Original Research Article

Local Management in The Varietal Diversity of Rainfed Rice (*Oryza glaberrima*) From Goh-Djiboua and Mountains Districts in Côte d'Ivoire

ABSTRACT

The awareness of farming practices regarding the varietal diversity management of cultivated crops is essential for setting up an in-situ preservation strategy. The objective of the current work was to probe the varietal diversity status of the rainfed rice and its management design in farming conditions. The study was implemented from Goh-Djiboua and Mountain Districts as significant locations for rainfed rice production in Côte d'Ivoire, through descriptive investigation at field led by 450 local farmers of traditional rainfed rice varieties. Data on the anthropological, production, and post-harvest preservation of the traditional rice varieties were collected.

The investigation evidenced the rice production as a gender activity accounting 58.5% men against 41.5% women. The most produced traditional rice varieties are spelled Danané (20.22%) and Danané fowl (17.80%). The rice seeds mainly result from self-production by the farmers investigated (91.3%), especially deriving from traditional varieties (96.6%). The cultivated lands are below 1 ha acreage for most farmers (63.1%) and are worked for auto-consumption needs (99.8%). Besides the survey exhibited four storage structures, most significant of which are the granaries (79.4%). Further attempts focusing nutritional and technological advantages of the traditional rice varieties could enhance their spreading in local culture of rainfed rice.

Keywords: Varietal diversity, rainfed rice, traditional production, preservation, Côte d'Ivoire

1. INTRODUCTION

Rice (*Oryza sp*) is the second most cultivated cereal crop in the world, with a global yield estimated at 754.6 million tons of paddy [1]. China, India, and Indonesia are the main rice provision countries and represent about 50% total world production [2]. Africa still runs with below 2% overall rice productions corresponding to 26.8 million tons [3, 4]. Considered as basic food in Asian countries for long, rice has also become the most consumed foodstuff in African families [5, 6]. For years, the crop's availability is essential to ensure the food safety throughout the sub-Saharan Africa, especially in West Africa, where agricultural practices are often controlled by environmental drifts (climates, soils, ants and other devastating, *etc*.). It provides about 27% food caloric contributions and contains many other nutrients (vitamins, minerals) requested in diets for healthy organism [7].

As a main food crop in Côte d'Ivoire, rice accounts for 1% to 2% national Gross Domestic Product. Its mean local yearly consumption stated at 70 kg per capita is broadly over that of the other food products. Because of the faster urbanization of the country and the agricultural concerns, the local rice culture is mainly extensive, with a global yield forecasted at 1.3 million tons in 2019 [8]. Unfortunately, the home rice supply is insufficient regarding the local needs in consumption and the country remains depending of the international rice market. Indeed, 1.5 million tons of hoary rice, representing 50% national needs, are yearly imported from Asian countries to fit the regular growth in food needs by populations [8]. For succeeding in lasting and suitable rice production, Côte d'Ivoire has planned an ongoing National Strategy of

Development of the Rice-culture that targets the increase of the local rice production through various farming assisting programs [9].

The rainfed rice is grown on over 80% overall cereals crops lands in Côte d'Ivoire. By many regions, some traditional varieties of African rice (*Oryza glaberrima*) are produced for home consumption and remain fairly promoted on the local market. Those varieties record socio-cultural importance and their spreading could result in better valorization from the whole consumers. Besides, scanty information are indicated about the varietal diversity, the local taxonomy, the management design from farming locations, and the main concerns of the traditional rainfed rice varieties. The current survey assesses the inventory of the local rainfed varieties and the seeds preservation strategies in order to fit suitable traditional rice diversity management in Côte d'Ivoire.

2. MATERIAL AND METHODS

2.1.Investigation site

The investigation was implemented in two locations of rice production in Côte d'Ivoire (Fig. 1), namely in Gagnoa and Danané departments from respective districts of Gôh-Djiboua and Mountains. Both locations are provided with bimodal climate engaging two rainy seasons (May to July and October to November), suitable for the rice growing, and alternated with dry seasons of December to April and August to September [10]. The average of annual rainfall oscillates between 1,300 mm and 1,600 mm while the average of recorded temperatures vary between 26 °C and 35 °C [11]. The rice culture is known to be the main food-crop grown in both areas.

