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Bats Guano from Magarawa in Niger: Exploitation, Marketing and Peasant Perception

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ABSTRACT: The use of organic manure is very old and practiced both in rainfed cultivation and in horticulture. In Niger it has been reported the presence of another source of organic manure called bat guano which is unknown to the population of the said country. The objective of this study is to describe the sector of guano exploitation in Niger. A series of questionnaires was formulated to describe the system of exploitation and use of bat guano. In addition to the agriculture and environment departments, three groups of stakeholders in the sector, including extractors and sellers, the trader (s) and users of guano were interviewed. The results of the investigations showed that to date, the only production and exploitation site of guano identified is that of Magarawa located in the department of Gouré in the Region of Zinder (Niger). The extraction is done using rudimentary tools (pick, knife, plastic) then bagged 40 and 85 kg. The quantity extracted per year is 332 tons. Marketing is mainly carried out by a single individual and the selling price is 4000 to 5000 FCFA per 85 kg bag of bat guano. The buyers are located in the vicinity of Gouré and the Diffa region, there is also a clientele coming from Nigeria. The users of guano are mainly horticulturalist in oasis basins. One of the biggest buyers is the commune of Guidimouni located in the southwest, 100km from Gouré. We conclude that this exploitation of bald guano is an income-generating activity and requires good organization.

KEYWORDS: Guano, Bat, horticulture, Gouré, Balla, Guidmouni, Niger.

1 INTRODUCTION

An important and diversified natural resource potential in terms of fauna and flora resources in Niger. However, these resources are threatened because they are exploited without establishing a real basis for management. Indeed, this management is based on the value that it brings to the country. In order to protect and ensure sustainable management of this biodiversity, it is important to gain a better understanding of it, at a time when natural habitats are increasingly threatened by the expansion of human populations and their activities [1].

Within this biodiversity, we find bats, which are one of the most ecologically diverse groups of vertebrates in the world. Belonging to the order of Chiroptera, there are currently 1,300 species of bats described throughout the world. This represents about a quarter of known mammals [2], [3]. It is the second largest group of mammals after rodents. Bats play an important role in maintaining ecosystem functions. Indeed, frugivorous bats participate in pollination and seed dispersal. In some areas, they participate in the regeneration of the vegetation cover [4]. In West Africa, several plant species such as *Adansonia digitata*, *Ceiba pentandra*, *Vitellaria paradoxa*, *Milicia excelsa* and *Cola sp.* are pollinated by bats or the seeds are dispersed by these bats [5], [6], [7]. Insectivorous bats are the primary consumers of nocturnal insects and thus participate in the regulation of populations of insects harmful to plants and humans [8], [9]. Sedentary bats provide a fertilizer called "bat guano" made up of their droppings mixed with other foods such as fruits and insects.

In horticulture, bat guano is well known on different continents and used as an organic fertilizer. Guano is one of the best organic fertilizers that can exist because of its multiple qualities including: high nitrogen and phosphorus contents [10], [11]. Contributing to soil construction, guano is also used as a fungicide and nematicide. It is also an excellent inoculant in composting [12], [13].

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Despite their important ecological and agronomic role throughout the world, they are most often neglected and receive very few studies, especially in Africa. However, these species deserve to be better known because of their roles in providing ecosystem, agronomic and fertilizer services from which humans benefit.

Most of the studies that have been conducted on this product around the world have focused on its biological quality. Also, bat guano from Niger is used by many horticulturalist who do not know any recommendations on its use and exploitation due to a lack of studies on this product.

The objective of this work is to list the benefits, the mode of exploitation and the commercialization of bat guano from Magarawa in Niger.

2 MATERIAL AND METHODS

2.1 MATERIAL

2.1.1 STUDY SITE

The study was carried out in three (3) villages in the department of Gouré (Zinder) Niger. They are: Magarawa (Issoufouri), Balla and Guidimouni.

The village of Magrawa is located 1.92 km north-west of the village of Issoufouri located along the RN1 road 18 km from the department of Gouré. The village of Magarawa is geographically located between longitude 10 ° 08'26 "East and latitude 13 ° 53'22" North. Balla islocated at 20 km Est from Gouré while Guidimouni is at 100km south -west from Gouré toward Zinder Region. Figure 1 indicates the geographic location of the three (3) villages.

