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Effects of Intensive and Traditional Rice Cultivation Systems on the Yield and Biochemical Composition of the Rice (*Oryza Sativa*) Grain (Faranah, Republic of Guinea)

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Abstract: *In the Republic of Guinea, the system of intensive rice cultivation was introduced about a decade ago with little expansion into rural areas. It is in this context that we carried out this study of the effects of intensive and traditional rice cultivation systems on the yield and biochemical composition of the rice grain at ISAV/F to know the limits of SRI in improving the grain quality. The work took place from June 25 to December 15, 2020 in the Urban Commune of Faranah for culture and from February 10 to April 13, 2021 in Conakry at the Laboratory of Central Veterinary Diagnostic (LCVD), Food Hygiene Section in Conakry located at the Ministry of Agriculture in the Municipality of Kaloum. The aim of the research is to see the effects of rice cultivation systems on the yield and nutritional value of the rice grain. The plant material used consisted of four varieties Binyana, Diana and Soronkadi (local) and CK211 (improved). The parameters evaluated are the yield per hectare, the growing cycle and the biochemical parameters. The data collected was subjected to statistical analyzes using Excel, SPSS 21 and Sigma Plot 12.5 software. The results of these analyze show that in terms of yield, SRI proved to be better on all varieties with relatively short vegetative cycles. For biochemical quality, parameter averages of four varieties show an increase in content by SRI in moisture, fat, mineral and protein levels; a reduction in the content of carbohydrates in this same system and a uniformity of the systems for the rate of dry matter. Yield has a strong positive correlation with protein content and a very strong negative correlation with those carbohydrates.*

Keywords: Rice (Oryza sativa), Yield, Biochemical quality, Intensive rice cultivation system, Traditional

1. INTRODUCTION

Grains represent two-thirds of the calories and half of the protein we eat (LAGACE, 2011). Many of them are gluten-free and are good sources of protein: brown rice, black rice, corn and buckwheat are the best known. (MIMEAULT, 2013). Rice is the staple food of more than half of humanity, mainly in Asia and Africa. It is the world's leading cereal in human consumption, the second after maize in terms of the tonnage harvested and after wheat in cultivated area (FAO, 2009).

West Africa is the largest producer, consumer and importer of rice in Africa and for several decades production has fallen short of demand. In response, countries in the region are looking for ways to increase domestic rice production (ERIKA and DEVON, 2014). According to SECK and al., 2013, in sub-Saharan Africa, the growth rate of rice production is estimated at 5% per year from 2000 to 2012. If this growth rate and the other parameters influencing demand were maintained, rice consumption in Africa Sub-Saharan Africa would have increased from twenty-four million tons of milled rice in 2012 to thirty-six million tons of milled rice in 2020. The vast majority or about 80% of this demand would come from West Africa and East Africa.

In Guinea, the theoretical annual consumption needs amount to about 1000000 tons for a population estimated at 10M inhabitants in 2011. This consumption is provided by local production (60%). According to the DYNAFIV Project in 2008, producers place around 120000 t/year of local rice on the market (DIAWARA and CONDÉ, 2011). Rice is mainly grown in three of the country's four natural regions (DIAKITE, 2010). Among the agricultural practices that increase the productivity of rice, we can cite the Intensive Rice Cultivation System (IRS). According to the farmers who have adopted it, the average yield of the paddy field has increased from 2 t/ha to 4 t/ha or even much more, 11 t/ha, (CORINNE, 2008).

This system is an agro-ecological and climate-smart method that produces more cereals based on rational management of plants, soil, water and nutrients. However, studies on the technological qualities as well as the biochemical composition of grains produced from SRI are very limited. By referring only to the increase in the yield in IRS, it seems quite pretentious to speak of a "miracle" properly speaking. Prior knowledge clearly states a negative correlation between the number of tillers and the number of kernels per panicle. However, from the first experimental tests of the system, the opposite fact was observed with a positive correlation of 0.65 (JOELIBARISON, 1998).

The different SRI performance factors each have an influence, the importance of which has been specified by the yields obtained. Thus, the age of transplantation contributes the greatest increase. Water control is essential, the use of organic amendments is also proving effective and the number of strands per tuft can still bring improvements (ANDIANKAJA, 2002).