2.2. Investigation survey

The survey was achieved by investigation at field using questionnaire guides targeting the rainfed rice farmers. A total number of 450 rainfed rice producers from 13 rural locations in both departments were investigated running six months, from January to June 2017 (table 1), with the supervision of local customary heads. In each village, the producers were invited to fill the questionnaire guide about their profile, rice seeds, local rice varieties cultivated, cultivation practices, preservation concerns, and uses of productions. Post-harvest storage sites were also visited for observation of the rice morphological traits and preservation conditions. Data were gathered through individual or collective interviews.

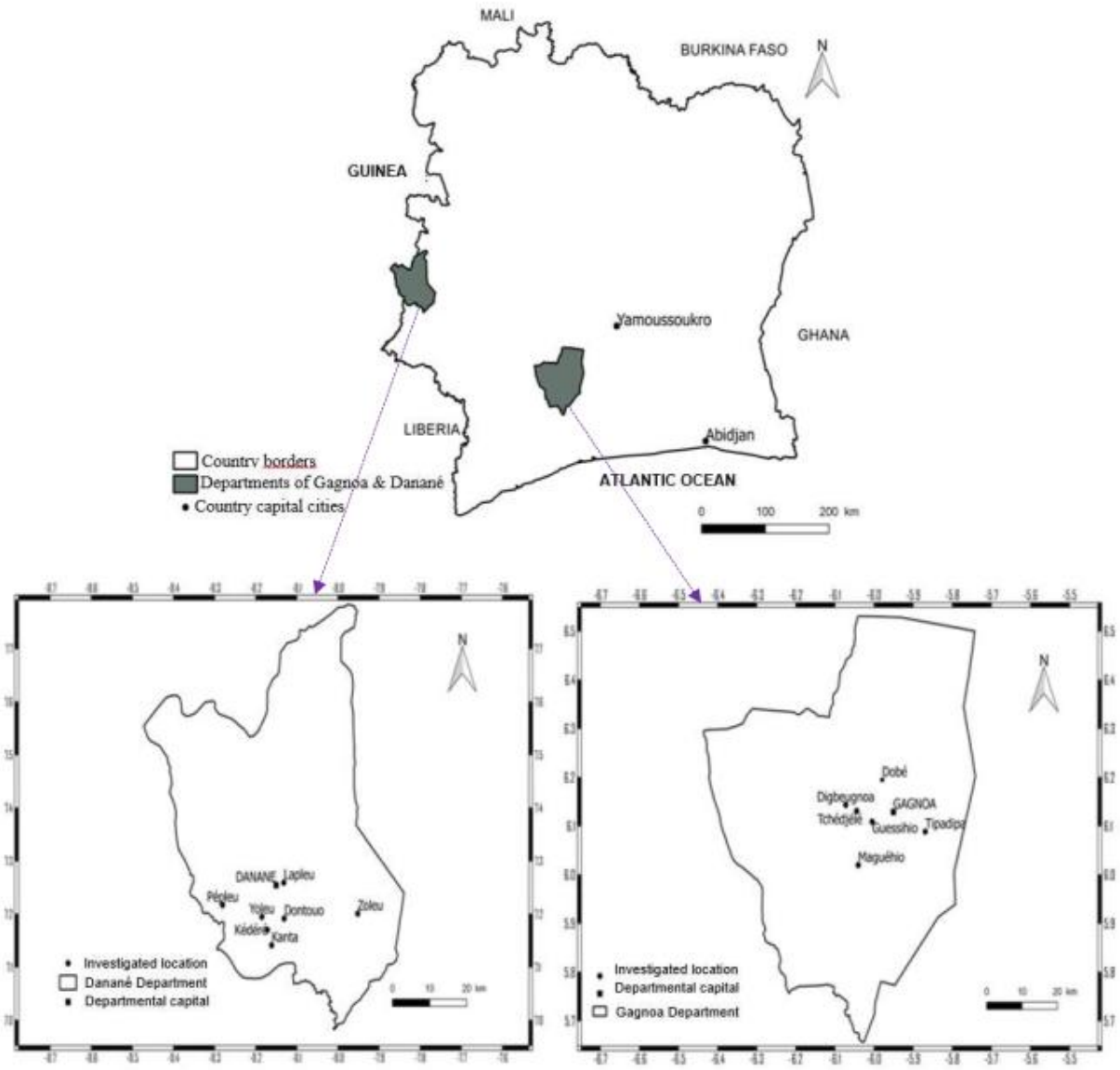

Figure 1. Mapping of the main locations investigated from Departments of Gagnoa (Gôh-Djiboua District) and Danané (Mountains District) in Côte d'Ivoire