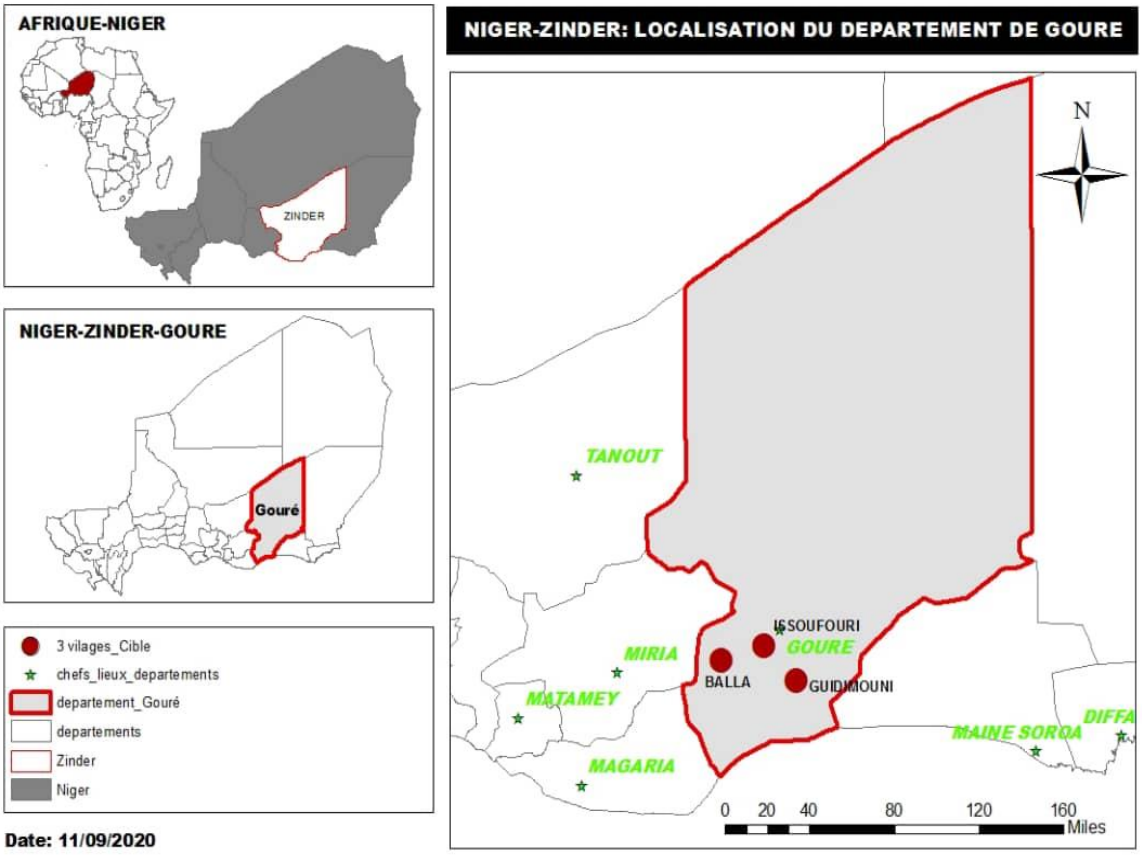

Fig. 1. Geographical location of the study area

2.2 METHODS

we first proceeded to the consultation of the already existing bibliography followed with Fieldwork which consisted of direct observations in the field and the administration of questionnaires through interviews with local actors and resource persons was carried out.

2.2.1 FIELD WORK

The field work carried out, in particular the surveys in order to understand the system of exploitation of bats guano.

2.2.2 PROSPECTIVE VISITS

The prospective visits help to inventory and identify potential bats guano production. Field observations were also carried out around the hillock thus making it possible to collect additional information.

2.2.3 INTERVIEWS WITH STAKEHOLDERS IN THE GUANO USERS

A series of questionnaires were administered to actors in the bats guano exploitation in order to collect information on the appreciation of bats guano uses. questionnaires were also administered to the officials of the local area, in particular the agriculture and animal husbandry department, but also to the elders of the village of Magarawa.

The study on the collection, exploitation and marketing of bats guano was done in the village of Magarawa while peasant perception interview on bats guano was in the villages of Balla and Guidimouni.

