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Traditional poultry farming in five regions of Madagascar (analamanga, anosy, atsinanana, atsimo atsinanana and vakinankaratra)

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Abstract
Village poultry farming is widely practiced by households in Madagascar and constitutes a significant source of income. To improve knowledge about its practice, 220 households were surveyed over a period of 25 months in 5 regions (Analamanga, Anosy, Atsinanana, Atsimo Atsinanana and Vakinankaratra). These surveys revealed that 58% of breeders were women, while 42% were men. The most numerous breeders were over 30 years old. The average number of poultry per farm in the regions of Atsimo Atsinana (32.96±21.09) and Vakinankaratra (34.43±26.44) were significantly higher than those of other regions. This significance was also observed for the poultry costs of Vakinankaratra (22616.66±5836.39 MGA) and Analamanga (21583.33±3110.28 MGA), compared to other regions. The reasons for selling poultry are mainly related to crises, festive events, and the need to acquire basic necessities. The reasons for eating poultry are mainly related to festive events such as a national holiday, weddings, and birthday celebrations. Farmers in the Analamanga and Atsimo Atsinanana regions consume more poultry and at higher frequencies. Vaccination is poorly practiced (44%) and the availability of vaccinators and the average cost of the injected vaccine dose (541 MGA for all regions) could explain this. Rice bran, corn, cassava, and kitchen scraps are the main foods given as supplements to poultry. For housing, farmers build shelters that are acceptable for some (50%) and others let the poultry sleep outside (30%). Others, for security reasons, sleep with their poultry in their homes (20%).

Keywords: Madagascar; traditional poultry farming, village poultry farming, local chicken

Introduction
Livestock production plays an important role in the fight against food insecurity in the world in general and in Africa in particular [1]. It also constitutes a niche of employment for young people and women. (1-3) Family poultry farming, also known as village or traditional poultry farming, is a widespread activity in rural areas of developing countries. Indeed, it plays an important role in households, both as a source of food and income [4-8].
The consumption of poultry meat and eggs plays an important role in human nutrition in general and that of children in particular [9-11]. Eggs are a food rich in protein and nutrients. Poultry meat is an important source of protein [12].
In Madagascar, village poultry farming is widely practiced. Several similarities and differences are observed in its practice depending on the area or region of the country where it is located. Furthermore, as in many African and Asian countries, village poultry farming faces several challenges, including genetics, breeding management, feeding, diseases, and care methods. Mastering these various challenges could lead to improved production and income for breeders who practice this activity.
Work by Koko and colleagues in 2006 showed that improved livestock management had a significant impact on poultry production. Similarly, our work in 2022 showed the existence of different ecotypes between poultry populations in two agroecological zones [8-13].
The question that arises is whether there are other differences in the usual practice of family poultry farming depending on the regions of Madagascar that have impacts on production and household income.
The objective of this work is to improve knowledge on the practice of traditional livestock

farming in five regions of Madagascar namely: Analamanga, Anosy, Atsimo Atsinanana, Atsinanana and Vakinankaratra located in four agroecological zones (Northern Highlands, Middle West, South-East and East).

Materials and Methods

Study area and period: The study was carried out between May 2021 and June 2023 in the regions of Analamanga, Anosy, Atsimo Atsinanana, Atsinanana and Vakinankaratra.

The Analamanga region has a significant area of arable land of approximately 457,446 hectares, only a third of which is cultivated. Rice cultivation is widely practiced there. Similarly, onion and tomato crops are common, with high yields. Analamanga has significant potential for livestock farming. In fact, the region is one of the areas suitable for dairy cattle farming. Poultry farming (intensive or extensive) is also widely practiced there [14].

Known for its high cassava and sisal production, the Anosy region has experienced a significant drought in recent years, exacerbated by sandstorms. Agriculture is essentially extensive, as is livestock farming. The most common livestock species are ruminants (cattle, sheep, and goats). Cattle occupy an important place in the culture of the populations of the far south of Madagascar [15, 16].

The Atsimo Atsinanana region is known for its agricultural diversity. Food crops are important, as are cash crops. In the coastal areas of the country, fishing is an important activity for the population. Poultry farming, although largely extensive, provides a source of income for households [17].

The Vakinankaratra region is a highly agricultural area, with more than half of the land arable. Cereal crops are widely grown, as are fruit and vegetable crops. It reportedly has the largest number of agricultural dams. Pig farming is quite developed, as are poultry and cattle farming. Like the Analamanga region, dairy production is important [18].

The Atsinanana region is frequently subject to climatic hazards, including cyclones. Agriculture is heavily practiced there for crops such as bananas and lychees. Livestock farming is reportedly low compared to other regions of the country. Cattle, pigs, and poultry are mostly raised for consumption. Fishing is an important activity that generates significant resources when the winds are favorable [19, 20].