2.3. Statistical analysis

The collected data were recorded under Window Excel program, and then treated using softwares Sphinx Plus version 5 and SPSS 22.0. Per descriptor assessed, results were casted as responses rates of investigated individuals; and then a Chi-square test (X^2) was performed to compare the percentages responses at 5% significance. A factor analysis of correspondences (FAC) was also achieved using software Statistica 7.1 to correlate the assessed descriptors with the investigated locations.

Table 1. List of the locations and size of rainfed rice farmers investigated

District	Department	Locations	Number of farmers
Goh-Djiboua	Gagnoa	Maguehio	56
		Tipadipa	45
		Guessihio	23
		Digbeugnoa	46

		Tchedjelet	38
		Dobé	24
Mountains	**Danané**	Lapleu	54
		Zoleu	50
		Yoleu	21
		Pépleu	20
		Kanta	20
		Kédéré	22
		Dontouo	31
Total			**450**

3. RESULTS AND DISCUSSION

3.1 Results

3.1.1 Social profile of the rainfed rice farmers

In both departments investigated, the production of rainfed rice is mainly of masculine interest achieved by 58.5% male farmers, but accounting a significant female involvement (41.5%). The modal age range of the farmers deals with adults people of 40 to 50 years (39.2%), followed by those of 30 to 40 years (31.4%). From the full investigation, 53.5% farmers exhibited over 10 years of agricultural practices. Otherwise, the rainfed rice farmers are generally (90%) native of local dialects, namely Bété for the department of Gagnoa and Yacouba in Danané (table 2).

3.1.2 Production parameters of local rainfed rice varieties

The main characteristics of the rice production are presented in table 3. The traditional varieties are the most represented rice seeds (96.6%) sown by the whole farmers investigated. Figure 2 displays the main criteria for such seeds as availability (37.11%), drought resistance (27.78%), earlier flowering and production (17.78%), and organoleptic traits during consumption (17.33%). The data also emphasize general lesser rice plots acreages worked by the farmers, consisting in 63.1% below 1 ha, 34.2% between 1 ha and 2 ha, and only 2.7% over 2 ha. Otherwise, the almost all farmers (96.5%) respond as owners of their rice plots and most of them (93.1%) do not use any chemical fertilizer nor pesticide for the culture. Thus, weak yields oscillating between 1 ton and 2 tons are generally resulted for the local rice culture from 60.5% investigated farmers (Fig. 3).

3.1.3 Seeds origin, varietal diversity, and local taxonomy of rainfed rice

The rice seeds origins are rated by farmers in Fig. 4. The traditional rainfed rice seeds are mainly (91.3%) resulting from farmers' self- production by sampling in the previous harvests.

Table 2. Main profile of the rainfed rice farmers investigated

Profile indicators	**Responses scores**
Gender	Male: 58.5% - Female: 41.5%
Age range	20-30 years: 4.3% 30-40 years: 31.4% 40-50 years: 39.2% 50-60 years: 17.6% ≥ 60 years: 7.5%
Farming experience	0-10 years: 46.5% 10-30 years: 40.8% > 30 years: 12.7%
Ethnic group	Gagnoa: Bété (90%) Otherethnic groups (10%) Danané: Yacouba (90%) Other ethnic groups (10%)

Table 3. Parameters of rainfed rice production from the locations visited

Production indicators	**Responses rates**

Varietal types	Traditional: 96.6%	Improved: 3.4%	
Lands acreages	< 1 ha: 63.1%	1-2 ha: 34.2%	2-3 ha: 2.7%
Use of fertilizers	Yes: 6.9%	No: 93.1%	

But they're rarely kept by inheritance (6.1%) or gift (2.6%). Moreover, 14 local rice varieties spellings appear as the most cultivated in the locations visited; the six predominant varieties of which are spelled *Danané*, *Dananéfowl*, *Danané1*, *Gbêklêazi* or *Azi*, *Guissi* and*Zonhonkloumin* with respective use rates of 20.22%, 17.80%, 11.33%, 8%, 8%, and 7.55% farmers (Fig. 5).

