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Participatory Assessment of the Potential of Traditional Lowland Rainfed Rice Varieties in Lower Casamance

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Abstract

Casamance was perceived as an agricultural granary that had rice potential which could meet the high food demand of Senegal. Given that the rice-growing lands have been degraded due to pedoclimatic variabilities, improved modern varieties are not usually well adapted to the Casamance rice-growing ecosystems. This work aims to contribute to the increase of rice production through varietal diversification and enhancement of cultural heritage. A participatory evaluation of five local farmers' traditional varieties along with one check was carried out in an experiment laid out in a one-factor complete randomized block design using the six accessions with five replications. ANOVA followed by a 5% mean comparison Tukey test and the Kendall Rate were performed with IBM SPSS Statistics software. The result showed very significant varietal differences for leaf blade of the penultimate leaves, 100-grains weight, panicle length, growth cycle, plant height, ramification of secondary branching of the spikelets, resistance to lodging and threshing facility ($p \leq 0.005$). However, traits including flag leaf, tiller numbers, sterile tillers number, panicle numbers, panicle yield, and grain yield did not show a significant difference ($p \geq 0.06$) among varieties. Thus, based on some of these characteristics, farmers selected their most preferred rice varieties or accessions. The most important characteristics were tillering ability, lodging resistance and fertility rate. Koussik Emandiouck selected by farmers as the best variety, had a high grain yield (4.9 $t \cdot ha^{-1}$), higher lodging resistance (9), and higher fertility rate (80.53%). Koussik Emandiouck, Koufekeny and Awandiaho varieties were the most preferred by farmers.

Keywords

Rice, Rainfed, Evaluation, Accession, Indland Valleys, Senegal

1. Introduction

In Senegal, rice is the first cereal crop in terms of production and harvested areas, with about 1,155,730 tons for 345,596 ha in 2019 [1]. Rainfed rice cultivation is practiced in the central (Fatick, Kaolack, Kaffrine), southern (Ziguinchor, Kolda, Sedhiou), and southeastern (Tambacounda, Kedougou) regions. Irrigated rice cultivation is mainly concentrated in the Senegal River Valley in the Northern regions and the Anambe basin in the South [2].

In Casamance, rice cultivation essentially practiced under rainfed conditions, is a very old tradition [3]. Casamance is one of the oldest centers of domestication and cultivation of rice (1500-800 BC) [4]. Rice cultivation is characterized by a great diversity of existing accessions and varieties derived from the two rice species, *Oryza glaberrima* and *Oryza sativa*. Casamance is the only area of Senegal where both rice species are cultivated. *Oryza glaberrima* has been progressively replaced by the Asian species, *Oryza sativa* introduced in the region by Portuguese navigators in the 16th century. Farming techniques are traditional and mainly performed manually using rudimentary tools in small land areas of less than ½ ha per farmer. However, arable lands are estimated at about 222,000 ha across Ziguinchor, Kolda, and Sedhiou [2]. Flooded rice cultivation, historically established in the estuarine zone of the Casamance River, held great promise [5]. However, most of the lowland ecologies are being progressively affected by a decrease of fertility, and soil toxicity constraints including acidity, salinity and iron toxicity [6]. In addition to these soil toxicities, rice productivity is particularly limited by disease and insect pests, occasional droughts resulting from rainfall variations, and inappropriate farming practices [7]. To cope with these constraints, the use of local farmers' varieties adapted to the environment could help since improved modern varieties are usually low performing because of inappropriate agronomical practices and soil conditions with average grain yield of less than 3 t/ha. The present study was conducted, with main objective of contributing to the increase of rice production through the valorization and use of traditional farmers' accessions adapted to local conditions. Specifically, this study aims to: 1) evaluate the performance of five common farmers' local varieties in five farmers' fields and 2) identify farmers' criteria for selecting and conserving rice accession from heritage.