Currently, the IRS is already published in French, English and some documents are translated into Spanish and Portuguese. Several countries have already expressed their interest in this system: Cambodia, China, Philippines, Indonesia, Sri Lanka, Thailand,

Bangladesh, Cuba, Sierra Leone, Gambia, Ivory Coast ... and even the United States where one of the largest group's seed companies launched into (SRI as an ANDIANKAJA Trial, 2002).

However, significant efforts remain to be deployed around the world for a wide dissemination of the IRS. AGRIDAPE, a platform for exchanges, popularization of peasant innovations and debates, by devoting this April 2013 issue volume-29 n°1 to SRI, seeks to highlight diverse experiences in Asia and Africa to draw lessons of their successes and failures. In-depth reflection on these experiences, involving all stakeholders, could help find the best way to strengthen knowledge about this practice, popularize it and facilitate its scaling up in order to contribute to its massive adoption (AGRIDAPE, 2013).

It is in this approach, that we asked ourselves the question of knowing what is there between the biochemical composition of the rice grain resulting from the SRI compared to the traditional rice growing system (SRT) and if the increase in yield by this system is proportional to the improvement of the nutritional value of the rice grain. Indeed, the nutrients that we absorb daily by eating are used by the body to provide the energy necessary for its maintenance, work, growth and protection.

The general objective of this research is to evaluate the effect of intensive and traditional rice cultivation systems on the yield and biochemical composition of the grain of four varieties of rice. The specific objectives are: *i*) to determine the paddy yield of four varieties conducted in SRI and SRT; *ii*) determine the dry matter content of grains by variety and by system and *iii*) assess the protein, carbohydrate and lipid content of rice grains from both systems.

2. MATERIALS AND METHODS

2.1 Material

2.1.1 Presentation of study sites

The test was carried out in the Founkama plain in the Urban Commune of the prefecture of Faranah, located 460 km away of Conakry with an average altitude of 340 m. This municipality covers an area of 1300 km^2 for a population of 325893 inhabitants, including 168600 women, for an average density of 18 inhabitants per km2 (DRPD/F, 2019). Biochemical analyzes were carried out at the Central Veterinary Diagnostic Laboratory (LCVD), Food Hygiene Section located at the Department of the Ministry of Agriculture in the Municipality of Kaloum in Conakry, Republic of Guinea (figure 1).

