bacterial wilt of bananas (80%) and Banana Bunchy Top Disease (7%); climatic hazards (winds, drought and hail), insecurity, soil infertility, use of low-quality planting materials, inadequate agricultural practices, non-use of agricultural inputs, lack of technical and financial assistance as well as the weak involvement of state authorities in production. These constraints not only exacerbate the misery of banana producers but also contribute to the erosion of certain varieties and to the loss of the region's hegemony in banana production. In order to eradicate these threats, it is therefore essential to practice intensive cultivation with more inputs and especially improved cultivars.

**Key words:** Constraints, cropping system, banana, Beni.

## **INTRODUCTION**

Banana production in Africa is carried out by smallholder farmers under different production systems. Apart from some commercial plantations of dessert bananas, the cooking and beer bananas as well as plantains are mostly produced in subsistence systems for local consumption and the exceeding harvest sold on local or regional markets for income generation (Komatsu et al.,

2010; Lassois et al., 2009). In subsistence systems, banana is cultivated in a complex mixture of food crops including roots and tubers, vegetables, legumes, cereals, cash crops (coffee and cocoa) and in few cases, fruit and agroforestry trees (Karamura and Frison, 1998). More recently, some market oriented plantations have been intensively managed in the Great Lakes Region of Africa,

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with Uganda producing majority of cooking banana (Bagamba et al., 2010) and the East and Central Highlands of Kenya for dessert banana (Sseshe Reddy et al., 2007).

In the Democratic Republic of Congo (DR Congo), banana is cultivated in different agro-ecological zones, from low to mid altitudes where banana is intercropped with other food and cash crops by smallholder farmers. They are mostly cultivated in subsistence farming systems and hence play a crucial role in food security of the population of these different agro-ecological zones. Banana cultivation occurs in home gardens, bush fallows and newly cleared farms from the forest (Dhed'a et al., 2019).

In spite of its economic importance, banana production is still constrained by biotic and abiotic factors causing a decline in banana productivity in all banana cultivation zones (Ndungo, 2008; Musongora, 2018). The common constraints are soil degradation, inadequate cultural practices and diseases and pests (Nyombi, 2013).

Currently, the eastern Democratic Republic of Congo in general and Beni territory in particular is still under *Banana Xanthomonas Wilt* threat (Ndungo, 2008; Musongora, 2018) where it has spread over a 800-km long and 100-km wide band from Kalehe territory in the South-Kivu Province to Irumu territory in the Ituri Province, through North-Kivu Province (Ndungo, 2008).

The generally alarming banana production situation described for all the banana producing zones of the Democratic Republic of Congo is worsened in Beni territory by other factors such the recurrent armed conflicts in the banana producing zones where farmers are either directly or indirectly exposed to unprecedented food paucity. Yet, the edaphic and ecological characteristics of this zone are suitable for a prosperous agriculture and plantain cultivation in particular (Sivirihauma et al., 2017b). Unfortunately, banana production is still low due to the exiguity of the farms and inadequate farming practices. Even though the individual production seems to be sufficient for the consumption needs of the farmers' household, it is still insufficient to meet the need of the actual domestic market as currently expressed. Besides, the potential for exportation of plantain to Uganda constitute an opportunity for investment in this supply chain in order to attract the foreign currency to the farmers in particular and for the benefit of the economy of Congo in general (Balimwacha, 2018).

In view of such a situation, this study was undertaken to characterize banana production systems in Beni territory, eastern DR Congo, and identify the related technical constraints for banana production in this territory.

## METHODOLOGY

### Study site description

This study was conducted from October 2019 to July 2020 in Beni

territory, North Kivu Province in the Democratic Republic of Congo. The administrative limits of Beni territory occupy an area estimated to 7 484 km<sup>2</sup>. It borders Rwenzori Mountain in the East, Ituri Province in the North, Edouard Lake in the South-East and Lubero territory in the South (Vikanza, 2011).

The climate is temperate by the mountains in the high mountains of Rwenzori in the East and Kyavirimu in the South-East whereas a tropical hot climate predominates in the plains in the Northern and Western part of the territory. Beni territory is mainly situated below 1,200 m above sea level (altitude) with average temperature of 25°C and mean annual rainfall of 1,716 mm evenly distributed on the whole year (Anonymous, 2015). On the plateau, the soils are clay whereas clay-sandy and volcanic soils predominate in the plains and on the sides of mountains, respectively. The vegetation cover is dominated by the equatorial rainforest and some wooded savannah on relatively fertile soils (Vyakuno, 2006).