The questionnaires and the interview guide developed help collection of information on the activities within the operation of the guano production site. They concerned the operators and beneficiaries of the operation of the site, namely: extractors and sellers of guano, traders and users of guano (horticulturalist). The interviews and questionnaires aimed to learn about the guano extraction and sale system, its marketing and the peasant perception. The random sampling involved 25 (twenty) guano extractors. This low number is explained by the fact that the village has only between 25 and 30 extractors. Also, at the time of the study, the others were in exodus.

Considering the information gathered from the local bat's guano trader, two villages were selected, namely Balla, Guidimouni. These two villages are the first and largest purchasers of bats guano. Then, in each village, a sample of producers using bats guano was drawn up at random, including 35 (thirty-five) from the village of Guidimouni and 25 (twenty-five) farmers in Balla.

2.2.4 STATISTICAL ANALYZES

The data collected was entered and processed using Microsoft Excel Spreadsheet 2016. Frequencies and averages were calculated using SPSS version software.

3 RESULTS AND DISCUSSION

3.1 DESCRIPTION OF THE GUANO PRODUCTION SITE

In the village of Magarawa, located in the Department of Gouré (Zinder Region in Niger), surveys and interviews have shown that this is the only production site for bats guano and is produced into a hill.

The location of this hill is shown in figure 2.

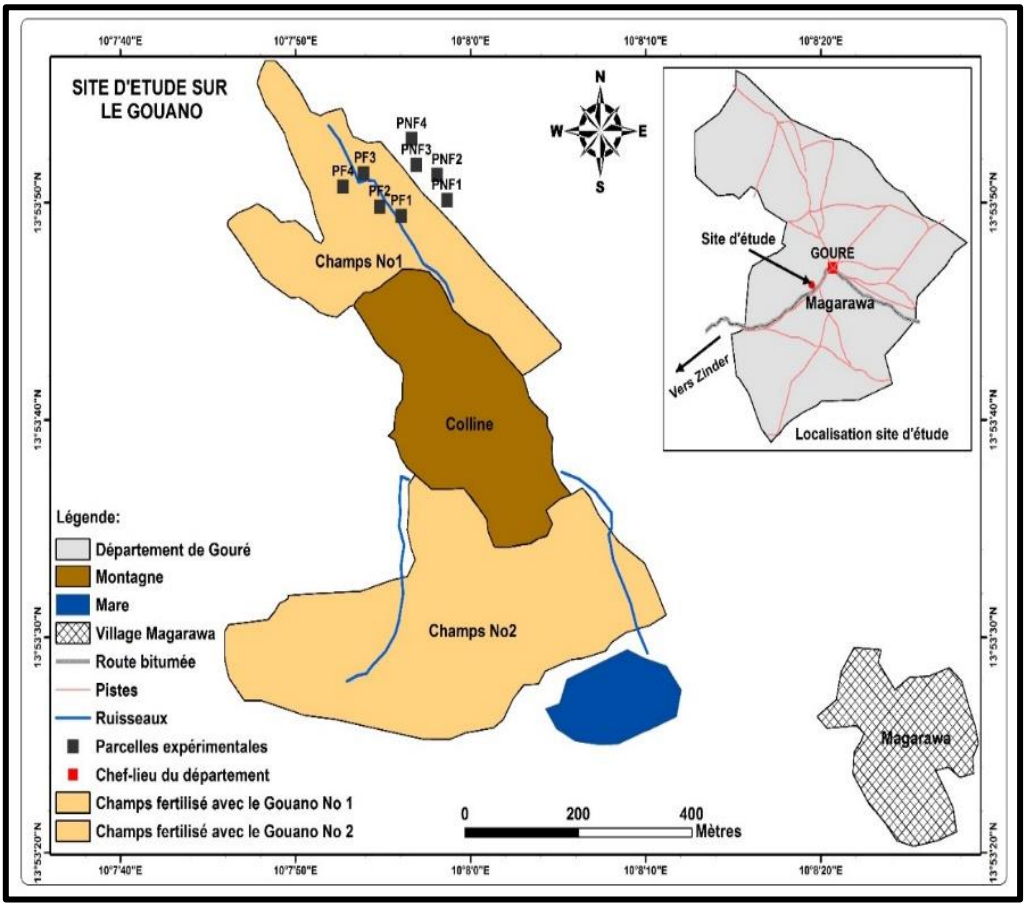

Fig. 2. Geographical location of the guano production site in the village of Magarawa

It emerges from the surveys and interviews that the guano production site is a hill called "Bourgha" located near the village of Magarawa. This description of the bat's guano production site in the village of Magarawa is illustrated in Figure 3.

