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Local Chickens Farming System Characteristics and Their Genetic Resources Management in Seno Province of Burkina Faso

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ABSTRACT

Local genetic resources have an important place in poultry production in Africa. However, knowledge of these genetic resources and their breeding systems is quite often limited. This study was conducted in Seno Province/Burkina Faso and aimed to characterize the local chicken production system, the genetic resources used, and their management in this area. A survey was conducted involving 185 chicken farmers in a rural area. The snowball sampling method was used to co-opt interviewees, and face-to-face interviews were done. The questionnaire includes closed and open-ended questions. Production system characteristics showed that local chickens were bred in a free-range production system with few inputs. There were multiple production purposes, such as self-consumption (meat and eggs), saving, selling, and donating to strangers. The sale of chickens was ranked as the main purpose with 0.48 as the index, and self-consumption of chicken meat came in the second position with 0.34 as the index. According to farmers, three phenotypes of chickens ("breed or ecotypes") are encountered in the area. However, these phenotypes are raised together with uncontrolled mating practice, leading to a tendency towards uniformity of phenotypes. Almost all farmers (98.9%) stated they select breeding roosters. This selection is mainly based on growth performance (96.6%). Nevertheless, they ranked "resistance to diseases" as the characteristic they would improve primarily if they had all the possibilities (index 0.43). In general, the production system was extensive with low input, whereas the local chicken genetic resources were under poor management, which can lead to genetic erosion.

Keywords: ecotypes; genetic erosion; local genetic resources; multiples purposes; uncontrolled mating

INTRODUCTION

In developing countries, specifically in Africa and Asia, animal productions rely primarily on local genetic resources (Leroy *et al.*, 2020). In Burkina Faso, for example, local populations for different species were estimated to be over 99% in 2016 (Leroy *et al.*, 2016). Most of them have characteristics of adaptation to various harsh environments as well as to various production systems (Ouedraogo *et al.*, 2015; Mahoro *et al.*, 2017). This diversity represents a great wealth for poor livestock keepers who have neither the means nor the knowledge to breed so-called more efficient breeds. It is also a treasure to be preserved for future needs.

However, local chicken genetic resources management is generally challenging in developing countries. Indeed, due to their low productivity, farmers frequently look for improvement. Crossbreeding is generally used (Leroy *et al.*, 2020) as it allows rapid results compared to within-breed selection. However, this crossbreeding is frequently uncontrolled (Leroy *et al.*, 2016), leading to genetic erosion and even the disappearance of some breeds or ecotypes (FAO 2015; Leroy *et al.*, 2020).

Although the importance of these local resources is no longer to be demonstrated, it should be noted that the level of knowledge on most of them remains very limited. Limited knowledge includes phenotypic, genetic, and physiological characterization, population size, and genetic resources management.

Studies of local chicken production systems are frequently undertaken but do not often integrate genetic resource management issues. For instance, in Burkina Faso, Pindé *et al.* (2020a) were interested in the characterization and typology of the local chicken production system in Burkina Faso. This study was conducted in the country's three agroecological zones, including our study area. Though, it did not consider the genetic resources encountered and their management. Another study conducted by the same authors (Pindé *et al.*, 2020b) on morpho-biometrical characterization estab-

lished a sample by agroecological zone. This did not allow us to know the presence of possible ecotypes within an agroecological zone. This study aims to characterize the local chicken production system, the genetic resources used, and their management in the Seno Province of Burkina Faso.

METHODS

Data Collection

The study was conducted in Seno Province, in Burkina Faso Sahel region, from May 20 to June 20, 2021. The climate in this area is Sahelian type, characterized by low rainfall (less than 600 mm of water/year) and intense evaporation. The vegetation is in the form of woody stands consisting mainly of thorns, such as *Balanites aegyptiaca, Ziziphus mauritiana, Acacia raddiana,* and *Acacia nilotica.* The herbaceous steppe is made up of seasonal herbaceous carpets, discontinuous due to the presence of zones of bare soil.