### Sampling and data collection

This study proceeded by surveys for data collection along four main axes of Beni territory. These four axes were determined based on their current or past renown and importance in banana cultivation and production. Considering Beni City as the centre, three villages (Kalunguta, Kabasha and Maboya) were selected on Beni-Maboya axis (south), three villages (Mavivi, Mbau and Mamove) on Beni-Oicha axis (North) and three other villages (Bingo, Kyanzaba and Kalibo) on Beni-Mangina axis (West). The fourth axis, Beni-Mtwanga in the eastern part of the territory, was not accessible due to the insecurity and hence our investigations were not extended to this axis due to the displacement of majority of inhabitants of most of the villages of this axis.

In each village of the considered axis, a minimum of three observation sites was considered but variable depending on the banana planted surface in a given village. The choice of the resource persons and the observation sites was based on the importance of banana on their farm and the period since the banana plantation establishment. Only farmers who had at least 20 banana clumps and at least four years old on their farm where involved in this survey. These lower limits as far as the number of banana clumps on the farm and their age are concerned were imposed so that we may collect data from resource persons who have gathered practical experience with regard to banana cultivation and to whom banana is a key crop in their farming systems.

The interviews coupled with direct observations were conducted with the owners of the selected farms. Hence, 30 farms proportionally distributed among the three axes were considered as representative sample of banana producers in Beni territory and responded to a standardized questionnaire. These interviews mainly focused on banana cultivation and related agricultural practices as they are carried out at an individual level. Collected data from both surveys and observations were combined for descriptive statistics (without transformation) for subsequent presentation in tables and figures.

## RESULTS

### Banana cultivation in Beni territory

#### *Acreege of banana farms*

Banana production in Beni territory is confronted with scarcity of land resources, which in 30% of the surveyed cases was bought or acquired as inheritance (70%) by

farmers, resulting in the cultivation of banana on a small scale only. In these conditions, the farm size allocated to banana cultivation ranges from 0.0625 ha to 2 ha with an average banana farm size of 0.68 ha. The small size of these farms can be justified by the demographic pressure coupled with the preponderance of inherited lands that are subject to land fragmentation. The arable land scarcity has caused farmers to allocate the small piece of land available to them to many food as well as cash crops both for subsistence needs of the household and source of income. Besides, the insecurity in Beni territory has forced farmers to rely on their nearby farms since they can no longer access their distant but spacious farms.

### ***Banana cropping systems***

Banana farms in Beni territory were established long ago. However, those established less than a decade ago are increasingly encountered. This situation could be a result of the gradual rehabilitation of banana farms in the region that had been previously decimated by the Banana *Xanthomonas* Wilt (BXW) epidemic that tend to become endemic to the region. In fact, more than 60% of the surveyed banana farms were established after 2009. Apart from the restoration of farms previously affected by BXW, the current configuration of newly established banana farms can be justified by the move of farmers and the emergence of cocoa cultivation for which banana provides a temporal shade from the very early stage of establishment.

In Beni territory, banana is cultivated in three distinct cropping systems, namely banana monoculture, banana-food crops intercrop and in agroforestry systems. Banana in monoculture is rare among these small-scale farmers and was practiced by only 10% of the surveyed farmers. The banana-food crops intercrop has the advantage of diversifying the agricultural production at different periods of the year.

The cash crops commonly intercropped with banana are cocoa (23% of cases) and coffee (13% of cases). Farmers who intercrop banana and cocoa tend to reduce the banana planting density as the cocoa grows. These bananas are progressively replaced by the trees regenerated from regrowth of old stumps or wildings. This practice justifies, to some extent, the current decline in banana cultivation and the banana production, consequently.

Planting materials are resourced from previously established banana farms. Farmers who resource from their own farms represent 13% against 60% of farmers who resource from their neighbours. The remaining 27% is made of farmers who resource from both their own farms and their neighbours'. These banana farmers select their planting materials based on four main criteria: the taste, the availability of the planting material, the

market demand and the bunch size. From a health standpoint, these farmers prefer suckers collected from disease free banana clumps (at least asymptomatic banana trees), without any signs of banana weevil attacks, etc. Regardless the origin of the planting material, no particular treatment is applied on these planting materials before as well as after transplantation. The final establishment of these bananas is preceded by the preparation of planting holes 0.3 to 0.5 m deep and of variable lateral sizes.