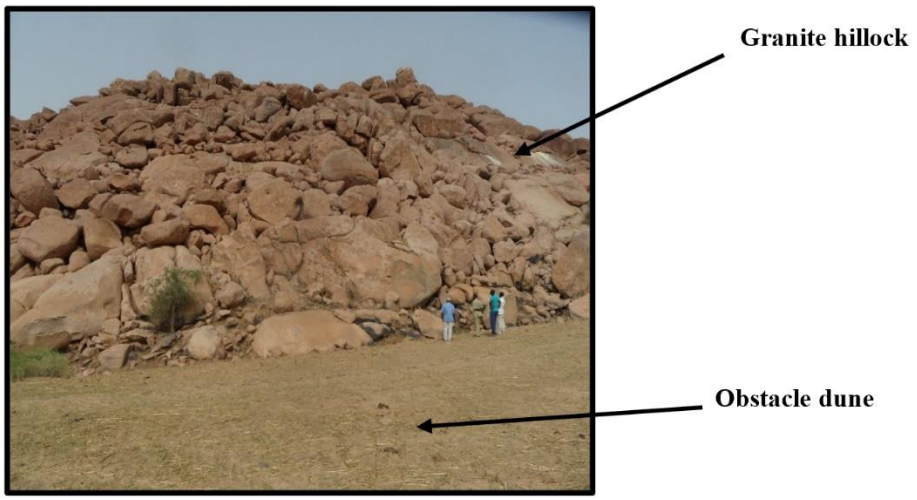

Fig. 3. Exterior view of the guano production site at Magarawa village in the dry season

This hill has two main parts: a granite hillock and a sandy bulge of an obstacle dune. The hillock is a geological formation made up of a superposition of blocks of granite rock, locally called in Hausa language "Damagrame". This hill extends over an area of

over 7 ha with a height of over 50 meters. The multivariate geometric shapes of the granite blocks pilled on top of each other reveal empty spaces that form caves with an entrance located on the outside.

The caves at the Magarawa bats guano production site vary in size and shape. Figure 4 illustrates the different entrances to the caves.

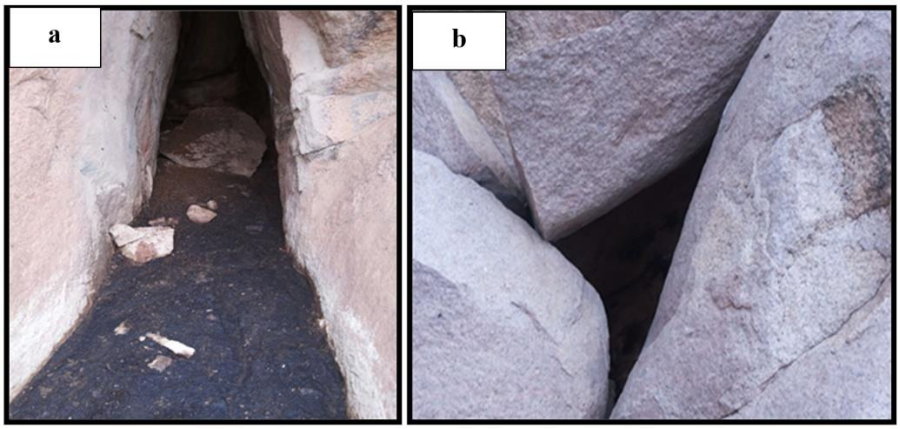

Fig. 4. Types of cave entrances at the guano production site on the hill in Magarawa village: (a): large cave entrance located at the base of the hill; (b): small entrance to the cave located at the height of the hillock

Some have entrances with large openings so easily accessible and others have entrances that are too narrow and therefore inaccessible. Field observations have also shown that the size of caves decreases from the bottom to the top. In other words, at the base of the hill there are caves with a large entrance (figure 4a) while the higher you go up the entrances to the hill become smaller (figure 4b). This characteristic is important because it conditions the choice of the guano exploited.