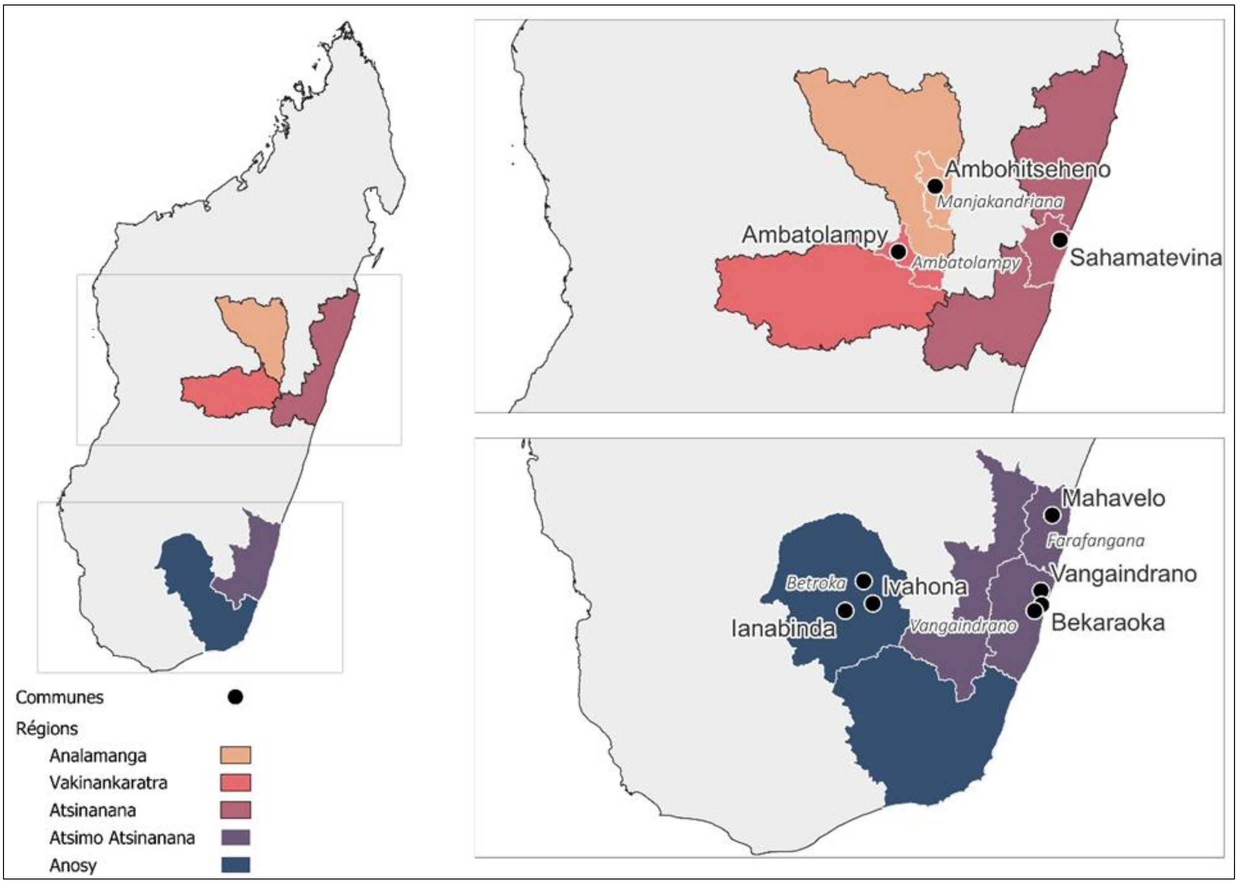

Fig 1: The study regions

Data collection and sampling

This is a descriptive and cross-sectional study which was conducted over a period of 25 months, via a questionnaire among households practicing traditional poultry farming in:

- The commune of Ambohitseheno, in the district of Manjakandrina, region of Analamanga;
- The communes of Betroka, Ivahona and Ianabinda, Betroka district, Anosy region
- The commune of Sahamatevina, in the district of Vatomandry, region of Atsinanana
- The communes of Anosy Tsararafa, Amporoforo and Mahavelo in the district of Farafangana, Atsimo Atsinanana region
- The communes of Bekaraoka, Matanga and Vangaindrano in the district of Vangaindrano, Atsimo Atsinanana region
- The commune of Ambatolampy, in the district of Ambatolampy, Vakinankaratra region.

A total of 220 poultry-farming households were surveyed. The inclusion criteria were household agreement to participate in the study and a flock size of at least 5 adult poultry. Sampling was carried out using the snowball method. The questionnaire was previously prepared and focused on the socioeconomic habits of households practicing village poultry farming.

The questions were translated from French to Malagasy during the interviews. The farmer was given the freedom to address questions related to poultry farming at his convenience. This was a semi-structured interview during which the answers to the questions were captured as the farmer's interview progressed. In addition to the interviews, a visit to the poultry habitats and also a count of the number of poultry were carried out in all households.

All collected data were compiled and cleaned using Excel software, then analyzed using XLSTAT software version 2024.3.

Results

The study involved 220 households spread across 5 regions of Madagascar (Analamanga, Anosy, Atsimo Atsinanana, Atsinanana and Vakinankaratra). A total of 6,358 birds were counted in the 220 households surveyed, including: 356 adult roosters, 1,264 adult hens, 1,100 chickens (young roosters and young hens) and 3,636 chicks (Table 1).

Of the 220 households, 58% were women and 42% were men. Table 2 presents the practice of poultry farming by gender in the 5 regions.

The categorization of breeders into two age groups showed that only 11% of breeders practicing poultry farming were between 18 and 30 years old and 89% were over 30 years old.