Based on their use, four main banana varieties were found predominant in Beni territory: cooking banana (in 100% of farms), plantain (in 93% of farms), brewing or beer banana (in 50% of farms) and dessert banana (40% of farms). The importance of one or the other variety of banana on one farm depends on the farmer's consumptive and financial needs, which can to some extent, justify the prevalence of some varieties on the expenses of the others.

The planting density of banana is variable depending on the kind of association or cropping system that is under consideration. In banana-cash crops intercrops, the planting density of banana is very low due to high spacing of banana plants. But, high planting densities of banana are encountered in banana-food crop intercrops. The average planting density of banana revolves around 140 banana clumps per hectare.

The only management practice carried out on these bananas is the removal of old/dead leaves and the male bud. Whenever done, weeding is only done for the other crops that are intercropped with banana. In banana-food crop intercrops, weeding is done with a manual hoe whereas it is done with a machete when banana is intercropped with cash crops like cocoa or coffee. In this context, there is a high risk of root injuries that favour parasitic infections and the transmission of pathogenic agents with contaminated farming tools.

### ***Banana production and marketing system***

In Beni territory, almost all the households cultivate banana on their farms. In this region, banana can be harvested all year round despite the seasonal fluctuations and hence constitute an important source of income. Where banana is well established on the farm, the recorded average yield is estimated at 6 bunches per week on an average farm of 0.68 ha. This average yield, however, hides a high variability in banana production that can range from a minimum yield of 2 bunches per week to a maximum of 10 bunches per week, with the majority of farmers producing 4 bunches (37%) and 8 to 10 bunches (23%). The average weight of these bunches is variable depending on the variety under consideration as illustrated in Table 1.

The weight of a plantain bunch ranges between 1 and 20 kg with an average weight of 11.75 kg. Plantain is

**Table 1.** Distribution of harvested banana bunches in weight classes.

Type	[1 - 5 kg]	[6 - 10 kg]	[11 - 15 kg]	[16 - 20 kg]	Mean weight (kg)
Plantain (%)	7.14	28.57	46.43	17.86	11.75 ± 7.121
Cooking banana (%)	17.24	55.17	27.59	0.00	8.52 ± 3.846
Dessert banana (%)	75	25	0.00	0.00	4.25 ± 1.593

**Table 2.** Distribution of banana bunch by prices.

Price (in DCF)	Plantain (%)	Cooking banana (%)	Dessert banana (%)
< 1,000	0	0	0
1,100 - 2,000	0	6.9	62.5
2,100 - 3,000	0	13.8	37.5
3,100 - 4,000	10.7	65.5	0
4,100 - 5,000	32.1	13.8	0
5,100 - 6,000	28.6	0	0
6,100 - 7,000	25	0	0
> 7,000	3.6	0	0
<b>Average price (in DCF)</b>	<b>5337</b>	<b>3412</b>	<b>1925</b>

followed by cooking banana weighing between 1 and 15 kg with an average weight of 8.52 kg and finally the dessert banana whose weight ranges from 1 to 10 kg with an average weight of 4.25 kg. Regardless of the banana variety in consideration, this average weight of banana bunch is lower compared to the one found by Dhed'a et al. (2019) (15-25 kg) for the whole region of Eastern Democratic Republic of Congo. This can be due to inexistence of fertilization and inadequate cultural practices in banana farms.

Banana bunches produced in Beni territory are on one hand consumed by the producers and on the other hand marketed on the local market. The share allocated to household consumption is relatively high and represents up to 77% of the total production; and only the remaining 23% are marketed. Among the farmers who sell part of their production, only 3% are satisfied with income generated by this activity against 87% of those who never get satisfied with these returns while the remaining 10% are only partially satisfied.