It was also noted that the dimensions of the entrances are not proportional to the size of the cave. We can observe small entrances at the level of a large cave and vice versa.

Inside the caves, the bats gathered in colonies are hung on the walls of the rocks and others on the roof as shown in figure 5.

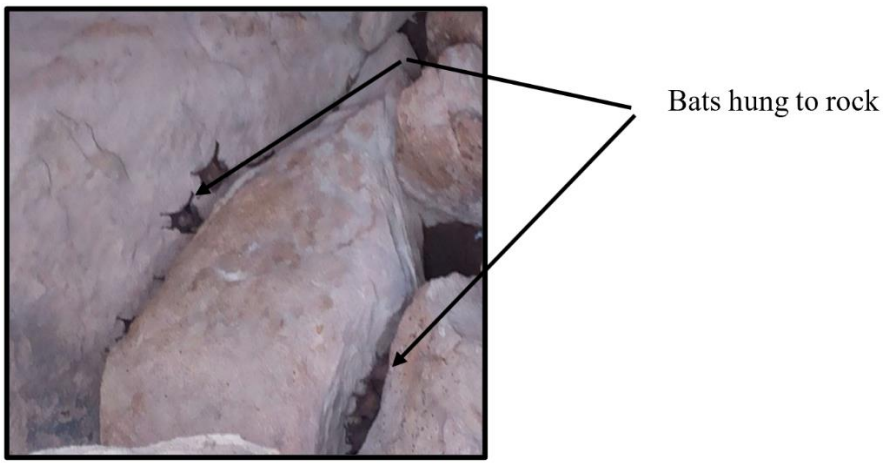

Fig. 5. Bats resting during the afternoon clinging to rock walls

These bats thus spend the whole day out of the sun in caves. At night, they come out to feed on fruits or insects. They are called nocturnal animals. Just before dawn they return to the various caves, the bats regurgitate the rest of the food ingested and defecate.

The droppings and the rest of the food fall and accumulate on the ground. Along the caves, the ground is lined with a blackish substance with a strong smell of ammonia. This substance consists of the droppings of bats locally called in Kanuri language "Takin Birbiro" which means "bat manure".

The granite mound is essentially surrounded by a sandy bulge forming the obstacle dune. This area is largely used as fields for millet cultivation in the rainy season. During the latter, the liquid guano flows from the streams that originate at the foot of the mound towards the low areas.

3.2 Description Of Guano In The Granite Mound

Guano in caves often comes in liquid or granulated forms in places. In the dry season, the freshly produced guano is in the form of granules and very shiny. Often, it is mixed with leftovers from bats, insects or dead birds. In addition to the corpses of animals, the interior of the caves is full of a multitude of species of insects and reptiles such as snakes and scorpions but also a few raptors such as hawks.

In the rainy season, the water which runs along the granite mound can flood the caves containing the guano. The water-guano mixture makes its way to the outside of the hill. Field observations showed three areas of liquid guano flow outside the mound. The liquid mixture flows into the fields through drainage streams observed at the foot of the granite mound. Which brings guano and water to nearby fields.

Figure 6 shows a stream with liquid guano flowing into the fields.