Due to the lack of a catalog of chicken farmers, the snowball sampling method was used. Snowball sampling is a non-probability sampling method that starts with one or a few individuals as an entry point and where new interviewees are recruited by those already in the sample (Kirchherr & Charles, 2018). Livestock farmers from 7 villages (Figure 1), belonging to an innovation platform for guinea fowl and reared chickens, served as the entry point. In each village, each platform member was interviewed and then asked to introduce us to at least one other local chicken farmer he knows. The same request was formulated for the new recruits after their interview, and so on. The recruitment process stopped in that village when the latest interviewee referred us to already interviewed farmers. A total of 185 chicken farmers were surveyed. A questionnaire including closed and open-ended questions has been developed for this purpose. This questionnaire considered the socio-economic characteristics of chicken farmers, production purposes and production management, chicken marketing, genetic resources used, and their management (Table 1). To assess the relative importance of production purposes and genetic improvement goals, it was asked to each interviewee to range his three first production purposes and his three first genetic improvement goals (the three first characteristics he would like to improve if he had all possibilities to do as he wanted). The relative importance of production purposes can help understand genetic resources management well. Indeed, more important purposes could influence producer's choices and practices on genetic resources. The relative importance of genetic improvement goals was researched to orientate an eventual intervention for genetic improvement.

The survey team comprised two technicians speaking *Fulfulde*, the primary language spoken in the locality. These technicians were recruited and trained on the questionnaire, which was tested with ten farmers and some modifications were made before the data collection phase.

Statistical Analysis

Statistical analysis was performed using R (version 4.0.2). A descriptive statistical analysis was done to calculate frequencies. The indices have been developed through data from production purposes and genetic improvement goals ranking. Three points were awarded to each production purpose or each genetic improvement goal whenever it was ranked first, 2 points whenever it was ranked second, and 1 point whenever it was ranked third. Thus, the overall points (N_i) for each production purpose or genetic improvement goal ($_i$) were calculated as follows:

$$N_i = 3.n_{1i} + 2.n_{2i} + n_{3i} \quad (1)$$

where n_{1i}, n_{2i}, and n_{3i} are the number of respondents who answered rank 1, rank 2, and rank 3, respectively, for the i-th genetic improvement goal or the i-th production