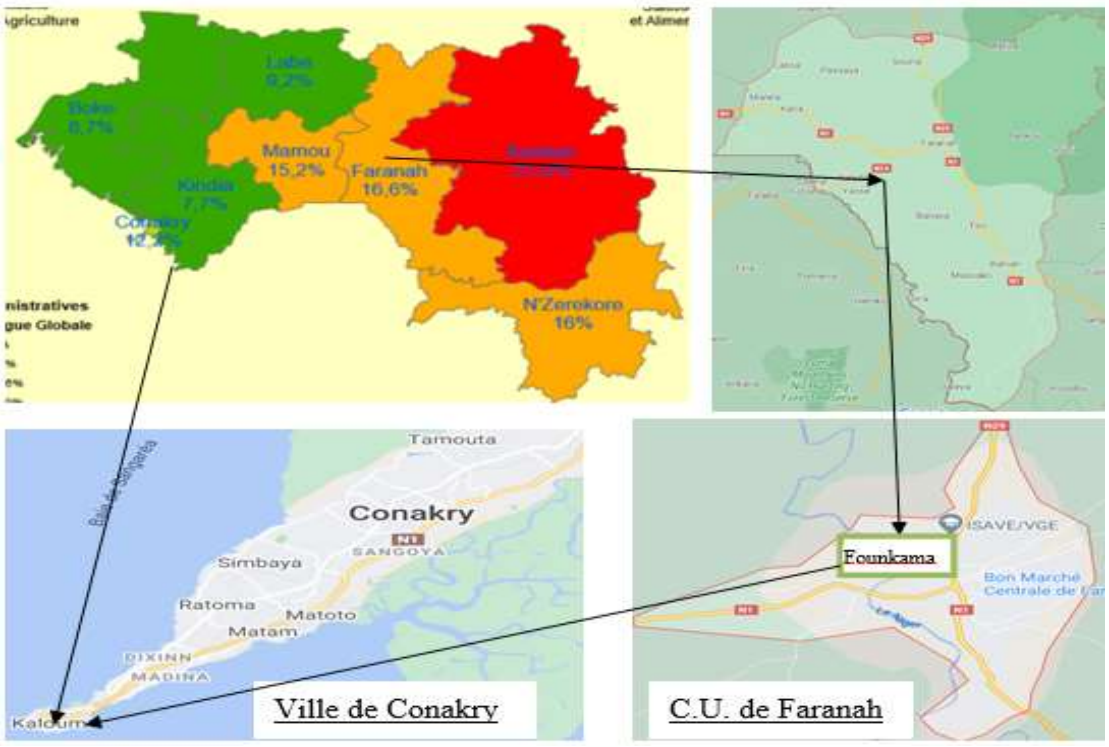

Figure 1: Presentation of the sites

2.1.2 Plant Material

The paddy rice grains of the four varieties tested together in the same trial in the period from June 25 to December 15, 2020 in the rice-growing plain of Founkama C. U. of Faranah served as plant material. Among these four varieties, three (Bintyana, Diana and

Soronkadi) are local collected respectively in the villages of Yatia, Magan and Damania of the Prefecture of Faranah and one (CK211) created at the Kilissi research center in Kindia, collected in the CU by Faranah. They are all lowland rice.

2.1.3 Equipment for conditioning grain samples for analysis

After harvest and determination of the yield, the samples were placed in Faranah in plastic bags and transported to the Laboratory of Central Veterinary de Diagnostic (LCVD), in Conakry, Republic of Guinea. The Laboratory is located at the Ministry of Agriculture in the Municipality of Kaloum. A 150g sample was taken from each of these two systems on all the varieties.

2.2 Methods

2.2.1 Study factors

The factors are represented by the rice cultivation system and the variety, namely: i) rice cultivation system factor with two levels (SRI and SRT) and ii) variety factor with four levels (Bintyana, CK211, Diana and Soronkadi). The combination of the levels of these two factors, gave us 8 variants which are: Bintyana in SRI (V1I), CK211 in SRI (V2I), Diana in SRI (V3I), Soronkadi in SRI (V4I), Bintyana in SRT (V1T), CK211 in SRT (V2T), Diana in SRT (V3T), Soronkadi in SRT (V4I). These eight variants were repeated four times on an open field BCR, for a total of thirty-two samples which were studied.

2.2.2 Yield determination

The yield was determined on an area of one square meter (calculation area) placed in the center of each elementary plot. The rice harvested from the calculation areas separately from the rest of the plot was threshed, winnowed, dried to a grain moisture of 13% and weighed and extrapolated per hectare to know the yield. It was from this amount that the 150 g sample was taken and packaged. For biochemical analyzes.

2.2.3 Determination of the vegetative cycle

For the vegetative cycle, phenological observations relating to the different phenophases from sowing to harvest have made it possible to know the vegetative cycle of each variety at the level of each system.

2.2.4 Biochemical parameters and methods of analysis

For each analysis, the results are expressed as a percentage of the dry matter. The moisture content in the samples was therefore determined.

2.2.4.1 Determination of humidity and dry matter

- Place empty weighing crucibles (cover + bottom) in desiccators, previously dried in an oven for 1 hour.
- Do not put too large a quantity of crucibles in the desiccators (maximum two rows).
- After cooling, tare to the nearest 0.1 mg each crucible to be weighed. Let M_0 be their mass. Weigh into the crucibles to the nearest 0.1 mg approximately 2 g of the ground sample. Let PE be the test sample.
- Spread out the test portion evenly with a slight rotary motion. Place the full weighing crucibles and their cover aside, in an oven at 103°C for 24 h.
- The stopwatch will be started as soon as the oven has again reached the desired temperature. After 24 hours, replace the lids and wait for the temperature to rise to 103°C. Then take out the crucibles to be weighed and let them cool in desiccators. Weigh them to the nearest 0.1 mg. Let M1 be their mass.