2. Materials and Methods

2.1. Presentation of the Experimental Area

The trial was conducted in Essaout (12˚24'28.87''N and 16˚37'19.86''W) and Niaguis (12˚34'09''N and 16˚10'25''W) in Lower Casamance, near the border with Guinea-Bissau in the region of Ziguinchor. The climate is sub-Guinean with two alternating seasons: seven months dry season (November to May) and five months rainy season (June to October). The cumulative rainfall recorded this year is 1235.6 mm in 4 months (Figure 1).

2.2. Materials

2.2.1. Plant Material

In each of the five sites, five traditional varieties and one local check variety were chosen by farmers. The check was sourced from the research development institutes and is commonly grown in the localities. These varieties from ancient legacy or from research institutes were evaluated in a randomized complete block design in farmers' fields using recommended agricultural practices. The extended varieties Camara represented the check variety in two field block in Essaout. The choice of these varieties was made by the farmers. Choices of evaluated varieties or accessions were justified by their yields, their growing cycle or their tolerance to salinity (Table 1).

2.2.2. Other Maturels Used for Plots Implementation

As in farmers' field conditions, basic agricultural tools and equipments were

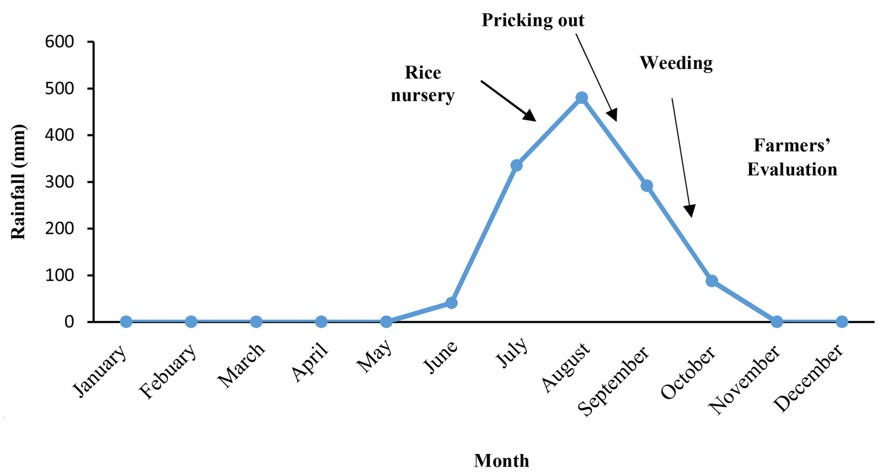

Figure 1. Evolution of the rainfall of Essaout and Niaguis.

Table 1. List of favorite traditional varieties and check used for the evaluation.

N°	Favorite varieties	Status (local or from reseach)
1	Awandiaho	Local
2	Eguite	Local
3	Etomoro	Local
4	Koufekeny	Local
5	Koussik Emandiouck	Local
6	Camara	From ISRA

used for soil preparation using "Kadiandou" to make ridges on which rice seedlings were transplanted, for weeding and harvesting. A questionnaire was used and administered to the farmers during the survey and participatory evaluation of the varieties.

2.3. Methods

2.3.1. Experimental Set-Up

The design was a single-factor (variety) randomized complete block design consisting of six treatments that were replicated on five farmers' fields, for a total of 30 elementary plots. Each famer field represented a replication. Varieties were coded as follow Etomoro (V1), Eguite (V2), Koussik Emandiouck (V3), Koufekeny (V4), Awandiahov (V5) and Camara (V6). Elementary plot was 19.26 m^2 (5.35 m × 3.6 m) and is composed of 4 ridges of 4 rows each, with a spacing of 20 cm × 25 cm. The elementary plots are separated by 54 cm distance.

2.3.2. Field Implementations and Evaluation of the Rice Varieties

1) Choice of varieties to be tested

After prospecting activities, a meeting was held in Oussouye on July 18, 2018 with 24 farmers and AJAC Lucaal Farmers Organisation to make an inventory of the most cultivated traditional varieties. After inventorying, six varieties were chosen by consensus for the trial.