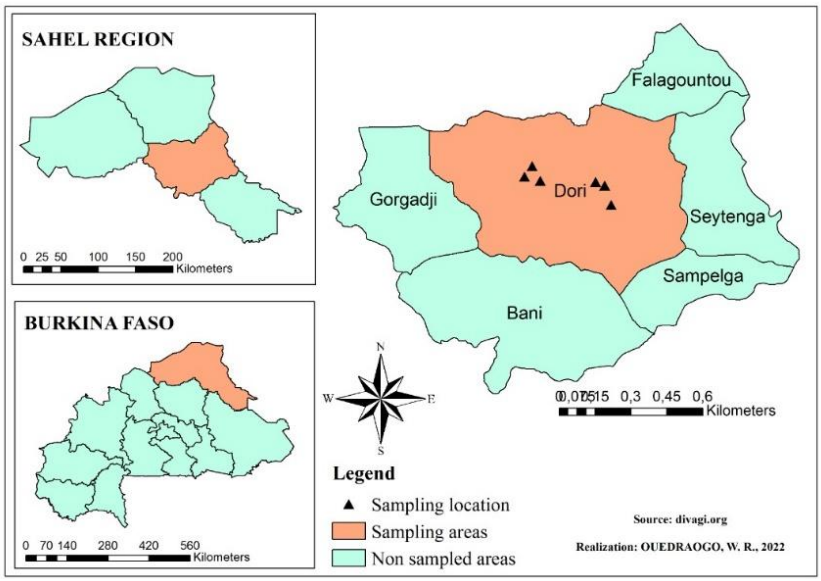

Figure 1. Map of the sampling sites in Seno Province of Burkina Faso

Table 1. The study variables

Variables	Data collected	Description
The farmers socio-economic characteristics	Farmers ethnic group, gender, marital status, instruction level, households' socio-economic activities	Farmers socio-economic situation shows in what socio-economic environment evolves genetic resources and can help to understand their management.
Production purposes and production management	Production purposes and the rank of the three more important purposes, husbandry equipment, chicken feed resources, feeding system, chickens health care	The objectives are to know: What farmers aim to achieve through chicken farming and what are they done? What resources are used to achieve that? Production purposes and resources available for production influence farmers choices.
Chicken marketing	Chickens' sale period, buyers, sale decision making, difficulties to sale, satisfaction about prices	These variables can allow us to understand market demand and the level of openness of production to the market. The market is often the best incentive for production.
The genetic resources used and their management	Genetic resources used, their description, their reproduction system	This information is important to know if there are many phenotypes and if genetic resources are sustainably managed.
The genetic improvement goals	Genetic improvement goals, selection practice, rank of the three more important genetic improvement goals	Genetic improvement goals can allow us to understand genetic resources management well and orientate for possible intervention.

purpose. The index (I_i) for a production purpose or a genetic improvement goal ($_i$) was calculated as follows:

$$I_i = \frac{N_i}{\sum_{i=i}^{t} N_i} \quad (2)$$

where t is total genetic improvement goals or total production purposes.

RESULTS

Socio-economic Characteristics

The respondents were mainly Fulani (97.30%), whose average age was 44±12 years. More than half (52.97%) were women, and the majority received no education. Socio-economic activities of households include agriculture (plant production), practiced by 95.68% of households, and animal husbandry, practiced by all households, and to a lesser extent, commerce, wage labor, and a variety of other minor activities (Table 2). Crop production was cited as the main economic activity of households by 88.11% of respondents, while only about 9.73% cited livestock keeping.

Chicken production was associated with other species, including cattle, sheep, goats, donkeys, and other poultry. In about 66.49% of households, chickens belonged to several family members.

Production Purposes and Production Management

Chicken production purposes included the sale of chickens (cited by 100% of producers), self-consumption of meat (99.46%) and eggs (10%), and making donations to strangers (91.35). Also, hens are used for guinea fowl eggs brooding (7.57). Production for sale, self-consumption of meat, and donations were respectively the first, second, and third production purposes with 0.48, 0.34, and 0.18 as indices, respectively (Table 3).

Table 4 shows husbandry equipment and production management information. Most farmers (94.05%)

Table 2. Households' socio-economic characteristics of chicken farmers in Seno Province of Burkina Faso

Variables	Modalities	Frequencies
Ethnic group	Fulani	97.30
	Bella	1.54
	Sonrhaï	0.54
	Mossi	0.54
Respondent gender	Female	52.97
	Male	47.03
Respondent education level	no education	54.59
	Literate in local language	21.08
	Primary school	4.86
	Secondary school	1.08
	Koranic school	23.24
Households' socio-economic activities	Plants production	95.68
	Livestock keeping	100.00
	Commerce	14.05
	Wage labor	3.24
	Others (gold panning, crafts, butchery, masonry, sewing, etc.)	20.00
Households' main economic activities	Crop production	88.11
	Livestock keeping	9.73
	Commerce	1.08
	Wage labor	1.08
Species raised	Cattles	80.00
	Sheep	73.51
	Goats	83.24
	Chickens	100.00
	Guinea fowl	27.57
	Asses	35.68
	Others	11.35
Ownership of the chickens	Head of household	15.13
	Wife	16.76
	Children	1.62
	Distributed among several household members	66.49

Table 3. Ranks and indices for production purposes

Purposes	Rank 1	Rank 2	Rank 3	N_i	Indices
Donation	1	17	163	200	0.18
Self-consumption of chickens' meat	20	150	15	375	0.34
Sale of chickens	164	17	4	530	0.48
Self-consumption of eggs	0	0	1	1	0
Brooding guinea fowl eggs	0	1	2	4	0
Sale of eggs	0	0	0	0	0

have traditional hen houses. These are coops constructed with local materials. They have about 1 m tall and give very little ventilation. About 4.87% of farmers said they did not have a hen-house, while about 1.08% of households had a semi-modern one. These last hen-houses are also made of local materials but are slightly taller than the first ones. They are easier to clean and often have small windows for ventilation. When they exist, the equipment (feeders and drinkers) is made essentially of local materials, and sometimes used kitchen utensils are used.

In all the farms, a scavenging system was used. Chickens wander during the day to search for their feed. Most farmers (62.3%) served a supplement distributed with irregular frequency. Termites, cereals, and/or household wastes were the main products used as a supplement. Farmers cited that feeding difficulties are one of the constraints to production.