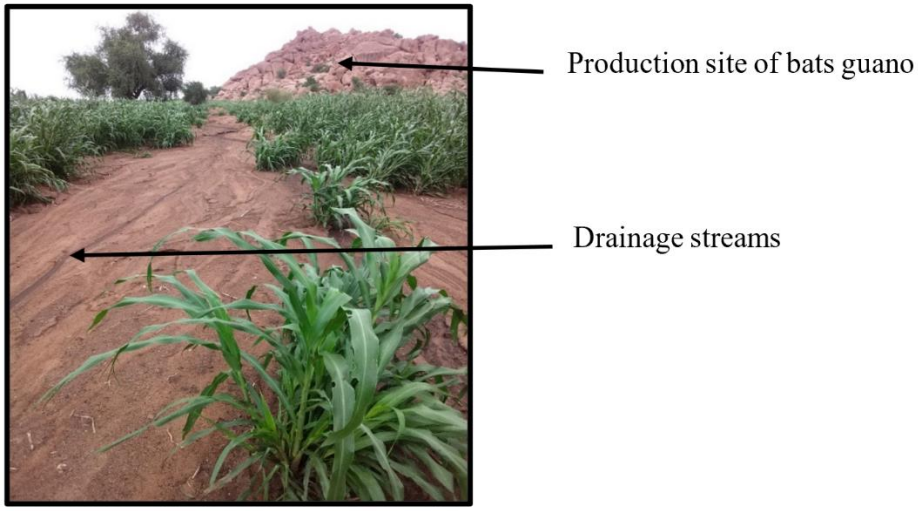

Fig. 6. View of a stream flowing liquid guano in the rainy season

3.3 Site History

Interviews with the elders, that is the elders and the village chief, allowed us to learn about the history of Magarawa hill where bats guano is found. Indeed, the results showed that the name of this hill was "Bourdja" which means in the Kanuri language "refuge of hyenas". Once upon a time, the hill was inhabited by hyenas who eventually left. The presence of the village and the agricultural activities that are practiced around the hill ended up destroying their habitat. This hill also served as a shelter for travelers. Indeed, pottery has been found in some caves.

However, the presence of bats in this hill could not be dated. Respondents have no idea when the bats arrived.

3.4 Guano Collection System In Magarawa

3.4.1 Characteristics Of Collectors

The characteristics of bats guano collectors at the village level of Magarawa are presented in Table 1.

Table 1. Characteristics of respondents at the village level of Magarawa

Variables	Modalités	Totals	Percentages
Sexe	Homme	25	100
	Femme	0	0
Age des exploitants	< 15 ans	0	0
	15 – 20 ans	10	40
	21 – 25 ans	12	48
	25 – 30 ans	2	8
	30 ans et +	1	4
Instruction level	Sans	22	88
	primary school	3	12
	middle School	0	0
Marital status	Single	3	12
	Maried mono	20	80
	Maried poly	2	8
	Widower	0	0
Main Activities	Agriculture	20	80
	Horticulture	0	0
	Husbandary	2	8
	Trade	3	12

The Magarawa site is the only known production and exploitation site of bat guano in Zinder region. All of the respondents confirm it. The extraction of bat guano at the Magarawa site is done in complete freedom without any control. All the bat guano collectors reside in the village of Magarawa next to the hill. This exclusivity of the exploitation is due to the perfect mastery of the places and techniques of extraction of the guano which they learned from their elders. The total number of extractors varies from 25 to 30. Among the collectors some are more experienced than others. Surveys show that 45% of extractors have an experience of 1 to 3 years against 55% who have a longer experience varying from 4 to 7 years. It also emerges that there is a subgroup of much more experienced extractors.

With regard to the sex and age of the operators, it can be seen from the table that all extractors are men whose age is between 15 and 25 years with an average age of 21.5 years. The male exclusivity of this activity and the youth of the guano extractors and sellers testify to the physical demands of the work of collecting guano from the caves. As respondents used to say, "the work of the hill is a man's job".

When considering the level of education, 12% have a level of education limited to primary school. It is also noted that more than 90% attended Koranic school. This low rate and low level of education can have an impact on the quality of life as well as on the awareness of the issues around this guano mining sector.

From the point of view of marital status, the high proportion of respondents (extractors and sellers) of bat guano is married (88%) of which only 8% are polygamous. Singles (12%) remain the youngest, aged 17 to 18.

The main activity of extractors - sellers of guano is mainly rain-fed agriculture. In the department of Gouré, horticulture is practiced in oasis basins and it turns out that the village of Magarawa does not have any. Guano mining is their first secondary activity, otherwise they would go on an exodus to Nigeria.

3.4.2 GUANO EXTRACTION AND SALE PROCESS IN MAGARAWA

The guano produced by the bats is found inside the caves in the hill located at different heights with varying dimensions. The process of extracting guano, usually on demand, is as follows:

The practice of extracting guano is done in the dry season from October to May and can continue in exceptional cases during the rainy season. Bats have activities associated with their annual life cycle (hibernation, grouping, reproduction) [14]. This activity is done in an ascending way, that is to say that the caves located at the base of the mound are the first to be explored then the one in height. The extractors locate the most easily accessible caves.