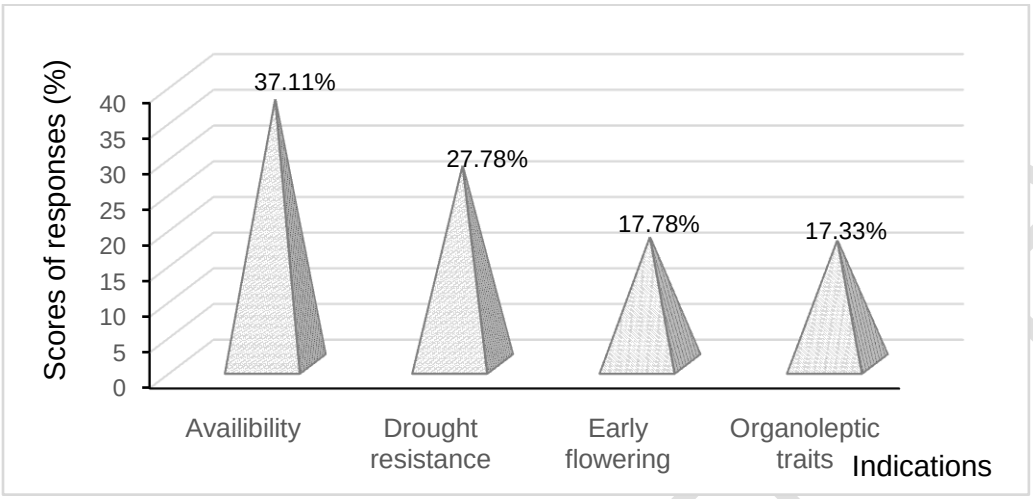

Figure 2. Main choice criteria of rainfed rice production rated by the farmers investigated