Once on the market, the price of a banana bunch is set depending on the variety, the bunch size and the bunch quality. The distribution of bunches of the different varieties with regard to their prices is visualised in Table 2. In Beni territory, the price of a banana bunch varies with the seasons and depends on its weight. The seasonal fluctuations induce lower prices during the rainy seasons when banana is overproduced. The average price of plantains with an average weight of 11.75 kg is 2.67 \$ (5,337 DCF). For cooking banana, an average bunch of 8.52 kg costs 1.7 \$ (3,412 DCF) whereas the dessert banana bunch of an average weight of 4.25 kg costs 0.96 \$ (1,925 DCF). Differently from plantains,

cooking banana and dessert banana, the brewing or beer banana is no longer marketed through formal supply chain. In fact, this variety seems to have been drastically affected by the BXW and since then, the number of banana clumps of this variety is very low on the farm and farmers can hardly harvest a single bunch that is given to beer banana brewers in exchange with a cooking banana bunch. Hence, farmers could not provide any information concerning the marketing aspects of this variety.

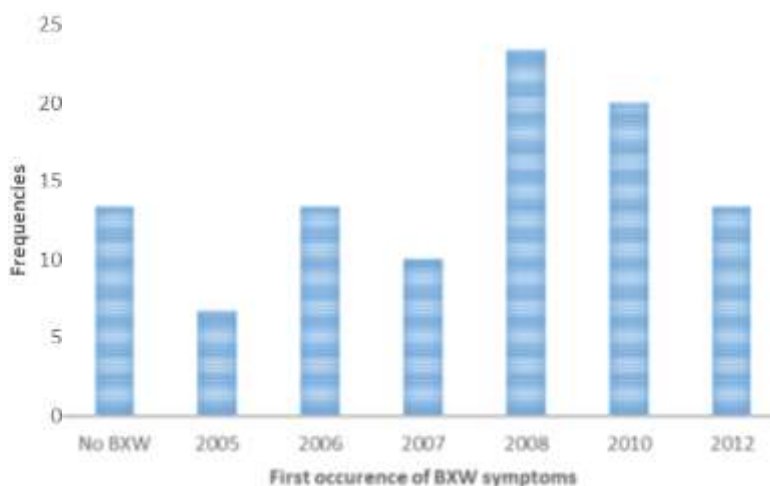
### Constraints to banana production

In Beni territory, the Banana Bunchy Top disease (7%) and the Banana *Xanthomonas* Wilt (80%) cause considerable damages to banana productions. Only 13% of the surveyed farms did not experience these two diseases.

#### ***Banana Xanthomonas Wilt (BXW) on banana farms***

Like in many others zones under the threat of BXW, this disease devastated large banana farms in Beni territory to the point of consuming some. Figure 1 illustrates the proportions of farms that experienced BXW depending on the period of occurrence of the first symptoms of this disease on the farm.

This disease devastated a large number of banana farms in the survey area (80%). It seems to have been acutely noticed around the years 2008 (23.33%) and 2010 (20%), yet it was still weakly prevalent around the period 2005 (6.67%) and 2007 (10%). As previously



**Figure 1.** Distribution of the surveyed farms based on the period of occurrence of the first symptoms of BXW.

**Table 3.** Severity of BXW on banana varieties encountered in Beni territory.

Condition	Plantain (%)	Cooking banana (%)	Dessert banana (%)	Beer banana (%)
Healthy	32	17	12	6
Slightly affected	54	25	19	10
Affected	7	35	31	38
Highly affected	7	24	38	46

mentioned, cooking banana is the most widely cultivated variety in Beni territory alongside plantain, beer banana and dessert banana. Each one of these varieties is endowed with a particular set of genes that determines either its high sensitivity or tolerance to BXW. However, it was noticed that all banana varieties cultivated in Beni territory are sensitive to BXW at different degree as illustrated by results in Table 3. These results show that the beer banana, the dessert banana and the cooking banana are highly affected in comparison to plantain.

#### **Damages due to the banana bunchy top disease**

This disease was noticed on Beni-Maboya axis only. The results of this survey indicate that this disease mainly affects dessert banana compared to other varieties. The high occurrence of this disease on Beni-Maboya axis can be due to the exiguity and promiscuity of banana farms that are established on steep slopes.