Dry matter content : $\%MS = \frac{M_1 - M_0}{PE}$; *Moisture content* : $\%HUMIDITE = 100 - \%MS$

With: M_0 = the mass of the empty crucible, in grams, M_1 = the mass of the crucible containing the dry residue, in grams, PE = the mass of the test sample, in grams. The difference between the results of 2 determinations carried out simultaneously by the same analyst must not exceed 0.2% in absolute value.

2.2.4.2 Determination of mineral content

- Place nickel crucibles previously oven-dried for at least 1 hour in a desiccators. Do not put too large a quantity of crucibles in the desiccators, at most two rows.
- After cooling, tare to the nearest 0.1 mg each crucible. Let M_0 be their mass. Weigh into the crucibles, to the nearest 0.1 mg, approximately 3 g of the ground sample. Let PE be the test sample. Evenly spread the test portion with a slight rotary motion.
- Place the full crucibles in the muffle furnace. Switch on the extractor hood. Calcite for 4 h at 550°C. The stopwatch will be started as soon as the oven has reached the desired temperature.
- When the time has elapsed, wait for the oven temperature to drop to 100 ° C, then remove the crucibles and let them cool in a desiccators. After cooling, weigh the crucibles to the nearest 0.1 mg. Let M1 be their mass.

$$\%MM = \frac{M_1 - M_0}{PE}$$

With: MM = the mineral content expressed as a percentage of the raw product, M_0 = the mass in grams of the empty crucible, M_1 = the mass in grams of the crucible containing the ashes. The difference between the results of 2 determinations carried out simultaneously by the same analyst must not exceed: 0.3 in absolute value for crude ash contents less than 3% ; 10% in relative value for crude ash contents of 3% to 5% ; 0.5 in absolute value for crude ash contents of 5% to 20% ; 2.5% in relative value for crude ash contents of 20% to 40%.
1 in absolute value for crude ash contents greater than 40%

2.2.4.3 Determination of the carbohydrate content

Solution

- In a 100 ml volumetric flask, weigh, to the nearest 0.1 mg, 1 g of sample crushed to 0.5 mm. Let PE be the test sample. Add a bar magnet, about 70 ml of 40% ethanol using a dispenser, close with a stopper and mix for one hour on a magnetic stirrer;
- After 1 hour, add 2 ml of Carrez I solution and stir for about a minute. Then add 2 ml of Carrez II solution and stir again for about a minute. Remove the bar magnet using a magnetic wand, rinse them and make up to 100 ml with ethanol. Homogenize and filter through a pleated filter;
- Transfer 50 ml of the filtrate into a volumetric flask and pour them into a 100 ml Erlen ballasted with a lead collar. Under the hood, immerse it in a boiling bath to evaporate about half the volume, to remove most of the ethanol;
- Transfer the still hot evaporation residue quantitatively to the 50 ml volumetric flask and rinse the Erlen with a minimum of water. Cool, make up to the mark with water and mix.

Inversion of total sugars

- Take 25 ml of solution with a volumetric pipette and place them in a 50 ml volumetric flask. Add a few drops of methyl orange solution then, while adding 4 N hydrochloric acid until it turns red. Add 7.5 ml of 0.1 N hydrochloric acid, immerse the flask in a water bath at high boiling point and keep it there for 30 minutes.
- Cool rapidly to 20 ° C by immersing the flask in ice and add 7.5 ml of 0.1 N sodium hydroxide solution. Make up to 50 ml with water and mix.