2) Setting up of the trial

A nursery was set up by the farmers in their fields, on July 22. After land preparation using the "Kadiandou" for ridging and delimitation of the experimental plots for each of the famers fields, the 30-days-old seedling were transplanted two days after ridging at the rate of two seedling/hill. Spacing was 20 cm × 0.25 cm between rows. Manual weeding was done at 15 days and 60 days after transplanting. Harvesting was done manually with a knife for the yield square for each variety and for each replication. Then the harvested panicles were labelled and dried under the sun for three days and one week in the shade. After drying they were threshed, winnowed, and weighed separately.

2.3.3. Data Collection

Data were collected at the same time for all farmers according to the method described in the IRRI rice descriptor [8].

1) Data collected seven days after flowering

These data included:

- Measured on the flag leaf of the main stem on five randomly selected plants and the average to the nearest cm was considered
- Number of tillers/hill was measured inside the yield square meter measurement, by counting the number of fertile tillers and the number of sterile tillers.
- 50% heading date was noted from the number of days from sowing to the day when 50% of the plants had headed.

2) Data collected at maturity

Data were taken from five representative plants randomly selected from the yield square and the average of the five measurements was recorded. These data included:

- Plant height was measured on the tallest stem from ground level to the base of the panicle.
- Panicle length was measured on the main stem from the base to the tip of the panicle.
- Secondary branching of spikelets on the panicle was noted with the presence or absence of secondary branching, its abundance, and the distribution of spikelets on the secondary branches of the panicle.
- Number of panicles per cluster was noted by counting the number of panicles per cluster.
- 80% maturity date was recorded as the number of days from sowing to the day when 80% of the panicles turn yellow.
- Lodging resistance was recorded by observing the degree of lodging at maturity.
- Ease of threshing was determined by grasping the panicle with the hand, applying light rolling pressure with the palm and fingers and assessing the percentage of kernels removed by the action.

3) Data collected after harvest

After harvesting, data were collected on:

- Number of spikelets per panicle was obtained by averaging the total number of spikelets on five representative panicles.
- Percent fertility was obtained by the abundance of well-developed spikelets as a percentage of the total number of spikelets on five representative panicles.
- Panicle yield was obtained by weighing the panicles in the yield square per hectare.
- Paddy grain yield was obtained by weighing the paddy obtained after winnowing on a per hectare basis.
- 100 grains weight was obtained by counting and weighing 100 well filled grains.

4) Farmers' evaluation

Participatory evaluation began with the assessment of traditional varietal diversity using the four-box method [9]. This method consists of inventorying varieties according to the number of households where they are grown and on what area they are grown in each household (**Figure 2**). Farmer-evaluators from different villages of the district visited the plots to evaluate the varieties and make their votes. They were given ballots and badges to indicate their preferences. Each farmer was given 20 ballots to choose from, allocating to each variety the number of ballots they wanted. Then to the question: On what basis do you choose the varieties? A number of criteria were cited and ranked by consensus, in order of importance by the farmers. Block 1 or farmer 1 was selected for the field visit because of its proximity and accessibility. The farmers went around the block twice to appreciate the varieties and then voted. Varieties were then ranked according to the number of votes obtained.

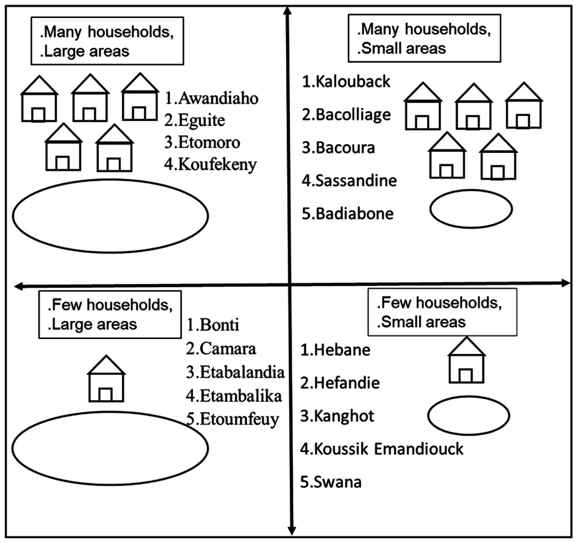

Figure 2. Distribution of the varieties based on four-box method.