Table 1: Distribution of poultry by region

REGIONS	Number of households (N)	Number of poultry (n)	Percentage (%)
Analamanga	30	749	12%
Anosy	40	884	14%
Atsimo_Atsinanana	82	2703	43%
Atsinanana	38	987	16%
Vakinankaratra	30	1033	16%
Grand total	220	6356	100%

N = Number of poultry

Tableau 2: Poultry farming practice and gender

Regions Genres	Number of households (N)	Percentage (%)
Analamanga	30	14%
Women	16	53%
Man	14	47%
Anosy	40	18%
Women	23	58%
Man	17	43%
Atsimo_Atsinanana	82	37%
Women	44	54%
Man	38	46%
Atsinanana	38	17%
Women	25	66%
Man	13	34%
Vakinankaratra	30	14%
Women	20	67%
Man	10	33%
Grand total	220	100%
Women	128	58%
Man	92	42%

N=Number of households

Characteristics of the numbers in the farms

All the poultry found in the farms in the 5 regions were local breeds (Gallus gallus domesticus) and came from the municipalities where the farms were located or from neighboring municipalities. No significant difference was observed between the number of poultry farms and the gender (p=0.9)

The roosters

While the total average of roosters per farm for all five regions is1.62±1.14, it is the lowest in the Analamanga region (1.13±035). The farms in the Atsimo Atsinanana and Atsinana regions have a higher number of roosters than the other regions with means of 1.99±1.23 and 1.82±1.52 respectively. The comparison of the average number of roosters in the farms between the Analamanga and Atsimo Atsinanana regions with the Student test (T-test) showed significance at the 1% level (p=0.0002), the same for Anosy and Atsimo Atsinana (p=0.001), as well as that of Atsimo Atsinanana and Vakinankaratra which was p=0.006. However, no significance was observed between the average numbers of roosters in the regions of Analamanga and Anosy, Analamanga and Vakinankaratra, Anosy and Vakinankaratra, Atsimo Atsinanana and Atsinanana and finally Atsinana and Vakinankaratra.

The chickens

The average number of hens in the farms of the Atsimo Atsinanana region was 7.01±4.03. This average is higher than that of other regions where they are 5.13±1.66 for the Analamanaga region, 5.66±3.28 for the Vakinanakaratra region, 4.76±2.68 for the Astinanana region and 4.6±1.60 for the Anosy region. The average number of hens in the five regions was 5.74±3.24. No significance was observed between the averages of poultry flocks from the regions of Analamanga and Anosy, Analamanga and Atsinanana, Analamanaga and Vakinankaratra, Anosy and Atsinanana, Anosy and Vakinankaratra, Atsimo Atsinana and Vakinankaratra, as well as Atsinanana and Vakinankaratra. On the other hand, these differences in averages of hens in the farms were significant for poultry from the regions of Analamanaga and Atsimo Atsinanana (p=0.01), Anosy and Atsimo Atsinanana (p=0.0003) and Atsimo Atsinanana and Atsinanana (p=0.002).

The chickens: In total, 1,100 young birds were counted in the farms of the five regions for an average number of 5±5.74 chickens per farm. The Analamanga region showed a higher average number of chickens (6.83±8.05) than in other regions. The farms with the lowest average number of chickens were those in the Anosy region (3.2±2.54). The average number of poultry in the Atsimo Atsinanana and Atsinanana regions was 4.46±4.16 and 5.29±6.47, respectively. Significant differences were observed only between the average numbers of young poultry between the regions of Analamanga and Anosy (p=0.009), Analamanaga and Atsimo Atsinanana (p=0.04) and Anosy and Vakinankaratra (p=0.01).

The chicks

Farms in the Analamanga region showed a low average number of chicks (11.87±11.66), compared to other regions. This average number of chicks was 20.80±20.45 in the Vakinankaratra region and 19.50±17.71 in the Atsimo Atsinanana region. The average number of chicks per farm in the five regions was 16.53±15.89. The test of comparisons of the average number of chicks in the farms of the different regions showed weak significance only between the regions of Analamanga and Atsinananana (p=0.03), Analamanaga and Vakinankaratra (p=0.04), Anosy and Atsimo Atsinanana (p=0.03) and between the regions of Anosy and Vakinanakaratra (p=0.03).

All the birds: Table 3 shows the average numbers of birds by category. Taken together, the farms in the Vakinankaratra and Atsimo Atsinanana regions would have more poultry than the farms in other regions. The average number of birds per farm for these two regions is respectively 34.43±26.44 and 32.96±21.09. The farms in the Anosy region have the lowest average number of poultry 22.10±10.98. This difference in average numbers observed between the Anosy and Atsimo Atsinanana regions is significant (p=0.0002< 0.001). The same is true between the numbers in the regions of Analamanga and Atsimo Atsinanana (p=0.02< 0.05), and those of the Anosy and Vakinankaratra regions (p=0.02<0.05). On the other hand, no significant difference was observed between Analamanga and Anosy, Analamanga and Atsinanana, Analamanga and Vakinankaratra, Atsimo Atsinanana and Atsinanana, Atsinana and Vakinankaratra, Atsimo Atsinanana and Vakinankaratra, Anosy and Atsinanana (see Table 3).