Titration according to Luff-Schoorl

With a volumetric pipette, take 25 ml of the reagent according to Luff-Schoorl and place them in a 200 ml Erlen; add 25 ml, exactly measured, of the defecated solution of sugars. Place the Erlen on a pre-heated baking sheet and cover with a freezer. From the first tremors, turn off the heating and start the stopwatch for exactly 10 minutes. Maintain a boil by regulating the heating (which will be turned back on after about 5 min).
After 10 minutes, cool immediately in ice and, after about 5 minutes, titrate as follows:

- Add 10 ml of potassium iodide solution and, immediately afterwards and very slowly (because of the risk of formation of an abundant foam), 25 ml of 6 N sulfuric acid. Then titrate with sodium thiosulphate solution 0.1 N until a dull yellow color appears, add the indicator to the starch and complete the titration until a pink color is obtained.
- Carry out the same titration on an exactly measured mixture of 25 ml of reagent according to Luff Schoorl and 25 ml of water, after adding 10 ml of potassium iodide solution and 25 ml of 6 N sulfuric acid, without bringing to boiling.

Calculation

Calculate the difference between the volume of sodium thiosulphate poured in when dosing the blank and the volume of sodium thiosulphate poured in when dosing the sample. Let V = V0-VE.
Determine the quantity of glucose in mg corresponding to volume V. The total sugar content expressed as % of sample is then:

$$\%\text{total sugars} = \frac{\text{mg glucose. read}}{PE} \times 0{,}8$$

With: PE, the test dose expressed in grams. The difference between the results of 2 determinations carried out simultaneously by the same analyst must not exceed 0.2 in absolute value

2.2.4.4 Determination of lipid content

Test sample

- Weigh, to the nearest 1 mg, approximately 5 g for category a samples and 2.5 g for category B samples. Let PE be the test portion.
- For a category A sample, place the test portion in an extraction cartridge and cover it with a degreased cotton ball.
- Hydrolysis (process B)
- Place the test sample in a 600 ml beaker. Add 100 ml of 3 mol / l hydrochloric acid to the test tube. Cover the beaker with condenser. Turn on the water supply. Bring the mixture to a gentle boil on a hotplate and keep it there for 1 hour. Stir from time to time to prevent the product from adhering to the sides of the container.
- After an hour, put the beaker in a hood and let cool completely. Then add 3 g of Celite to prevent any loss of fat during filtration.
- Filter through moistened filter paper positioned in a Büchner funnel on a vacuum flask. Wash off the residue with about 0.8 liters of cold water, not forgetting the filters, especially between the pleats.

- Carefully remove the filters containing the residue, place them in an extraction cartridge and cover with a cotton ball. Dry them in an oven at 60 ° C. overnight. The next day, extract as described below.

Extraction (process A and process B)

- Weigh, to the nearest 0.1 mg, a flask containing a few pieces of pumice stone (to regulate the boiling) previously dried in an oven. Let M0 be the mass of the flask. The ethereal extract will be collected in this matras. Place the flask in the heater and turn on the hood.
- Overcome the flask of a Soxhlet, place the cartridge there. Then add a sufficient quantity of petroleum ether for reflux to take place (approximately 130 ml). Cover with a cooler with a tear-off stopper on top and turn on the water supply. Adjust the heater so as to obtain at least 10 siphoning per hour (approximately 155°C). Start the stopwatch when the 1st siphoning takes place. Extract for 6 h.
- After 6 hours, turn off the heating and recover as much solvent as possible through the Soxhlet tap. When the unit has cooled, shut off the water supply, remove the condenser and the Soxhlet, and remove the flask from the heating block. Arrange the flasks in a tank by tilting them without laying them down, as well as the cartridges, and allow the ether to evaporate overnight under the hood.
- The next day, dry the flask containing the residue for 1 hour in an oven set at 60 ± 2°C. Cool the flask in desiccators, and then weigh it to the nearest 0.1 mg. Let M1 be the mass of the fluff containing the extracted fat.
- Discard the filter and clean the cartridge with compressed air.

Calculation

Calculate the fat content of the test sample according to the equation:

$$\%MG = \frac{M_1 - M_0}{PE} \times 100$$

MG is the fat content of the sample; PE is the mass of the test portion, in grams; M0 is the mass of the flask containing the stone pieces ounce, in grams; M1 is the mass of the flask containing the pieces of pumice stone and the residue of dried ethereal extract, in grams.

Express the result to the nearest 0.1%. The difference between the results of 2 determinations carried out simultaneously by the same analyst must not exceed 0.4 in absolute value.