5) Parboiling

Three varieties (Eguite, Koussik Emandiouck, and Koufekeny) were selected for the paraboiling. The traditional method of stewing was used. It consists of soaking the paddy in cold water for 8 hours; followed by draining and pre-cooking in small quantities in pot. After this pre-cooking, the paddy was spread out in the sun for drying. After drying, the parboiled and unparboiled rice were dehulled and subjected to bromatological analysis to assess nutritional quality such as protein, lipid and ash content.

6) Data processing and analysis

The collected data were computed using Excel spreadsheet. Statistical processing was performed with IBM SPSS Statistics version 23. An analysis of variance (ANOVA) was performed with the Tukey test at the 5% threshold in order to compare the means of the different varieties tested. Principal Component Analysis was performed for the bromatological analysis data. The relationship between the varieties and the measured parameters, as well as the relationship between the selection criteria and the voting of the varieties are determined by the interpretation of the correlation coefficient R.

Frequency analysis was performed on the survey data and the chi-square test and Kendall's ratio for the voting data. When $p > 0.05$, there is no significant dependence. When $p < 0.05$, there is a dependence between the variables. Sphinx version 4.5 software was used to prepare the questionnaire.

3. Results and Discussion

3.1. Results

3.1.1. Agro-Morphological Parameters

1) Tillering ability and panicles per cluster

Number of tillers and panicles per cluster are presented in Table 2 and Table 3 for the 6 varieties.

Table 2. Variation in the number of tillers and panicles per cluster according to rice varieties.

Varieties	Tillers/cluster	Sterile tillers/cluster	Panicles/cluster
Etomoro	12.6 ± 3.6^{a}	4 ± 2.2^{b}	8.6 ± 2.07^{a}
Eguite	9.4 ± 2.6^{a}	1.8 ± 1.6^{ab}	7.6 ± 1.5^{a}
Koussik Emandiouck	11.2 ± 0.83^{a}	3 ± 1^{ab}	8.2 ± 1.7^{a}
Koufekeny	9.6 ± 3.5^{a}	0.8 ± 0. 4^{a}	8.80 ± 3.5^{a}
Awandiaho	10.8 ± 2.1^{a}	2.6 ± 0.8^{ab}	8.2 ± 1.4^{a}
Camara	13 ± 3.1^{a}	2.4 ± 0.8^{ab}	10.2 ± 2.7^{a}
Mean	11 ± 2	2.43 ± 1.59	8 ± 2
p-value	0.33	0.0019*	0.61

Table 3. Correlation matrix (test de Khi^2) of yield parameters.

Variables	Tilles/cluster	Sterile tillers/cluster	Panicles/cluster
Tillers/cluster	1		
Sterile tillers /cluster	0.0002	1	
Panicles/cluster	0.0002	0.001	1

The number of tillers and panicles per cluster did not show a significant difference among varieties, while for the number of sterile tillers a significant difference was noted between Koufekeny and Etomoro. Indeed, the type of variety used is strongly correlated with the number of tillers and panicles per cluster as well as the number of sterile tillers per cluster (R = 0.66; R = 0.66; R = 0.69). In algebraic value, Camara had the higher tillering and more panicles, while Eguite had fewer panicles and tillers. Etomoro had more sterile tillers and Koufékény and Eguite had few number of sterile tillers (Table 2) than the others. The associations between the number of tillers per cluster and the number of panicles per cluster are statistically significant as well as for the number of panicles per cluster and the number of sterile tillers (Table 3).

2) Panicle and grain yield

Table 4 shows the panicle and paddy grains yield, 100 grains weight for the tested six rice varieties.

Analysis of variance shows that panicle and paddy yield showed no significant difference between varieties. However, the 100-grain weight showed that Koussik Emandiouck, Camara, and Koufekeny are statistically different from Eguite, Etomoro, and Awandiaho. Thus, Koussik Emandiouck had the highest yield and Awandiaho the lowest (Table 4).

3) Panicle length, fertility rate, and number of spikelets per panicle

Parameters of panicles such as the length (L), the fertility rate, and the number of spikelets per panicle for the six rice varieties are presented in Table 5.