The process of extracting guano involves digging up the guano spread on the ground, which is then collected and packaged in bags. Due to the increased in demand, the easily accessible caves are quickly exhausted and then the smaller and narrower ones are then exploited. When almost all of the guano in the caves at the base of the mound is exhausted, the extractors access those located a little higher up using much stronger ropes. This requires extra effort and equipment to climb the granite mound. The same process as in the caves at the base is carried out in height. The filled bags are transported to the ground using the ropes.

Extractors take some protective measures. Indeed, 75% of workers in caves use protective measures against 15% who do not. Among those who adopt protective measures, we note 75% use the muffler and 15% of makeshift protective clothing. Only 10% use both the muffler and protective clothing [15]. highlighted three main groups of people at risk of disease contamination following exposure to guano. These groups of individuals are: cave guano extractors; the conditioners of the extracted guano and the buyers of the guano at the extraction site.

Despite protective measures, this guano mining activity carries many risks (snakebite; risk of falling or sprain; risk of lung infection) for workers. Apart from the risk of physical accident, a large number of extractors complain of respiratory problems, including colds and coughs. These manifestations could be caused by respiratory infections due to inhalation of guano dust which contains numerous bacteria [16], [17] and fungi [18], [19], [20] [21]., [22] proved the presence of Histoplasma capsulatum spore grows in bat habitats. Inhalation of *Histoplasma capsulatum* spores cause histoplasmosis which is an infectious disease that can cause respiratory problems [23], [24].

Once harvested, the guano is transported to the village of Magarawa by donkey cart 100% of the respondents. Otherwise, the wheelbarrow is used (5%). Note that the large bags filled with guano weigh 70 to 80 kg, and the smallest 40 and 45 kg.

The main difficulties in collecting guano lie in the exploration of small caves, especially in the dry period, generally at higher heights in the dry period, and then in the delivery of bags of guano to the ground.

The guano collected is mainly intended for sale on order according to 100% of respondents, but a fringe of respondents (25%) can offer it as a gift to relatives, friends and acquaintances. The amount of guano collected is taken back to the village and sold to Les, the only merchant who ordered it. The purchase price of guano paid by the trader to the young man from Magarawa varies from 400 to 500 CFA per 70 to 80 kg bag. What will become of the guano given to the merchant? The next step in looking at the guano marketing chain.

3.5 MARKETING OF BAT GUANO

The marketing of guano in the Department of Gouré began in 2000. This activity is owned by a single operator. This could be explained by the lack of information on the usefulness of guano but also the distance and the lack of means of transport.

Thus, over the years, we have observed an increase in the price of guano depending on demand and the location of the clientele. However, despite the delay in delivery and sometimes the poor quality of some deliveries of guano, users continue to buy guano at the price offered to them. This is one of the consequences of monopolizing the sale of guano. These results are confirmed by the work of economists who emphasize that competition is the main factor of performance and innovation [25], [26], [27], [28].

The distribution of Magarawa's guano has experienced a meteoric rise year after year. The clientele comes mainly from Niger and also from the northern states of the Federal Republic of Nigeria are perfect examples.

The quantity of guano collected at the Magarawa site per year exceeds 332 tons. The village of Guidimouni, particularly at the level of the basin, receives 90% of the guano extracted from the Magarawa site. It is one of the largest basins in the Zinder region. This exploitation and marketing of guano is an important source of income for the locals. According to estimates depending on the quantity extracted, the turnover can reach 18 million FCFA / year. Indeed, according to the ([29], the extraction of bat guano constitutes a renewable and invaluable resource for many local communities in developing countries in Asia, Africa and Africa. from Latin America. For example, thanks to the ecosystem services provided by bats, the Thai cave of Khao Chong Pran has become a major source of income (10,000 to 135,000 $) for local communities in the region, as well as a unique tourist attraction for travelers [30].

3.6 HORTICULTURE IN BALLA AND GUIDIMOUNI

The main buyers of Magarawa's guano are mainly horticulturalist who use it as a fertilizer in their plots. Women are poorly represented in in this activity. The average age of horticulturalist is respectively 39.52 ± 12.37 and 32.17 ± 9.99 in Balla and Guidimouni.