Table 3: Distribution of bird numbers by region

		Region					
Poultry		**Analamanga**	**Anosy**	**Atsimo_ Atsinanana**	**Atsinanana**	**Vakinankaratra**	**Total**
Roosters	*Effective*	34	51	163	69	39	356
	M ±σ	1.13±035	1.28±0.75	1.99±1.23	1.82±1.52	1.3±0.92	1.62±1.14
Chickens							
	Effective	154	184	575	181	170	1264
	M ±σ	5.13±1.66	4.6±1.60	7.01±4.03	4.76±2.68	5.66±3.28	5.74±3.24
Chickens							
	Effective	205	128	366	201	200	1100
	M ±σ	6.83±8.05	3.2±2.54	4.46±4.16	5.29±6.47	6.67±7.84	5±5.74
Chicks							
	Effective	356	521	1599	536	624	3636
	M±σ	11.87±11.66	13.03±9.66	19.50±17.71	14.11±14.29	20.80±20.45	16.53±15.89
Total birds							
	Effective	749	884	2703	987	1033	6356
	M ±σ	24.97 ±13,74^{a*}	22.10 ±10,98^{ab***}	32.96 ±21,09^{bac***}	25.97 ±18,45^{abc}	34.43 ±26,44^{ac**}	28.89 ±19.58

M±σ: Mean ± Standard deviation; a,b and c = indicate the existence of statistically significant differences; *** p<0.001; ** p<0.01; * p<0.05.

Traditional poultry farming and habitats

Of the households surveyed, 50% had a chicken coop specifically designed for poultry outside the home. 20% of households sleep with their poultry inside their homes and cite safety measures as the main reason. Some households (30%) responded to the question of whether they had a chicken coop for their poultry, stating that the poultry slept outside the home, either in trees or under their hut. This latter option is very widespread on the coastal coasts (Atsimo-Atsinanana and Atsinana) due to the architecture of their habitat. Of the livestock farmers in the Analamanaga region, 67% have a chicken coop or acceptable shelter built specifically for their poultry. 37% of livestock farmers in Vakinankaratra answered yes to the question of whether their poultry slept inside their homes.

Fig 2: Example of a poultry shelter, Mahabo Commune, Anosy Region (source: Author)

Fig 3: Example of a poultry shelter; Betroka Municipality, Anosy Region (Source: Author)

Traditional poultry farming and food

All households surveyed reported that poultry feed while roaming in the barnyard or in the fields. Almost all farms provide their poultry with feed supplements. Only 9% of households provide feed as a supplement to their poultry. The supplement varies depending on the growing season, agricultural waste, and kitchen scraps. Thus, 66% of households report giving their chickens corn, 65% cassava, 94% rice bran, 42% green vegetables such as Brède Mafana or Acmella oleracea, and 15% breadfruit. For the latter variety, they are mainly provided by farmers in the two coastal regions. Animal protein, such as insects (flies, mites, crickets, and maggots), is provided by 12% of farmers, mainly in the Analamanga and Anosy regions.

Traditional poultry farming and frequently encountered pathologies

Diseases observed in livestock farms

Of the most common ailments encountered in our farms, hoof disease was the most common (25%). Nearly 50% of the farmers surveyed in the Atsimo Atsiranana region reported having experienced this condition in their farms. Only 10% of farmers in the Analamanga and Vakinankaratra regions respectively reported having encountered hoof disease in their farms.

Head disease was ranked second (15%) followed by skin disease (5%). Head disease is most common in poultry farms in the Anosy region (78%) followed by the Atsinanana region (8%). Farmers in the Analamanga, Atsimo Atsinanana and Vakinankaratra regions reported not having observed head disease in their farms.

Skin diseases were rarely encountered by the surveyed breeders except for 10% among those surveyed in the Atsimo Atsinanana region (see Table 4).

Viral diseases observed in livestock farms

Four diseases can be vaccinated against in the surveyed farms, allowing farmers to determine whether the disease is viral or not. These are: Newcastle disease, fowl cholera, fowl pox, and infectious bronchitis.

Avian cholera has already been observed in 40% of the farms surveyed. 57% percent of farmers in the Analamanga and Vakinankaratra regions have already experienced this disease in their farms. Very few farmers (8%) in the Anosy region report having observed this disease in their farms.

Newcastle disease is the most common disease among farmers, with 50% reporting having observed it in their herds. Farmers in the Analamanga and Anosy regions have observed this infectious disease the most, with 67% and 63% responding positively, respectively.

Fowl pox (2%) and infectious bronchitis (1%) were observed very rarely in livestock. 8% of livestock farmers in the Anosy region reported having already observed fowl pox in their livestock and 7% of livestock farmers in the Analamanga region reported having observed infectious bronchitis.

Vaccination

In total, 44% of households surveyed reported practicing vaccination against poultry diseases. The survey also revealed that only 36% of farmers have access to a vaccinator in their farming area. 78% of farmers in Analamanga practice vaccination and 80% of them have access to a vaccinator. Only 8% of farmers in the Anosy region reported having access to a vaccinator and practicing vaccination. The Vakinankaratra region comes in second place for the practice of vaccination (57% positive response) and vaccinator (53% positive response).

The average cost of vaccination (per dose) regardless of the pathology is 540.94±214.58MGA. According to statements from breeders, the injected dose of vaccine would be higher in the Atsinanana region (706.25±274.39 MGA), followed by that of the region of Atsimo Atsinanana (622.1±219.7 MGA). The regions of Analamanga and Anosy would have the lowest vaccination costs 396.66±87.03 MGA and 300±122.47 MGA, respectively. It is important to note that a maximum of 1600MGA and a minimum of 200MGA for a dose of vaccine were observed in some regions.