#### **Other banana production constraints**

Apart from biotic constraints, banana producers in Beni territory are also challenged by climatic disasters among others strong winds, hail and drought. The strong winds

are not frequent in Beni territory except in the mountainous zone of Maboya where 33.3% of farmers acknowledge the winds as one of the threats to their bananas. Damages caused by hail and drought are rather rare (3.33%) in Beni territory. To circumvent the disasters caused by the winds, farmers stake the banana trees with much more attention to those bearing bunches already.

The lack of fertilization coupled with the physical insecurity caused by the armed conflicts in banana producing zones of Beni territory are, as well, among the major constraints to banana production in this region. Besides, banana producers of this region do not belong to any farmers' association. Hence, access to credits as well as healthy planting material in the surveyed area is a bottleneck to increasing banana production in this region due to lack of financial or credit facilities in these rural areas. Theft of maturing banana bunch is also recurrent in Beni territory.

## **DISCUSSION**

### **Banana farming in Beni territory**

The average farm surface allocated to banana cultivation

in Beni territory is estimated to be 0.68 ha. Previous studies in Butembo region came up with similar conclusions. In fact, these studies found out that production facilities including banana, and particularly beer banana, are practiced at a small scale level, where banana is cultivated on average land surface of 0.67 ha with more than 80% of farmers exploiting less than 1 ha (Musavandalo, 2018). On one side, this land exiguity is due to demographic pressure, which is common in the eastern part of the DR Congo and results in land fragmentation and allocation to several food crops (Vyakuno, 2006). On the other hand, this small size of banana farm is due the fact that after the long period of BXW devastation, banana farms are gradually rejuvenated and restored and farmers are still reluctant to plant banana on a large scale since they are still facing BXW (Sivirihauma et al., 2017a). Hence, they are obliged to manage small banana farms that can easily be controlled and managed (Musongora, 2018). In this territory, the cooking banana can be found in all farms in association with plantain, beer banana as well as dessert banana that are present in 93, 50 and 40% of farms, respectively. These results are not consistent with those found by Adheka (2010) in the Tshopo District (current Tshopo province) where plantains alone stand for up to 81% of all the district banana production, the remaining 19% distributed among the other banana varieties with dessert banana representing 14%, followed by cooking banana and exotic hybrids representing 3 and 2% of banana in Tshopo District, respectively. The inconsistency of results in these two studies can be due to phytogeographical position of Beni territory. In fact, cooking banana, beer banana and dessert banana predominate in the highlands of East Africa (Karamura and Frison, 1998) as it is the case for the highlands of the Noth-Kivu province whereas plantains are the highly cultivated variety in the lowlands of Beni territory (Sivirihauma et al., 2017b). The beer banana which was formerly a widely expanded variety on the farms in this region, can only be found scattered on the farm as a result of its extermination by the BXW (Musongora, 2018) due to its high sensitivity (Ndungo, 2008). This situation can severely affect the banana genetic diversity that was characteristic of the high and lowlands of Beni territory and hence induce an unprecedented genetic erosion (Sivirihauma et al., 2017b).

In Beni territory, the planting materials are selected with regard to the farmers' needs (finger length, taste and colour of the fruit) on one hand and their health status (absence of diseased plants on the clump, absence of banana weevils' galleries in the rhizome, etc) on the other hand. A previous study found that farmers select the planting materials based on their morphological appearance (Musongora, 2018). Even though these criteria are essential, they are not enough to ascertain the supply of healthy planting material since some banana diseases like BXW have been shown to be systemic with

a possible transmission of the disease by asymptomatic planting material (Ocimati et al., 2015). Hence, the planting material acquisition is questionable and cast doubts about the sustainable prevention of the spread of diseases. Besides, the lack of a specialised centre for the production and supply of certified and healthy planting material obliges farmers to resort to poor planting materials (Sivirihauma et al., 2017a). However, the existing research centres and institutions in Butembo region are not able to supply enough macro- and micro-propagated planting materials due to their poor facilities and related structural, administrative and technical problems.

In Beni territory, banana is cultivated under three farming systems, banana monoculture, banana-food crop intercrops and agroforestry systems. Banana-food crop intercropping systems are the most prevalent in the region where banana is associated with beans, maize, potatoes, arrowroots, etc. whereas the agroforestry systems generally consist of banana intercropped with the cash crops among others cocoa and coffee alongside some trees and fruit trees that are scattered on the farm (Musongora, 2018). Banana in monoculture systems is rather rare (10%) and are an exception, and these results are consistent with the previous research in all the surrounding regions as well as in Beni territory (Musongora, 2018; Sivirihauma et al., 2017b).