The main constraint raised by the farmers is the high prevalence of diseases that causes heavy losses. Newcastle disease was the most often cited as responsible for these losses by livestock keepers. However, other diseases may occur in the area. Despite this high prevalence highlighted, 87.03% of respondents declared they did not vaccinate their poultry against any disease. They explained this at first glance by the negligence or low accessibility to veterinary services. Further discussion, however, reveals a problem of confidence in the effectiveness of vaccination to protect their poultry. Indeed, some farmers stated they had been vaccinated in previous years, but their chickens died due to epidemics. According to their declaration, some have even linked mortalities to vaccination because mortality started a few days after vaccination. Among farmers who stated they vaccinate their poultry, 87.50% said they did not know against what disease it is done.

Table 4. Farms equipment, feeding, and health management of chicken farmers in Seno Province of Burkina Faso

Variables	Modalities	Frequencies
Type of henhouses	Traditional	94.05
	Semi modern	1.08
	No henhouse	4.87
Type of feeders	No feeder	46.11
	Used kitchen utensils	44.32
	Modern feeders	9.19
Type of drinkers	Traditional	69.73
	Used kitchen utensils	23.78
	Modern	6.49
Practice of supplementation	Yes	62.30
	No	37.70
Use of vaccination	Yes	12.97
	No	87.03
Knowledge of the disease against which the vaccination is done	Yes	1.62
	No	11.35

Chicken Marketing

The marketing of chickens was mainly linked to liquidity needs. But some farmers declared also they targeted favorable market periods, such as festive periods, for sale. When chickens belong to several household members, the head of the household was consulted for sale in a large majority of cases (72.87%). Resellers were the most important buyers; about 78% of farmers stated that finding buyers was not difficult. Almost all farmers (95%) stated they were often satisfied with chickens' prices on the market (Table 5). It should be noted that no farmer marketed chicken eggs.

Genetic Resources Used and Their Management

Most respondents recognized the existence of different phenotypes ("ecotypes") of chickens in the area: 53.52% cited two phenotypes, 32.97% cited three, and the others cited one. The local names of the three phenotypes cited were: *Dêguêrêdjé, Pulpuli* (also called *hakoundêdjé* or *tchiofé foulbé*), and *Kolontoodjé* (also called *doogodjé, tchiofébellabé* or *tchiofétoubaako*). These phenotypes were distinguished by morphological and functional characteristics, as well as (according to approximately 17% of respondents) by the organoleptic characteristics of their products. They were described by farmers as follows: 1) *Dêguêrêdjé* was described as a dwarf with short legs, prolific and less susceptible to diseases than others. According to some farmers, its eggs and meat have the best taste compared to the others. 2) *Kolontoodjé* was described as large and tall, less prolific than the others, and very susceptible to diseases. Some farmers described its eggs and meat as less flavorful than the others. 3) *Pulpuli,* also called *Hakoundêdjé,* which means in Fulani "those of the middle", has *Dêguêrêdjé* and *Kolontoodjé* intermediate characteristics.

If farmers gave a fairly precise and repetitive (from one farmer to another) theoretical description of the three phenotypes, they found it difficult to physically identify them too precisely and distinctly. Indeed, when a producer stated raising several phenotypes, we asked several family members to identify these phenotypes for

us. The results showed that they did not often point out the same chickens for a given phenotype. This is because the chickens had approximately similar physical characteristics. All farmers raising several phenotypes declared they raised them together without any mating control system.

Genetic Improvement Goals

Almost all farmers (98.91%) stated they selected breeding roosters. This selection was mainly based on growth performance (96.61% citation), plumage (47.46% citation), resistance to diseases (15.25%), docility (11.86%), and to a lesser extent laying (5.08%). Seventeen percent (17.29%) of farmers stated they chose breeding roosters systematically from *Kolontoodjé*. Its greatest market value justified this preference for the large-size phenotype. The few farmers who said they do not select breeding roosters explained their choice by the presence of several roosters in their neighborhood. These roosters ensure the hens' mating since the birds scavenge together all day. The results of the genetic improvement goals ranking and the indices calculated are reported in Table 6. The results showed that resistance to diseases is the most important characteristic, with 0.43 as the index, followed by growth performances (0.22).