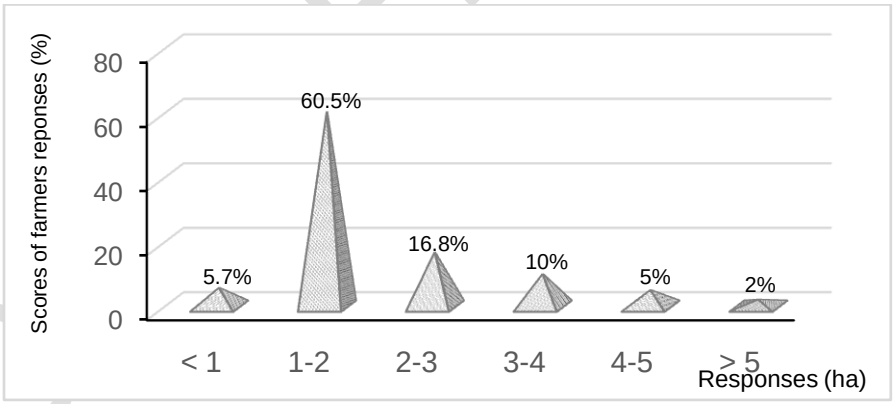

Figure 3. Yield of rice production responded by the farmers investigated

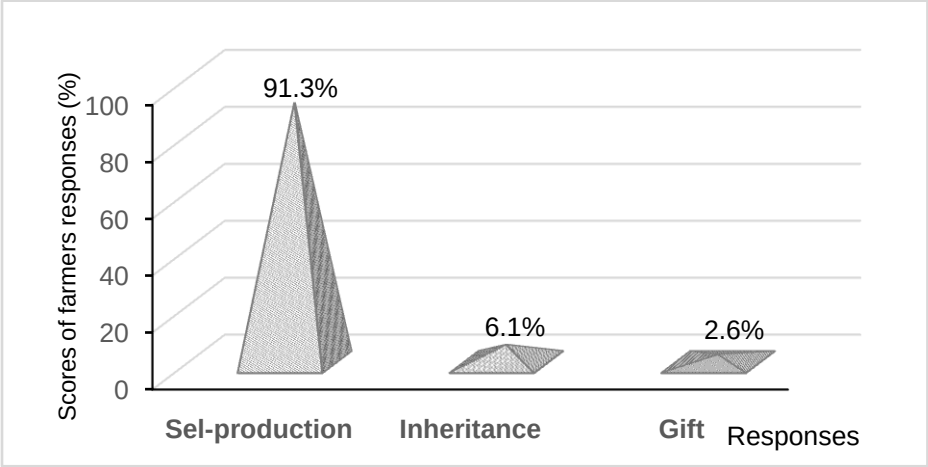

Figure 4. Main rainfed rice seeds origins responded by the farmers investigated

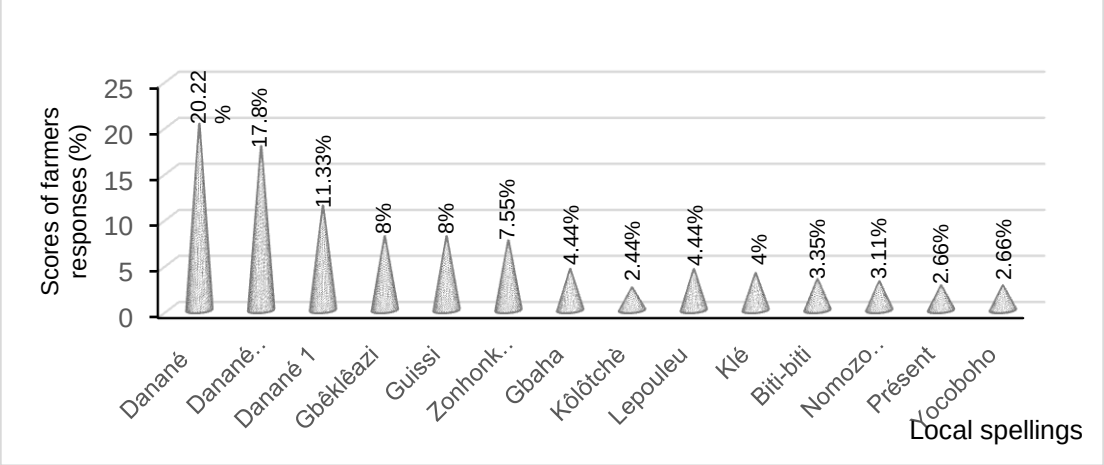

Figure 5: Local varieties produced in the 13 localities investigated in the Gôh-Djiboua and Mountains Districts