Table 4: Pathologies observed in traditional poultry farming and vaccination

			Region					
			Analamanga (N=30)	**Anosy (N=40)**	**Atsimo_ Atsinanana (N=82)**	**Atsinanana (N=38)**	**Vakinankaratra (N=30)**	**Grand total (N=220)**
Diseases observed in breeding	Head disease	No	100%	23%	100%	92%	100%	85%
		Yes	0%	78%	0%	8%	0%	15%
	Skin condition	No	100%	93%	90%	100%	100%	95%
		Yes	0%	8%	10%	0%	0%	5%
	Paw disease	No	90%	95%	51%	79%	90%	75%
		Yes	10%	5%	49%	21%	10%	25%
Viral diseases observed in livestock	Avian cholera	No	43%	93%	57%	55%	43%	60%
		Yes	57%	8%	43%	45%	57%	40%
	New Castle disease	No	33%	38%	62%	55%	43%	50%
		Yes	67%	63%	38%	45%	57%	50%
	Fowl pox	No	100%	93%	98%	100%	100%	98%
		Yes	0%	8%	2%	0%	0%	2%
	Infectious bronchitis	No	93%	100%	100%	100%	100%	99%
		Yes	7%	0%	0%	0%	0%	1%
Vaccination	Presence of a vaccinator	No	20%	93%	76%	58%	47%	64%
		Yes	80%	8%	24%	42%	53%	36%
	Vaccination practice	No	27%	93%	55%	55%	43%	56%
		Yes	73%	8%	45%	45%	57%	44%
	Average cost of vaccination (MGA)	Average	396.66	300	622.1	706.25	529.41	540.94
		Standard deviation	87.03	122.47	219.7	274.39	46.96	214.58
		Maxi	500	500	1500	1600	600	1600
		Mini	200	200	240	500	500	200

N = number of breeding

Traditional poultry farming and the future of production

Various products are produced by village poultry farming. All farmers stated during the survey that droppings were generally used in the fields for market gardening. Eggs are mostly intended for hatching and are rarely consumed or sold. As for poultry, they can either be sold or consumed by the household.

Self-consumption of poultry

Surveys showed an annual average of14.66±17.98 of poultry consumed by households.

Farmers in Atsimo Atsinanana (21.89±25.98 birds/year) and Analamanaga (18.33±10.09 birds/year) would consume more poultry each year. However, those in the Anosy (5.73±2.98 birds/year) and Vakinankaratra (5.93±4.39 birds/year) regions would consume much less.

Livestock farmers in the Atsimo Atsinanana and Analamanga regions have an average frequency of poultry consumption per year of 17.32±15.97 and 14.43±7.78 respectively. These averages are significantly higher than those obtained during surveys of livestock farmers in the Anosy (4.95±2.21), Atsinanana (7.08±5.70) and Vakinankaratra (5.93±4.39) regions. It should be noted that the average annual consumption frequency of poultry for all households surveyed is 11.35±11.86. Ninety-two percent of farmers reported slaughtering and consuming poultry meat mainly during festive events such as the national holiday, the birth of a newborn, or a family wedding. A small proportion (8%) of farmers reported eating poultry as they wish, but not systematically during festive periods.

Poultry marketing

Selling poultry is an activity commonly observed in households that practice traditional poultry farming. This survey showed that 62% of households surveyed sell their poultry during times of crisis (health problems of a family member or schooling problems of a child in the household). 80% of farmers in the Vakinankaratra region report selling their poultry during times of crisis, compared to 43% in the Analamanga region. Festive events such as national holidays, religious or cultural festivals are another reason for selling. Thus, 56% of households sell their poultry during holiday periods to raise money. This practice is widely observed among farmers in the Vakinankaratra (80%) and Anosy (70%) regions. Only 10% of households in the Analamanga region sell their poultry for festive reasons. The marketing of poultry for the purchase of household needs such as basic necessities (PPN) is declared by 61% of poultry farmers with a very low frequency (37%) for farmers in the Analamanaga region.

The average selling cost of an adult rooster in our study was19256.81±5417.60 MGA. For the Vakinankaratra region (22616.66±5836.39 MGA) and Analamanga (21583.33±3110.28 MGA), these average costs were higher than those of the Atsimo Atsinanana (17542.68±5731.76 MGA) and Anosy (17087.5±3257.90 MGA) regions. The same observations were made about the prices of hens. Table 5 shows the average sales costs of poultry in the different regions of our study. It appears that the sale of adult poultry (rooster or hen) is more expensive in the Vakinankaratra and Analamanga regions than in other regions. Poultry is less expensive in the Atsimo Atsinanana region.

Poultry marketing for all households surveyed is primarily done at the municipal level (77%). Only 12% and 11% of farmers, respectively, reported selling their poultry in neighboring municipalities, respectively in their own and neighboring municipalities. Of the farmers, 24% reported selling their poultry specifically to collectors, compared to 76% who sell to the highest bidde.