DISCUSSION

Socio-economic Characteristics

The majority of respondents were females with no education level. This is explained by the fact that the questionnaire is intended for the household, and any available person who can provide the information was accepted as a respondent. As the study occurred at the start of the rainy season, men were often busy in the field for sowing. The poor level of education of respondents could be a handicap. Indeed, education might allow farmers to understand well a training program for better farm management (Ali & Hossain, 2010), including genetic resources management. Chicken farming was done in association with other species and plant production. Thus, this farming fits into an agricultural system and contributes to its equilibrium, as Padhi (2016) noted.

Production Purposes and Production Management

Chickens are reared for several purposes; this agrees with the multifunctional role often described for this type of farming. Among all the purposes mentioned, the sale of chickens is ranked as the farmers' first and most important purpose. However, the sale was mainly done when liquidity was needed. Therefore, this sale hides a saving and insurance role, corresponding to what is encountered in the literature on local chickens in developing countries (Padhi, 2016).

Rearing conditions are generally poor: unsuitable habitat, absence of health care, and a scavenging system for feeding with no or irregular supplementation. This is in line with what is seen in several locations across Africa (Mbuza *et al.*, 2016; Mahoro *et al.*, 2017; Manyelo *et al.*, 2020). Despite a high prevalence of diseases, a large majority said they did not vaccinate their chickens. These results are similar to those already observed

Table 5. Chickens marketing management of chicken farmers in Seno Province of Burkina Faso

Variables	Modalities	Frequencies
Chickens' sale period	In case of money need	98.92
	Festive periods	13.51
	When chickens reach their optimal growth	4.86
	Epidemic period	1.62
Authorization for sale when chickens belong to more than one household member	The head of the household gives authorization	72.87
	Everyone makes their own decision	27.13
Buyers of chickens	Resellers	98.92
	Transformers	14.05
	Direct consumers	22.16
	Others chicken farmers	2.70
Existence of difficulties in finding buyers	Yes	21.62
	No	78.38
Satisfaction about market prices	Yes	95.00
	No	5.00

Table 6. Ranks and indices for improvement goals

Characteristics	Rank 1	Rank 2	Rank 3	N_i	Indices
Resistance to diseases	128	43	11	481	0.43
Growth performances	21	42	97	244	0.22
Prolificacy	32	91	48	326	0.3
Plumage	3	7	10	33	0.03
Docility	1	2	19	26	0.02

by several other authors in developing countries (Kumaresan *et al.,* 2008; Ouedraogo *et al.,* 2015; Mbuza *et al.,* 2016; Mahoro *et al.,* 2017). In our case, this situation seems to be linked to a lack of confidence in vaccination. Indeed, farmers who have previously experimented with vaccination declared it ineffective in protecting their chickens. Some have even linked the occurrence of an epidemic in their poultry to the vaccination. The lack of confidence in vaccination can explain the strong desire of farmers for disease-resistant chickens. Vaccination failure may be due to non-compliance with certain rules, such as maintaining a cold chain in vaccine storage, using the proper route for vaccination, and vaccinating only healthy birds. Among the few farmers who said they vaccinated poultry, 88% said they did not know against what disease this was done. This could exacerbate the crisis of confidence as farmers vaccinate against a disease (probably Newcastle disease) and expect no epidemic. The occurrence of any other disease-causing losses could therefore be interpreted as an inefficiency of vaccination. It appears important to improve communication between farmers and vaccinators to avoid misunderstandings. Indeed, comprehension of how vaccination works and that a vaccine only protects against a specific disease can improve the farmers' adhesion to vaccination (Lindahl *et al.,* 2019).

Chicken Marketing

According to their statements, most farmers did not encounter any sales difficulties and the prices were satisfactory. This could mean that there is a strong demand. The consumer preference for local chickens considered more flavorful and relatively cheaper, could explain this demand (Manyelo *et al.,* 2020). Chicken farming can therefore be seen, on the one hand, as an opportunity for farmers and, on the other hand, as a means of fighting poverty for policymakers (Desta, 2020). The market incentives can explain the tendency to select for the chicken weight improvement, as farmers stated that the large chicken had the best prices. Farmers would then be faced with a trade-off: on the one hand, the prevalence of disease pushes for resistance improvement, and on the other, the market incites large chickens.