Table 4. Variation in yield and 100-grain weight by rice variety.

Varieties	Panicle yield (kg/ha)	Paddy yield (Kg/ha)	100 grains weight (g)
Etomoro	3758.4 ± 107.8^{a}	3286.7 ± 100.5^{a}	2.45 ± 0.9^{a}
Eguite	4524.6 ± 73.96^{a}	3395.2 ± 70.43^{a}	2.46 ± 0.14^{a}
Koussik Emandiouck	4982.8 ± 119.8^{a}	4398 ± 127.1^{a}	2.91 ± 0.16^{b}
Koufekeny	3768.4 ± 148.9^{a}	3218.6 ± 153.3^{a}	2.83 ± 0.15^{b}
Awandiaho	3224.6 ± 59.02^{a}	2683.4 ± 52.7^{a}	2.34 ± 0.13^{a}
Camara	4390.4 ± 95.07^{a}	3865 ± 80.7^{a}	2.90 ± 0.1^{b}
Mean	4100.8 ± 112.41	3474.5 ± 108	2.65 ± 0.27
p-value	0.142	0.191	0.0001**

Table 5. Variation in panicle length among rice varieties.

Varietes	Panicle length (cm)	Fertility (%)	Spikelets/panicle
Etomoro	25.88 ± 1.4^{ab}	81.62 ± 4.5^{ab}	142.6 ± 20.25^{ab}
Eguite	30.33 ± 1.08^{c}	78.01 ± 5.9^{ab}	189.8 ± 40.02^{b}
Koussik Emandiouck	27.13 ± 2.5^{bc}	80.53 ± 5.08^{ab}	152.2 ± 40.91^{ab}
Koufekeny	23.71 ± 1.2^{a}	87.55 ± 3.8^{b}	119.6 ± 31.88^{a}
Awandiaho	25.04 ± 2.08^{ab}	88.58 ± 2.1^{b}	110.2 ± 21.04^{a}
Camara	23.81 ± 1.2^{a}	72.41 ± 10.2^{a}	130.8 ± 16.9^{a}
Mean	25 ± 2.7	81.45 ± 7.74	140 ± 37
p-value	0.0001**	0.002*	0.005*

A high significant difference was noted in panicle length between Eguite and the other varieties except Koussik Emandiouck, which was also different from Awandiaho and Koufekeny (**Table 5**). Camara is statistically less fertile than Awandiaho, and Koufekeny. Eguite produced more spikelets than Camara, Awandiaho, and Koufekeny. Eguite had the longest panicles, but Awandiaho was more fertile and has fewer spikelets.

4) Date of heading and maturity

The dates of 50% heading and 80% maturity for the six varieties are presented in **Table 6**.

Highly significant difference was noted between Eguite, and the other varieties except Etomoro for the date 50% heading date. At maturity, a very significant difference was noted between Eguite, Koufekeny, and Awandiaho who were also statistically very different from Camara, Koussik Emandiouck, and Etomoro. Koufekeny, and Awandiaho did not statistically differ for heading while at maturity significant difference was noted, as well as for Eguite, and Etomoro (**Table 6**).

Table 6. Variation in growing cycle of the rice accessions.

Varieties	50% heading date (days)	80% Maturity date (days)
Etomoro	107 ± 2.7^{cd}	130 ± 2.1^{c}
Eguite	109 ± 1.3^{d}	136 ± 1.6^{d}
Koussik Emandiouck	104 ± 2.8^{bc}	127 ± 3.08^{c}
Koufekeny	93 ± 2.04^{a}	113 ± 1.7^{b}
Awandiaho	74 ± 2.5^{a}	97 ± 1.9^{a}
Camara	102 ± 2.7^{b}	129 ± 2.9^{c}
Mean	98 ± 12	122 ± 13
p-value	≤0.0001***	≤0.0001***

5) Plant height

Average plant height for the six rice accessions are presented in Table 7.

Plant height was more important for Eguite compared to Camara, Etomoro, and Awandiaho varieties. Varieties such as Koussik Emandiouck, and Koufekeny had medium plant height. Camara was the shortest variety (Table 7).