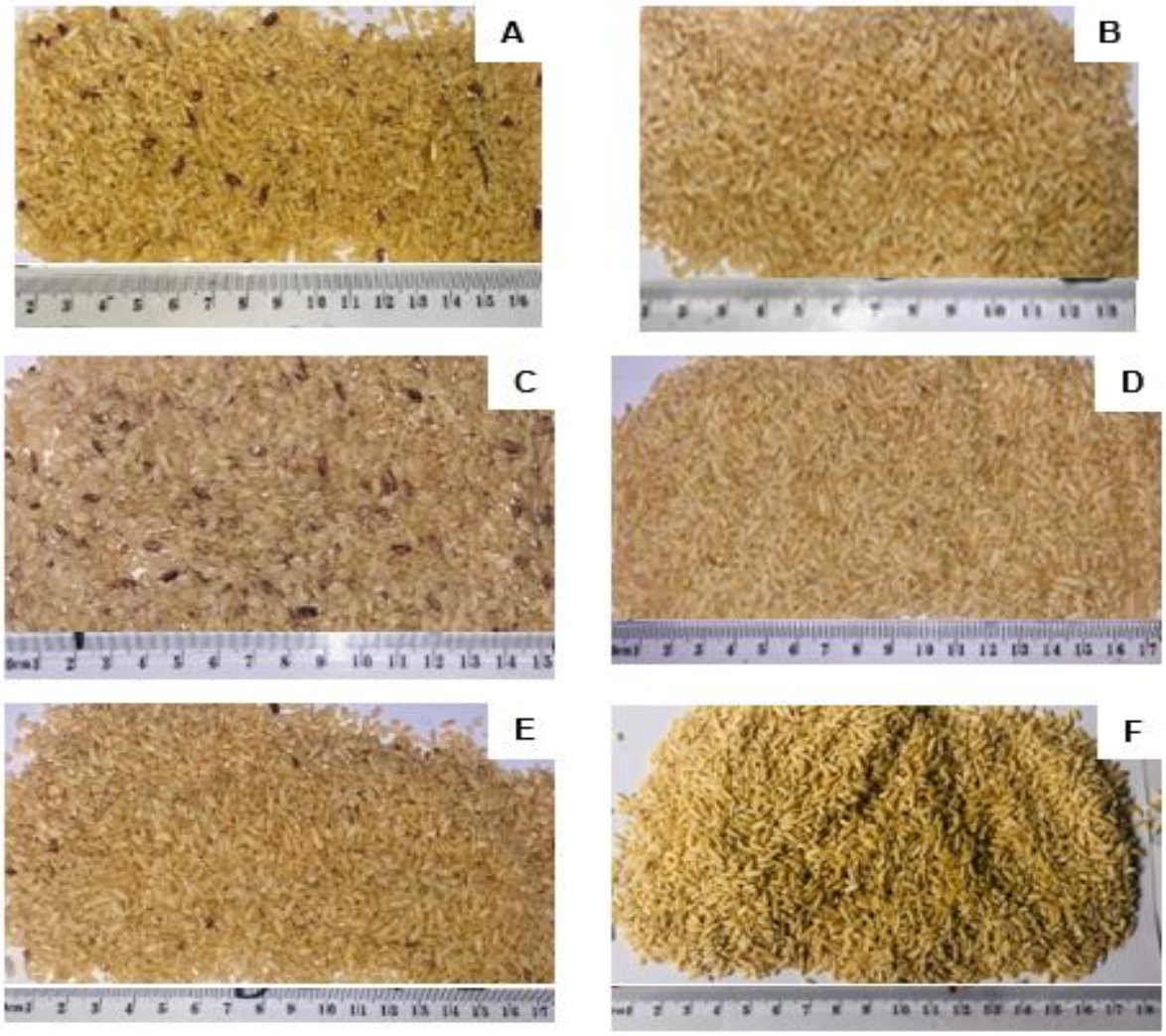

Figure 6. Main traditional rainfed rice varieties spelled in native ethnic groups and presentation of six rice grains samples collected from the rural locations investigated

Local spellings: Gbêklêazi (A), Danané (B), Present (C), Kôlôtchè (D), Zonhonkloumin (E), and Danané fowl (F)

Otherwise, the factorial correspondence analysis (FCA) displays significant correlations between the rainfed rice varieties and the production locations assessed ($P_{\text{-value}}$<.001). Thus, the varieties locally spelled *Biti-biti*, *Danané fowl*, *Kôlôtchè*, *Guissi*, *Zonhonkloumin*, *Klé*, *Yocoboho*, and *Present* are more cultivated in Guessihio, Dontouo, Zoleu, Yoleu, Dobé, Pépleu, and Tipadipa locations. The spelling *Danané 1* is the most widespread rainfed rice variety found inLapleu village, while the locations Maguehio, Digbeugnoa, and Tchedjelet are more fitted with varietal spellings *Danané*, *Gbêklêazi*, and *Lepouleu*. Two other traditional rainfed rice varieties spelled *Gbaha* and *Nomozogui* are recovered as most cultivated in Kanta and Kédéré villages (Fig. 7).