Chicken eggs were used very little for consumption and no producer has reported selling these eggs. This may be due to the poor laying capacities of local hens: the few eggs laid are preferentially used for brooding. These results differ from those Mahoro *et al*. (2017) observed in Rwanda, where egg production for consumption is cited as the primary production objective.

Genetic Resources Used and Their Management

The description given by the farmers for the three phenotypes shows clear differences in their morphological and functional characteristics, which contrast with the fact that there are difficulties in physically identifying them. Also, some farmers in the same villages do not recognize the existence of several phenotypes in their localities. This situation could be linked to the practice of crossbreeding within the three phenotypes, which tend to standardize their morphological characteristics. Indeed, more than half of respondents declared raising at least two phenotypes and all declared did not have any mating control. To this, we must add the fact that chickens from the same neighborhood scavenge together daily. Also, almost all farmers select breeding roosters among those with good growth. All these practices lead to a trend towards morphological uniformity, making distinguishing phenotypes more challenging. FAO (2015) has cited these indiscriminate crossbreeding as factors causing local genetic resources erosion. Similar results have been observed in Tanzania, where crossbreeding is made between three ecotypes (Mushi *et al.,* 2020). Thus, the descriptions of the three phenotypes given by some farmers would be linked much more to the knowledge they received than to their own observations. Therefore, this hypothesis suggests that we are in a situation where phenotypes are being absorbed.

The largest phenotype *Kolontodjé* is also called *tchiofébellabé* or *tchiofétoubaako*, which in Fulani mean respectively "chicken of the Bella" and "chicken of the whites". That raises the question of the exact origin of this phenotype. In-depth discussions with resource persons suggest the possibility of merging two strains of chickens. Indeed, it emerged on the one hand that a very tall and large chicken was traditionally raised by Bella ethnic group. A similar breed called Kolonto has been described in Niger (Hassan *et al.,* 2020). On the other hand, a hypothesis of crossbreeding between local chickens (probably pulpuli) and a breed or strain imported from Europe is suggested to lead to a new large-size strain. Due to the similarity of these two types, they were finally considered the same.

Genetic Improvement Goals

Growth performance and plumage color were the most characteristics cited as selection criteria. Growth performance as a selection criterion is following the sale purpose ranked as the most important production purpose. These results differ from those found in Rwanda, where farmers most preferred prolific ecotypes (Mahoro *et al.,* 2018). In our study, resistance to diseases as a selection criterion is less cited by respondents (15.25%). Meanwhile, this character was ranked as the first trait farmers would like to improve if they had the power to do as they wanted. At first glance, this appears to be a contradiction.

Nevertheless, this could be understood by considering that farmers are aware of the difficulties in improving resistance to diseases by selection. Indeed, genetic progress in selection is too slow due to the low heritability of this trait and the difficulty in measuring it and, therefore, comparing candidates. So, although farmers want to improve this characteristic as a priority, in practice, they are satisfied with what seems more accessible to them, namely, the improvement of growth. It is, therefore, important to direct efforts toward improving resistance to diseases to meet farmers' needs. Integrating genetic and genomic information can

achieve significant results in disease resistance (Banos *et al.*, 2020).

CONCLUSION

The local chicken was produced in a scavenging system with unsuitable habitat and no health care. Three phenotypes of chickens were cited as encountered in the study areas with clear morphological and functional different characteristics. However, these genetic resources are under poor management because they are reared together without mating control. This leads to a tendency towards uniformity of phenotypes. The production purposes are primarily oriented toward selling chickens, and the market incites farmers to look for large chickens. The roosters are then chosen to improve growth performances. Nevertheless, due to the diseases' prevalence and a lack of confidence in vaccination, farmers would like to improve chickens' resistance to diseases primarily if they had all possibilities.

CONFLICT OF INTEREST

We certify that there is no conflict of interest with any financial, personal, or other relationships with other people or organizations related to the material discussed in the manuscript.

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