In Beni territory, banana cultivation is carried out without any fertilization. For various reasons, Sivirihauma et al. (2017a) found out that farmers of this region have never resorted to fertilizers. The most commonly cited reasons have to do with accessibility of the agricultural inputs due to their onerous costs and lack of technical knowledge about their use. Hence, these farmers argue that even if they could access these fertilizers, the current production of banana farms could not be able to compensate for the acquisition costs. Only degradable domestic wastes can be discharged in banana farms from time to time to remediate the nutrient deficiency. Yet, soil fertility loss is one of the big challenges facing most of the arable lands of Beni territory.

Banana produced in Beni territory is either consumed immediately by the farmer's household (77%) or sold on the local market. Similar results were found by Musongora (2018) in Butembo region where 65% of farmers grow banana only for auto consumption against 29% of farmers who can sell part of their harvest. The remaining 5% is constituted by farmers who cultivate banana (essentially beer banana) for marketing only. The share of banana production in Beni territory involved in foreign exchange (sold to Uganda) is produced in Rwenzori sector (Balimwacha, 2018) where insecurity prevented access to the resource persons during this study. Next to coffee and cocoa marketing in Rwenzori sector, banana trading contributes to the improvement of economic conditions of banana farmers and traders (Balimwacha, 2018), but no relevant data is available as

far as the quantification of banana exportation from this region is concerned.

### Constraints to banana production

Banana production in Beni territory is hampered by BXW (80%) and Banana Bunchy Top Disease (7%). These results are consistent with those found out by Ndungo (2008) in Minova region where 95% of farms in the surveyed villages were affected by the BXW but with different disease prevalence. The same has been reported from Butembo region (Musongora 2018, Musavandalo, 2018) where the BXW epidemic devastated almost all banana farms and the current banana farms are regenerated from the previously diseased plants or those that survived this disease. This situation is representative of the general trend in the Great Lakes region of Africa where BXW has reduced 90 to 95% of banana production (Damme, 2008).

Some of the agricultural practices like weeding, banana staking, and removal of the male bud as carried out by banana producers in Beni territory are likely to weaken the banana production system. These farm management operations are similar to those carried out in Butembo region (Musavandalo, 2018) where weeding is done by the machete (when banana is intercropped with cash crops) or a hand hoe (when banana is intercropped with food crops) and male bud usually removed by sharp tools (machete and pruning knife). In this case, these farming tools are a risk factor for damaging the root system with adverse effects on plant anchorage, plant nutrition and the injuries can become a route of contamination to soil borne pathogens. Moreover, these farming tools can also facilitate the accidental transmission of infections or diseases (BXW for instance) from diseased banana plants to healthy ones (Ndungo, 2008; Maina et al., 2007). Conversely, on the removal of the male bud, desuckering and banana staking are not common among banana farmers of Beni territory. Unfortunately, the removal of the male bud is carried out late compared to the intended time for the prevention of BXW spread. Besides, farmers use machetes or pruning knives to remove this male bud in contradiction with what is preconized in the BXW management package, namely the use of a forked stick. This is also another risk factor of the propagation of BXW within the same farm.

### Conclusion

In Beni territory, banana is produced into three farming systems: banana monocrop, banana-food crops intercrop and agroforestry systems. Despite the high potential of Beni territory for banana cultivation, its productivity is hampered by diseases (Banana *Xanthomonas* Wilt and Banana Bunchy Top Disease), climatic constraints (strong winds, hails and drought), poor farming practices

(lack of fertilization and lack of healthy planting material), lack of an organized supply chain, theft of mature bunches and insecurity. In view of the challenges facing banana production in Beni territory, there is need to improve the agricultural practices (selection of planting material, management of the farm, fertilization, etc.) and capacity building for proper management of diseases. Banana farmers in Beni territory should resort to new technologies such as improved varieties for resistance to pests (Banana weevils and nematodes) and diseases (BXW, Fusarium Wilt, Banana Bunchy Top Disease), though efforts are still underway for the production of banana varieties resistant to both BXW and nematodes. This process requires intensive collaboration between farmers and research centres at local, national and international levels.

### CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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