Table 5: Future of village poultry production

	Region					
Become poultry	**Analamanga**	**Anosy**	**Atsimo_ Atsinanana**	**Atsinanana**	**Vakinankaratra**	**Grand total**
Self-consumption						
Average number of poultry consumed/year	18.33±10.09	5.73±2.98	21.89±25.98	12.45±7.30	5.93±4.39	14.66±17.98
Average frequency of poultry consumption/year	14.43±7.78	4.95±2.21	17.32±15.97	7.08±5.70	5.93±4.39	11.35±11.86
Sales						
Average cost of a rooster (MGA)	21583.33±3110.28	17087.5±3257.90	17542.68±5731.76	20750±5376.06	22616.66±5836.39	19256.81±5417.60
Average cost of a hen (MGA)	18050±1949,13	13125±2690.79	11451.21±3436.91	15894.73±2628.21	18866.66±4118.78	14434.09±4251.13
Average cost of adult poultry (MAG)	19816.66±3129,90^{a***}	15106.25± 3576,16^{ba***}	14496.95± 3576,16^{ba***}	18322.36± 3576,16^{ba***}	20741.66± 3576,16^{ba***}	16845.45± 5430,02

M±σ: Mean ± Standard deviation; a, b, c and d = indicate the existence of statistically significant differences; *** $p<0.001$; ** $p<0.01$; * $p<0.05$.

Discussion

Characteristics of the households surveyed

Our study involved a total of 220 households spread across four agroecological zones in Madagascar. This number is lower than that of Mugumaarhahama and colleagues, who surveyed 304 households spread across two agroecological zones in South Kivu. In the same study, the proportion of women who practiced poultry farming was 55.7% while 44.3% were men. In our work, we found a higher proportion of women who practiced traditional poultry farming (58%) compared to 42% for men [21]. The work of J. Ebwa *et al* in 2018, focused on 150 households with a proportion of 56% women. This proportion is similar to that of Fotsa and his colleagues found during their study in Cameroon in 2008, which was 56.6% [22]. In the context of Madagascar, this trend towards more women being responsible for village poultry farming is culturally related. Similarly, men's input is essential for the marketing of poultry. Indeed, livestock farming activities that do not require or represent a large amount of financial capital are managed primarily by women, unlike the farming of small and large ruminants, such as sheep, goats and cattle, where the main managers are men [23, 24]. In the same work, Fotsa speaks of this observation as being due to the fact that traditional poultry farming is a female activity in most African countries [22, 25]. On the other hand, the work of Djitie *et al*. reported a proportion of 85% of male poultry farmers out of the 85 households surveyed in the Adamaoua region of Cameroon [26].

Of the farmers surveyed, 89% were over 30 years old and only 11% of farmers were between 18 and 30 years old. This could be explained by the important place that village poultry farming occupies in the household, on the one hapart, as an income-generating activity and on the other hand, as a main or secondary occupation of at least one of the members of the household and complementary to other activities including agriculture. This result is similar to that found by Fotsa *et al*. in the South Cameroon region in 2008. In the work of Ebwa carried out in the city of Kisangani in Congo, 69% of the households surveyed were over 30 years old. Djitie and his colleagues in their work mention that 91% of the livestock farmers questioned were at least 35 years old [4, 22, 26].

Characteristics of poultry populations: During our survey, we counted a total of 6,358 animals (roosters, hens, chickens and chicks) in 220 farms. This number is higher than that of Ebwa. In our different farms, poultry were all common breeds with different phenotypes including naked neck, wrinkled, smooth. The studies carried out by Ebwe and Fotsa respectively in the Democratic Republic of Congo and Cameroon presented diverse phenotypes in the farms and similar to ours [4, 22].

In our study, the average number of roosters in the farms of the Atsimo Atsinanana region is almost double that of the Analamanga and Anosy regions. Similarly, the total averages of poultry in the farms of these same regions differ significantly. Several factors could explain this difference, among which: the climate, the Atsimo Atsinana region having a tropical climate (humid and hot) favorable to reproduction in general and particularly to the incubation and management of chicks under mother [27]. It is also favorable to agriculture and therefore to better food availability for poultry. The number of roosters in farms improves the sex ratio and therefore impacts reproduction. This significant average difference is also observed between the Vakinankaratra and Anosy regions and could also be explained by the same factors. Access to healthcare and the practice of vaccination also play important roles in the size of flocks.

Poultry habitat: Although the Atsimo Atsinanana and Vakinankaratra regions have the largest number of poultry per farm, the results show us that of the 50% of farmers with a chicken coop or acceptable shelter in our study, 67% are from the Analamanaga region. This proportion could be explained by the fact that it is a fairly developed region on various levels including educational, socio-cultural and zootechnical. Many farmers in the Vakinankaratra region sleep with their poultry inside mainly for security reasons (theft and predators). Ebwa's work reports the existence of semi-open shelters (73%) and semi-adapted shelters (27%). Compared to their work, semi-adapted shelters represent 50% and semi-open 30% in our work. This is the second type of shelter located outside the breeder's habitat and located either under the house or attached to it or in the kitchen located outside the house, or in the trees. As in the studies of Fotsa *et al*, Djitie *et al*, Ebwa *et al*, as well as Mugumaarhahama *et al*. the animals are almost continuously wandering and among our pastoralists [4, 22]. In our surveys, farmers reported providing supplemental feed to their poultry once or twice a day, either in the morning for the most part, or in the evening, or both. These statements are similar to those found by Fotsa *et al*. in 2008.