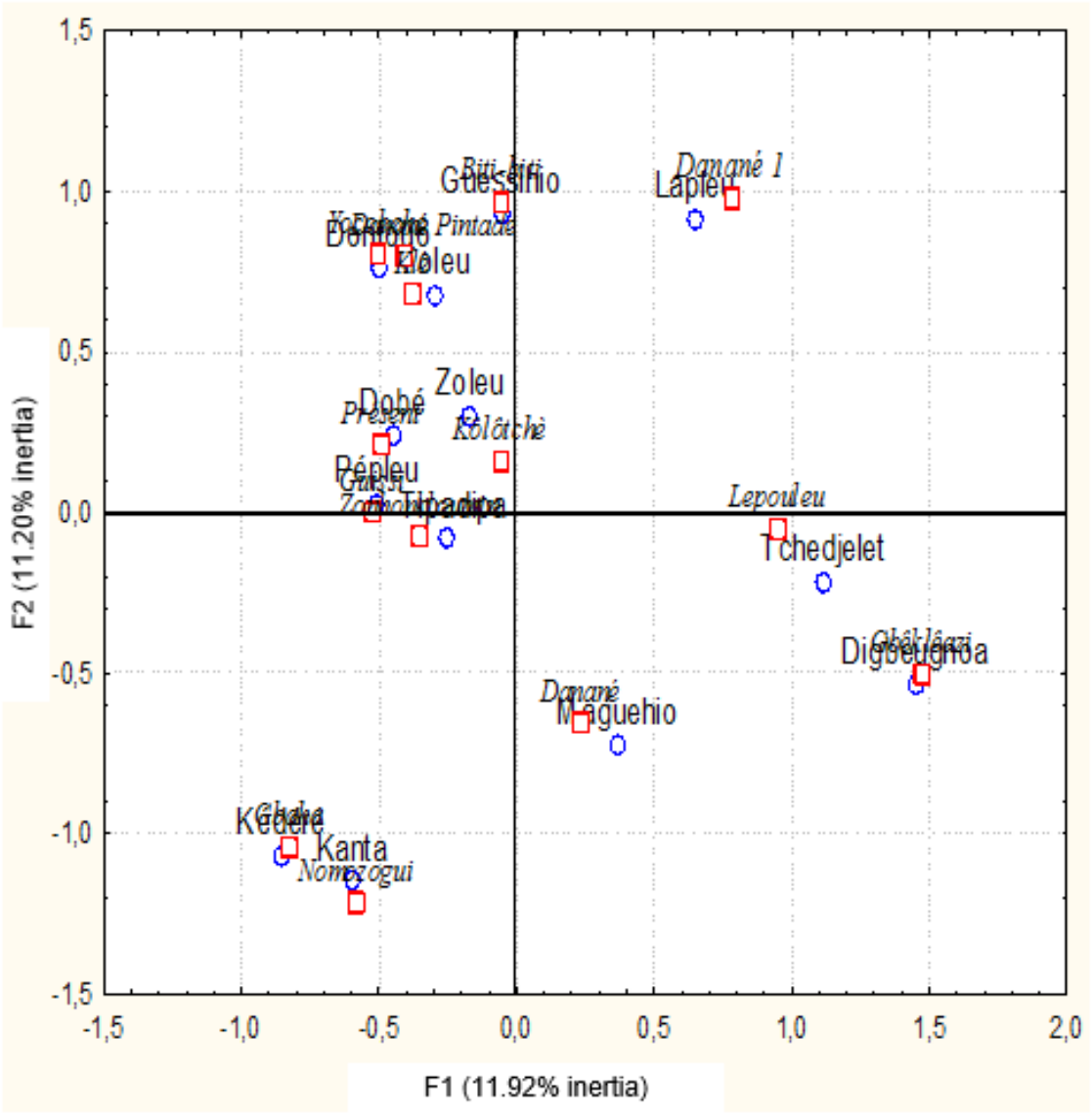

Figure 7. Distribution of the traditional rainfed rice varieties and the rural locations investigated by Factorial Correspondence Analysis

3.1.4 Post-harvest practices on the traditional rainfed rice

Tables 4 and 5 record the farmers' responses regarding the main post-harvest activities achieved on the traditional rice. The rice is harvested once or twice per year, between May and December according to the production trend of the cultivated varieties. Yet, the most significant harvest frequencies are told between June - July (34.44%), October - November (23.11%) and July - August (15.56%). The rainfed rice productions are used prior for the home consumption of the near overall farmers (99.8%). The rare rice surplus are either sold (0.1%) or granted (0.1%). The full interviewed farmers (100%) apply the sun-drying of the fresh rice harvested and thereafter the dried rice storage (99.6%). Thus, four main storage types are accounted from the rural locations visited, with a predominance for the granaries (79.4%). The overall farmers (100%) store their rice productions, without any preservative treatment, generally during 3-5 months (27.6%), 6-9 months (50.2%), against 20% farmers applying a quasi-yearly storage (10-12 months). The preservation of the rice seeds forecasted for the next sowing are essentially achieved under rice boots (92.4%) and only 7.6% in rice grains.