6) Ramification secondary rachis branches, resistance to lodging, and ease threshing

Secondary ramification of rachis branches, the resistance to lodging, and the ease of threshing were appreciated by farmers and presented in Table 8. The secondary rachis branches and the resistance to lodging highlight three groups of varieties and the ease of threshing two groups. Koussik Emandiouck alone constituted a group and differed from the others for these three parameters (Table 8).

The secondary rachis branch, resistance to lodging, and ease of threshing depended on the varieties. The Khi^2 Test shows dependence between the secondary branching of spikelets and resistance to lodging ($p = 0.002$) and between resistance to lodging and ease threshing ($p = 0.0001$) are statistically significant. And between the secondary branching of the spikelets and the ease threshing there is no dependence ($p = 0.009$).

3.1.2. Farmer Assessment in Oussouye

Participatory evaluation of varieties by farmers yielded the results presented in Table 9.

The Koussik Emandiouck variety was voted as the best variety for all criteria except cycle length, drought resistance and taste where it comes third. Awandiaho came in seconde place in farmers' selection for its tillering ability, its resistance to lodging and its low abortion rate. Eguite was ranked last because of its long cycle length, low resistance to drought and shedding, and high abortion rate. Kufeneky is voted in third place for the number of grains per panicle, resistance to lodging and capacity of swelling, and abortion rate. Etomoro was ranked fourth because of its cycle and swelling. And Camara was ranked fifth for

Table 7. Variation of plant height of the rice accessions.

Varieties	Plants height (cm)
Etomoro	86.04 ± 3.62^{ab}
Eguite	107.85 ± 5.7^{c}
Koussik Emandiouck	103.19 ± 16.53^{bc}
Koufekeny	95.39 ± 13.84^{abc}
Awandiaho	83.85 ± 10.01^{ab}
Camara	79.30 ± 5.98^{a}
Mean	92 ± 14.1
p-value	0.001*

Table 8. Varieties rank following their qualitative criteria.

Varieties	Secondary rachis branches	Resistance to lodging	Ease of threshing
Etomoro	2	5	3
Eguite	3	5	3
Koussik Emandiouck	1	9	2
Koufekeny	3	7	3
Awandiaho	3	7	3
Camara	2	5	3

Number of spikelets: 1 (sparse); 2 (dense); 3 (clusters); Resistance to lodging: 1 (very low); 3 (low): 5 (intermediate): 7 (strong): 9 (very strong); Threshing Ease: 1 (difficult): 2 (intermediate): 3 (easy).

Table 9. Selection and classification of varieties.

Variétés	Etomoro	Eguite	Koussik Emandiouck	Koufekeny	Awandiaho	Camara	Kendall's	p-value
tillers	1	4	1	4	2	3	0.94	**0.02**
Cycle length	4	6	3	2	1	4	0.4	0.32
Grains/panicle	2	2	1	3	5	4	−0.2	0.62
Resistance to lodging	5	5	1	3	2	4	0.8	**0.05**
Taste	1	3	2	2	1	4	0.31	0.44
Swelling	4	2	1	3	3	4	0.10	0.80
Resistance to drought	5	5	3	2	1	4	0.4	0.32
Abortion rate	5	5	1	3	2	4	0.8	**0.05**
General rank	4	6	1	3	2	5		

all criteria except the number of tillers (Table 9). The analysis of variance shows that the general rank is very strongly correlated with the number of tillers, the resistance to lodging and the abortion rate. The number of grains per panicle, and the grain swelling are lowly correlated with the general rank as shown by the Kendall's Test and its p-value.

3.1.3. Bromatological Analysis

Bromatological analysis showed that for each variety the protein content does not vary whether the rice is stewed or not. However, for lipids and ash, there is was slight variations between stewed and non-stewed rice for all varieties. The varieties are richer in protein and less rich in lipids than in ash. The lipid and ash content increased when the rice is parboiled for Koussik Emandiouck and decreases for Eguite. Koufekeny has fewer lipids and more ash when it is parboiled. Koussik Emandiouck and Eguite have the same amount of protein. Principal component analysis shows that lipids are highly contributed to F1 while ash and protein are associated with the F2 axis. The amount of nutritional elements is related not only to the variety, but also to the treatment: stewed and non-stewed (Figure 3).