Poultry watering is not systematically carried out in all the farms surveyed. It is generally done using wooden or bamboo materials or kitchen utensils used as waterers in most cases. This observation was also made in the studies of Fotsa *et al*., Ebwa *et al*., and Mugumaarhahama *et al*. [4, 21, 22].

Poultry pathologies: Of the most common diseases encountered in our study, that of the legs was the most frequent and particularly in the Atsimo Atsinana region. This could be explained by the fact that the animals are raised in stray and the hygiene of the poultry habitat is not systematically carried out. One of the most common and known leg pathologies in poultry is leg mange caused by Cnemidocoptes mutans and which affects one in 10 hens in traditional farming. Indeed, mange manifests itself on the legs by hyperkeratosis or crusts of the horny scales and could impact production if no measures are taken [28, 29].

In our study, 50% of farmers reported having already observed cases of Newcastle disease (ND) epizootic in their farms. This infection is caused by avian paramyxovirus serotype 1 (APMV-1) or Newcastle disease virus with very high morbidity and mortality rates, over 90% in farms. Several studies, including those of Maminiaina *et al*., Arbelot *et al*., Fotsa *et al*., present this infectious agent as very virulent and very common in poultry farms [4, 13, 21, 26, 30, 31].

We observed that only 44% of the households surveyed practice vaccination, and 36% reported having access to a vaccinator in their livestock area. These proportions are high for the Analamanaga region, which is 57% for vaccination practice and 80% for access to a vaccinator, respectively. These proportions support the analysis made by the Ministry in charge of livestock in Madagascar [25]. They could be explained in at least two ways. On the one hand, by accessibility to the vaccine, seen in the case of the regions of Analamanga, Vakinankaratra (57%) and Atsinanana (45%) closer to the centers of production and importation of vaccines (large urban centers) and the region of Anosy (8%) and very far from these centers. The work of Hien and collaborators. In Ivory Coast, presents distance as a factor of non-vaccination by breeders [32]. The development of the road network would certainly play a role in access to the vaccine and therefore the practice of vaccination. On the other hand, the presence of vaccinators would align with the level of development of the regions. Thus, access to the vaccinator would be higher in the most developed regions such as Analamanaga, Vakinankaratra and Atsinanana (42%), unlike the Anosy region (8%) which is less developed [15]. In the study entitled: Characterization of local chicken production systems in two agro-ecological zones of South Kivu (Democratic Republic of Congo), done by. Mugumaarhahama and his colleagues. The practice of vaccination is rare and is done by 2% of the farmers surveyed at the hatching of chicks [21]. Furthermore, the practice or not of vaccination could also be explained by the cost of vaccination. Indeed, the average cost of the dose of vaccine injected in our work is 540.94±214.58MGA, with a significantly lower cost for the regions of Analamanaga and Anosy respectively396.66±87.03 MGA and 300±122.47 MGA. These low costs could be explained by the proximity of vaccine production and import centers for breeders in the Analamanaga region. For the case of Anosy, the most remote region, the cost of vaccine, although low, does not explain the low practice of vaccination. This observation could draw part of the answer from the level of knowledge of the population about the practice of breeding in general and that of vaccination in particular. The level of education of the population and breeders more specifically in this region could be a factor limiting the practice of vaccination, as well as the very low proportion of vaccinators (8%). These two factors, which are the practice of vaccination and the existence of vaccinators in the breeding area, could justify the low average number of poultry observed in the Anosy region. Atsinanana and Atsimo Atsinanana regions have average vaccination costs of 706 respectively, 25±274.39 MGA and 622.1±219.7 MGA. The study carried out by Awuni *et al*. in Ghana had obtained an average cost of the vaccinated dose of approximately 60 FCFA, or approximately 450 MGA, and lower than ours [33].

Becoming poultry in village poultry farming

This study showed that breeders in Atsimo Atsinanana (21.89±25.98 poultry/year) and Analamanaga (18.33±10.09 poultry/year) would consume more poultry each year with higher frequencies (respectively 17.32±15.97 and 14.43±7.78) compared to other regions. This could be explained by the purchasing power of the populations of the two regions and in particular those of Analamanga, but also the diversity of sources of animal protein in these regions. Indeed, the Atsimo Atsinanana region is not the most supplied with livestock such as cattle, sheep and goats. The sources of animal protein are mainly fishery products, and therefore poultry farming would occupy an important place in this area. From the data obtained on the number of poultry consumed per year and the annual consumption frequency, we deduce that for each poultry consumption, each household would slaughter and consume at least one poultry each time in terms of the number of poultry slaughtered. In our study, 92% of farmers reported raising poultry for consumption only during festive periods. Fotsa *et al*. in their study, obtained a proportion of 26.5% in favor of farmers who produced for self-consumption. They also state in the same study that, in 48.5% of cases, farmers confirmed the importance of poultry meat and eggs for improving nutritional quality in protein. In our study, although poultry donations and their use in cultural rites were mentioned, the proportions are lower than those announced in the work of Fosta and colleagues in Cameroon and those of Hien *et al*. in the Cascades region of Burkina Faso [22, 32].