Table 4. Period of rainfed rice production in the locations investigated

Harvest periods	Responses rates
May- June	20%
June- July	30.44%
July- August	15.56%
August- October	3.11%
October- November	23.11%
November- December	7.78%

Table 5. Post- harvest activities performed on the traditional rainfed rice from the rural locations investigated

Post-harvest indicators	Responses rates
Sun-drying	Yes: 100% No: 0%
Drying delay	4-7 days: 29.1% > 1 week: 70.9%
Rice products uses	Home consumption: 99.8% Sale: 0.1% Gift: 0.1%
Storage achievement	Yes: 99.6% No: 0.4%
Storage areas	Granary: 79.4% Home shop: 5.2% Chicken: 13.6% Other house site: 1.8%
Storage delay	3-5 months: 27.6% 6-9 months: 50.2% 10-12 months: 20% > 12 months: 2.2%
Use of chemical preservatives	Yes: 0% No: 100%
Rice seeds preservation forms	Rice grains: 7,6% Rice Boots: 92.4%

DISCUSSION

In Côte d'Ivoire, rice is known as fundamental importance for the economy and household consumption. The rainfed rice and irrigated rice are both main agro-systems practiced for rice production. Those systems are met in forest and savannah ecologies [12]. The investigation has revealed the rainfed rice production as a widespread farming route strongly used in the western country, in accordance with the observations casted by Fall [13]. This author reported 92% lands cultivated with rainfed rice and accounting for 73% total rice production in Côte d'Ivoire, with a clear dominance in the Western, Centre-Western, and Northern regions. From the overall investigated locations, the rainfed rice is more produced by male individuals, generally of the second age, between 41 and 50 years. The traditional rice varieties most cultivated of which are *Danané*, *Dananéfowl*, *Danané1*, *Gbêklêazi*, *Guissi*, and *Zonhonkloumin*, are differentiated by the grains shape and colour and the productive cycle.

Missihoun *et al*. [14] also indicated the grains colour and reproductive cycle as the most significant criteria used from north-western Benin by farmers during the traditional production of Sorghum, another cereal crop. Besides, the cultivation of rainfed rice is known to be watered by rains, especially on flat lands.

The rice varieties rated by farmers generally record weaker yield about 1 or 2 ton per ha. This slight yield of the traditional rice varieties has also been reported in Democratic Republic of Congo, with an average of 0.75 T/ha [15]. In the same way, the Inter-professional Funds for Agriculture Research and Council has forecasted the yield in rainfed rice between 1 and 1.5 T/ha [16].

Most farmers rated little acreages of rainfed rice lands without any fertilizer nor weeding or fungus treatment. Similar observations were previously made by Yao *et al*. [17] who showed that the farmers usually use the home manpower and work little areas for the rice culture. Otherwise, Boone *et al*. [18] have investigated the maize provision chain and found a major involvement of the small-scale farmers with rather craft agricultural practices that hardly yield between 1 and 2 tons.

According to the investigated stakeholders, the rainfed rice cultivation is achieved after incineration of the reclaimed land flora and most often in association with other foodstuff or income crops. This statement corroborates the study of Kotchi and Aloko[19] reporting the use of various food plants in the rice lands from Gagnoa department. Thus, for increasing their livelihoods and home consumption raw products, farmers attempt several cultivation strategies as intercropping rice fields with cassava, maize, yam, and plantain. Industrial crops as cocoa, rubber, and oil palm are even often associated, whatever in very weak proportions [20, 17].

The farmers use traditional rice seeds from their previous harvests, because of availability criteria, climate resistance, earlier production, and organoleptic interests. Indeed, according to the local consumers, the traditional rice varieties are more enjoyed for their taste and aroma, but would also present therapeutic properties [21]. Similar data were reported by N'Da *et al*. [22] from the purple maize variety richer in anthocyanin, suitable antioxidants for the prevention of cardiovascular diseases, earlier ageing, cholesterol regulation, and arterial pressure [23, 22].

Granaries appeared as the most rated rice storage and preservation conditions from the villages visited without any post-harvest treatment. The availability of local building materials, the local farmers' ability, and especially the lack of finances and post-harvest preservatives from rural families could prove the use or granaries for the cereal's storage [24, 25, 26].

4. CONCLUSION

This survey revealed the cultivation of numerous traditional varieties rainfed rice from Gôh - Djiboua and Mountains districts in Côte d'Ivoire. The local spelling of the rice varieties is specifically related to morphological (shape and colour) and organoleptic traits of the rice grains. The rice is produced in small-scale by farmers, kept into craft storages structures and mainly used for home consumption. However, the weak productivity of the traditional rice varieties and the climate changes could constrain farmers in progressive surrendering of these traditional rainfed rice varieties and use of the improved varieties which provide higher yield. Significant actions aiming the preservation of the local rainfed rice genebank should be afforded through farmers' training and food valorization of these agro-resources on national scale.

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