3.2. Discussion

The results obtained through this study showed that the varieties do not differ significantly according to the tillering ability and the number of panicles per hill though a difference was noted between blocks (p = 0.007 and p = 0.001 respectively). This difference between blocks could be explained by the difference in the water level in the plots. Lacharme [10] states that too high water level at the beginning of the growing cycle (seedling stage and early tillering) decreases the ability of the rice plant to tiller. Similarly, too much height during the active tillering phase will accelerate the booting phase and reduce the tillering period.

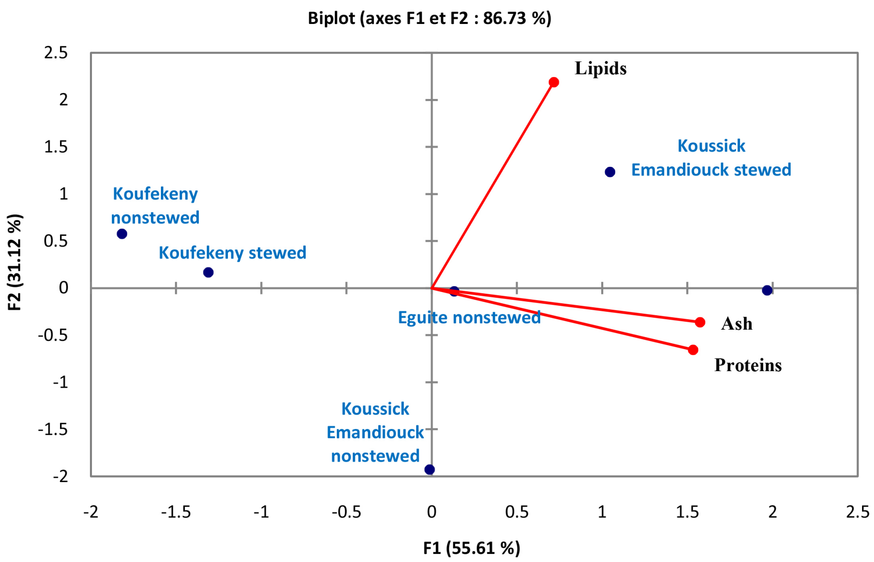

Figure 3. Analysis of the main components carried out on varieties.

The best tillering was obtained with Camara variety and based on tillering ability, the varieties can be classified into two groups: a group of low-tillering varieties (Koufekeny, Eguite: NT < 10 tillers) and a group of medium-tillering varieties (Etomoro, Koussik Emandiouck, Awandiaho, and Camara: 11 < NT ≤ 15 tillers). Paddy and panicle yields do not statistically differentiate varieties. However, the mean comparison of 100 grains weight divided the varieties into two classes composed of three varieties each, class **a** (Etomoro, Eguite, and Awandiaho) and class **b** (Koussik Emandiouck, Koufekeny, Awandiaho). Koussik Emandiouck obtained the highest yield (4.39 $t \cdot ha^{-1}$). This variety is not only higher in terms of yield than that of the improved varieties grown in Casamance which are mainly of 3 t ha^{-1} in farmers fields [11] but also that of Camara which was used as check. Panicles differed from one variety to another according to their length, fertility, and spikelet numbers. Eguite had the longest panicles and more spikelets, Awandiaho presented the higher fertility rate and fewer spikelets.

Following the IRRI rice descriptor [8], the varieties were grouped into two groups according to the panicle length. The medium panicle length (15 < L ≤ 25 cm) group including Etomoro, Koufekeny, Awandiaho, and Camara, and the high panicle length group (25 < L ≤ 35 cm) composed of Koussik Emandiouck and Eguite. Depending on the fertility rate, two groups were noted, a group with 75% to 90% fertility consisted only of local varieties and a group of 50% to 74% fertility composed of the check variety. The results showed that short panicle type does not necessarily have less spikelet than long panicle. There are varietal differences for panicle length, shape, number of spikelets per unit length and angle of panicles [12]. Similarly, the importance of spikelets does not determine their level of fertility. This could be explained by the fact that the level of susceptibility to biotic and abiotic constraints differs between varieties.