The proportion of our households that sell poultry for crisis situations (illness and children's schooling) is 62%. This proportion is 61% for the supply of basic necessities (BNP) for households and 56% for financial availability needs during festive periods. Only 10% of livestock farmers in the Analamanga region sell their poultry during festive periods and 37% for the acquisition of BNP. Indeed, the diversification of household income sources could explain these proportions. Livestock farming is not the primary source of household income in large regions like Analamanga. On the other hand, these proportions are 80% during crisis periods and 80% for festive periods in the Vakinankaratra region. These results could be explained by the key role that livestock farming plays as a financial safety net in this region. The same is true for the Anosy region for cases of crisis (58%) and the need for financial availability during festive periods (70%). Our results also show that the practice of livestock farming is done in the regions of Atsimo Atsinanana and Atsinanana firstly to meet the household's PPN needs (72% and 84% respectively), then to respond to various crises in the household (54% and 84% respectively) and finally for the needs of financial availability during festive periods (52% and 68% respectively). These different reasons for marketing poultry are similar to those observed in several studies. Ebwa *et al*. state in their study that the practice of poultry farming is done to meet family expenses. Similarly, in the work entitled: traditional poultry farming practices by the different ethnic groups of the Cascades region in Burkina Faso, it is specified that the marketing of poultry is done for "The coverage of immediate monetary needs (school fees, school supplies, prescription costs, alcohol consumption, etc.) [4, 22, 32].

The regionsof Vakinankaratra (22616.66±5836.39 MGA) and Analamanga (21583.33±3110.28 MGA) have the highest poultry costs. These results can be explained by the concept of supply and demand. Indeed, traditional poultry farming is less practiced in large regions or urban areas and does not constitute the main source of income and employability unlike other regions (less urbanized or rural). The availability of poultry flocks is therefore lower in relation to the practice of traditional poultry farming and population density (demography). The supply of poultry would be lower than the demand in regions with high demographics. This observation can also be explained by the value given to local breed poultry unlike other types of poultry (meat and laying) that can easily be found in large regions and therefore the organoleptic quality would not be unanimous among consumers unlike that of local poultry [34]. Our study shows that roosters are more expensive than hens. This could be explained by genetics. Indeed, males are generally larger and heavier than females [8]. The average cost of an adult poultry in our study is 16845.45±5430.02 MGA or approximately 10.3±3.57 USD. This cost is significantly higher than that obtained by Hien *et al*. in Burkina Faso in 2003 and which would be around 1125 FCFA, or approximately 8335 MGA or 1.77 USD. It is also higher than those found by Ebwa *et al*. which was 6.8 USD in 2028 and Djitie *et al*. in the Adamaoua region of Cameroon in 2014 which was approximately 6 USD [4, 26, 32].

Poultry marketing is mainly done at the community level (at the market and at home) or in neighboring municipalities without an informal circuit. It is done in small proportion to poultry collectors who crisscross the various municipal markets. These marketing sites are similar to those found in studies conducted in Burkina Faso and the Democratic Republic of Congo [4, 32]

Limitations of the Study

This study involved 220 local breed poultry farmers across five regions of Madagascar. A broader survey of farmers and regions would further refine our results.

Considering the level of education, absent from our study, could have helped to explain to some extent the behavior of certain breeders with regard to the priorities made in the event of a crisis, a celebration or the need for PPN in the household. It could also explain the reasons for the practice or not of vaccination other than the cost. For example, breeders in the Anosy region, whose vaccine cost is low compared to that of other regions and whose vaccination practice is the lowest.

The lack of data on the production performance of local breed poultry in terms of eggs or chicks and their growth could provide another perspective on the different results obtained in this work. Indeed, the existence of different ecotypes could result in different production and reproduction performances depending on the origin of the poultry.

Conclusion

At the end of this study, several important information and results for a better understanding of the practice of traditional poultry farming in Madagascar were found.

- Traditional poultry farming in Madagascar is practiced more by women than men, and culture may explain this to some extent. People over 30 are more involved, and there is no significant relationship between gender and the number of poultry on farms.
- The average number of poultry farms is28.89±19.58. However, it is clear that the farms in the Atsimo Atsinanana and Vakinankaratra regions have more poultry than those in other regions with significant differences.
- Building a chicken coop isn't standard practice in traditional poultry farming. Some farmers build acceptable shelters, while others don't, leaving their birds to sleep in trees. Others sleep with their birds in their homes, primarily for

safety reasons.

- Although all poultry farmers provide supplemental feed, very few provide animal feed. The products distributed are mainly rice bran, corn, cassava, and kitchen scraps.
- The most common disease observed in village poultry farming is that of the feet, which would be mange based on descriptions made by farmers. Newcastle disease is the most prevalent in farms. Vaccination is poorly practiced. This is mainly due to a low number of vaccinators in rural areas than in urban areas and also to the costs and accessibility of vaccines, which are less expensive in urban centers than in rural centers. The average cost of the administered vaccine dose is 541 MGA. Other factors could explain the low vaccination practice by farmers in the Anosy region.
- The average cost of adult poultry is approximately 17,000 MGA. The Analamanga and Vakinankaratra regions have higher costs, and the concept of supply and demand would justify this. Similarly, the frequency and number of poultry consumed annually are higher in these two regions. The sale of poultry by households depends on the situation. Many farmers in the regions sell their poultry when the household is in crisis or during the festive season. This is not the case in the Analamanga region, where household income sources are more diversified.

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