The system of cultivation of horticulture areas remains mainly polyculture. Depending on the basins, there are 5 to 7 speculations on a plot, mainly small family-type farms. The interview with the horticulturalist of Balla and Guidimouni reveals that cabbage occupies the first place of cultivated speculations. These results are in agreement with those of the [31], which ranks the Zinder region in second place as a producer of cabbage around 49,290.76 tons in Niger after Tahoua.

3.7 APPRECIATIONS OF THE USE OF BAT GUANO

It should be noted that the inhabitants of the village of Magarawa, where guano is collected and exploited, do not practice horticulture. So, to provide answers to the point concerning the peasant perception of guano, we had to go to the villages of Balla and Guidimouni. The assessment by producers of the effects of guano, both on crops and on the soil is illustrated in Table 2.

Table 2. Description of farmers' perception of Magarawa guano

Variable	Balla (%)	Guidimouni (%)	Meam (%)
First contact ith bats guano (%)			
Parent	48	54,3	51,7
Neighboring village	32	25,7	28,3
Marcket	12	5,7	8,3
horticulturalist	8	8,6	8,3
Source of supply (%)			
Cave	0	5,7	3,3
Market	100	88,6	93,7
Gift	0	5,7	3,3
Beginning of bats guano use (%)			
Less 5 years	4	37,1	23,3
5 à 10 years	28	48,6	40
11 à 15 years	40	2,9	18,3
16 à 20 years	12	8,6	10
21 years to more	16	2,9	8,3
Benefits of using bats guano (%)			
Loosened soil	48	42,9	45
Soil aeration	4	5,7	5
Vigorous plants	84	65,7	73,3
Good quality fruit	92	54,3	70
Production	88	62,9	73,3
Water holding	48	57,1	53,3
Constraints (%)			
Expensive	-	2,9	1,7
Hardened soil	12	2,9	6,7
none	88	88,6	88,3
Burn plant	-	5,7	3,3

The first uses of guano by producers are mainly due to the 54.3% family relationship. Except the ¼ of the producers knew the guano following displacements in the neighboring villages. 96.7% of guano users obtain their supplies from the market in the two villages. 10% of respondents use their profits for purchases of items such as clothes, motorcycles and carts, but also food. Remember that guano exists in two forms at the hill level of the village of Magarawa: dry guano and fresh guano. The surveys then showed that 28% of guano users prefer to buy fresh guano.

Thus, the results showed that 96.7% of the horticulturalist in the Balla and Guidimouni basins use guano. To improve agricultural production in the different basins, producers use three types of fertilizer namely manure, chemical fertilizer and guano. The soils of the countries of sub-Saharan Africa have a low level of intrinsic fertility specific to each agro-ecological zone. Mineral deficiencies are real factors limiting agricultural productivity, the use of fertilizers is an alternative [32]. Guano has a good

performance in stimulating the growth and production of vegetable crops. According to the Oregon Department of Agriculture (USA), [33] cited by, Nurhida (2019), bat guano is a very good quality fertilizer and not contaminated with pathogens or toxins. This quality is due to the decomposition process by bacteria and fungi that the guano is said to have undergone from inside the caves. A well-decomposed guano improves the physical properties of the soil, can be used as a fungicide, nematicide and also a compost inoculant [12], [35], [36]. This is how, for the horticulturalist in the villages of Balla and Guidimouni, especially in the different basins, guano is a very good fertilizer for both growth and yield.

However, investigations revealed that no use of guano has been made on rainfed crops including millet.

4 CONCLUSION

It emerges from this study that the exploitation and use of guano dates back a long time in the Department of Gouré, but its sale is recent. The exact dates could not be determined. Today, the Magarawa site supplies guano for the towns of Zinder, Diffa and even exports to Nigeria. The extractors and sellers of guano at the Magarawa site are insufficiently organized. Guano operators lack protection information for its extraction. During operation it was found that the workers did not take precautions to expose themselves to diseases and viruses. Guano is heavily used and well known in the Balla and Magarawa cuvettes. It has been found to be very effective as it improves production and soil quality. Given that an average of 332 tons of guano is mined per year at the Magarawa site, it will be preferable to set up a management committee that will facilitate the exploitation of the guano.

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