A huge difference was noted between the varieties according to the growing cycles. The duration of the growing cycle varied between 97 and 136 days. It highlights four types of varieties, very early (Awandiaho: Less than 100 days), Early (Koufekeny: 101 to 115 days), Medium cycle varieties (Etomoro, Koussik Emandiouck, and Camara: 116 to 130 days), and Late variety (Eguite: 131 to 145 days). Cycle length is one of the most important traits of a variety when it comes to adaptability and agronomical performance [13].

Plant height distinguished significantly the tested varieties. Local farmers' varieties had higher plant height than check varieties. Jacquot *et al.* [14] state that modern varieties are shorter than traditional varieties. The varieties can be classified into two groups, the short-plant height varieties (71 - 90 cm) Etomoro, Awandiaho, and Camara, and the short-to-medium-plant height varieties (91 - 105 cm), Eguite, Koussik Emandiouck, and Koufekeny.

Regarding the qualitative characters, Koussik Emandiouck differs from the other varieties by its open panicle, its strong resistance to lodging, and its threshing which is not easy. Etomoro and Camara have compact panicles and intermediate resistance to lodging. Koufekeny and Awandiaho have compact-folded panicles and strong resistance for lodging while Eguite had compact panicles and intermediate resistance. These results reveal that the resistance to lodging may depend on the secondary rachis branching of the spikelets but also on the ease of threshing. The robustness of the stems (diameter) and their height are also criteria for resistance to lodging [8].

The participatory evaluation identified eight farmers' criteria for selecting varieties which were ranked in order of importance. The selection criteria are not always the same for varieties. Koussik Emandiouck was selected as the best variety because of its high tillering ability, high number of grains per panicle, high resistance to lodging, and low abortion rate. Eguite was the less preferred variety by farmers because of its high abortion rate, low resistance to lodging, and cycle length. Farmers vote more for a variety if it has high tillering, low abortion rate, and high resistance for lodging. This is explained by the fact that for farmer, tillering is an important component of productivity, the resistance to lodging keeps the plants in erect position which facilitate the harvest and also minimize post-harvest lose in grains. The low abortion rate is not only associated with fertility but also with resistance to insects and diseases.

Bromatological analysis reveals that the varieties do not have same nutritional value. Stewing allowed an increase in ash and lipid content (except for Koufeneny). However, it had no effect on protein content. Stewing makes physico-chemical and organoleptic changes which provide nutritional and economic advantages [15]. However, it should be noted that poor parboiling, due to lack of experience or any other reason, can decrease the quality benefits and also reduce the dietary value of rice variety [16]. The increase in nutritional value is more related to parboiling for lipids while for proteins it is more related to the variety type and for ash, it is related not only to parboiling but also to the variety.

4. Conclusion

The general objective of this study was to contribute for increasing rice production by valuing peasant seeds. The different results showed a very significant difference between varieties for 100 grains weight, panicle, growing cycle, plant height, secondary rachis branches of spikelets, resistance to lodging, and ease of threshing. However, the varieties do not differ significantly according to the number of tillers/hill, the number of sterile tillers/hill, the number of panicles/hill, the yield of panicles, and the yield of paddy grains. Stewing had an effect on ash and lipids content, which increased along with the nutritional value of the rice variety and differ among the tested varieties. Koussik Emandiouck presented the higher nutritional value and obtained the highest yield (4.39 $t \cdot ha^{-1}$) and was voted as the best variety. The study also reveals that farmers select varieties based on criteria including tillering ability, resistance to lodging, and low abortion rates. Three varieties were selected by farmers: Koussik Emandiouck, Koufekeny, and Awandiaho. Thus, for better production using local farmers' varieties, the following recommendations are made: reconducting the experiment by adding other local varieties that could meet farmers' criteria and preferences, expanding the evaluation sites across districts, and performing more detailed bromatological analysis for better assessment of the nutritional value of farmers' traditional varieties.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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