2.2.4.5 Determination of protein content

Test portion: homogenize the sample well before taking the test portion. The test sample must contain between 0.005 and 0.2g of nitrogen. Usually 0.5g of sample will be taken.

Blank test: carry out a blank test using approximately 0.5 g of sucrose as a test sample.

Mineralization: introduce the test sample into the flask and add 25ml of sulfuric acid with an automatic pipette (5.3). Add 5.0. Add 15g of potassium sulphate and 1.2g of copper sulphate pentahydrate. Add a few boiling regulators and quickly boil the contents of the flask on the digestion digester.

5ml of boric acid (5.7) as well as 1 to 2 drops of methyl red, and place them in the receiving flask of the distillation apparatus. Make sure the end of the condenser is below the surface of the boric acid solution.

Dosage: after digestion, leave to cool to room temperature. During this time, take 10

Preparation of the Gerhart still

Phase 1: 3 seconds (the addition of 40% soda is carried out prior to the distillation); *Phase 2:* 20 seconds (contact time); *Phase 3:* 240 seconds (steam distillation). Perform a blank distillation with a Matras of distilled water (rinsing the device): press "run". The list of error messages is specified in appendix 2 of the ABVT/TMA procedure, 08-MO-05.

Sample distillation

20ml of water to the mineralization flask. With a graduated cylinder, add 60ml of 40% sodium hydroxide solution and immediately connect the flask to the distillation apparatus.±Carefully add 40

Heat the flask for 240 seconds so as to collect 150 ml of distillates in the receiving flask. Press "Run"

Sample titration

Then assay the sample with 0.2N sulfuric acid for samples with low protein concentration, use 0.1N sulfuric acid. Titrate the distillate with the sulfuric acid solution until it turns red. First, perform the white dosage. Note the volume V1 resulting from the titration of the blank on the bench sheet. Then assay the samples in duplicate, if possible, and record the VA and BV volumes from the titration on the bench sheet. Then calculate the mean, V2, of the replicates and transfer it to the bench sheet.

Calculation of the Kjeldahl nitrogen concentration as a percentage by mass of the product: Nin% = ((V2-V1)×0.14)/m. Where m is the mass, in g, of the test portion, V1 is the volume, in ml, of the sulfuric acid solution used for the titration of the blank, V2 is the volume, in ml, of the sulfuric acid solution used for the titration of the sample. This is the exact concentration, in normality, of the sulfuric acid solution used for the titration.

Calculation of the protein rate (Total Nitrogenous Matter) in percentage: Protein% = N × 6.25.

2.2.4.6 Statistical analyzes

The data of the biochemical evaluations collected after analyzes at the laboratory of Central Veterinary de Diagnostic (LCVD), Food Hygiene Section in Conakry were subjected to the analysis of variance (ANOVA) through the statistical software Excel and SPSS 21, the comparison of the means by the PPDS test at the 5% and 1% thresholds; graphics are designed using Sigma Plot 12.5 software.

3. RESULTS

3.1. Yield and vegetative cycle

The average yield obtained in the test field with the vegetative cycle recorded by variety and by system during the test period for this study is given in Table 1 below.

Table 1: Average yield and vegetative cycle of varieties in systems

System	Varieties	Yield(t/ha)	Vegetative cycle (days)	Origin
SRI	Bintyana	6,67 ± 0,12	139	local
	CK_{211}	6,56 ± 0,06	133	improved
	Diana	7,11 ± 0,07	133	local
	Soronkadi	6,97 ± 0,07	137	local
SRT	Bintyana	4,66 ± 0,23	149	local
	CK_{211}	4,62 ± 0,09	140	improved
	Diana	4,50 ± 0,12	139	local
	Soronkadi	4,65 ± 0,10	141	local

The results in this table indicate that the highest yields are obtained by SRI with the shortest vegetative cycles for all varieties unlike SRT. Among varieties, Diana had the highest yield in SRI, however she placed last in SRT. This could translate into the efficiency of the agronomic performance of the intensive rice cultivation system on the reaction of the tested varieties.

4.2 Statistical analyzes of the parameters studied on the paddy rice grain

The statistical calculations of the biochemical parameters and of the yield studied under the effects of the systems on the four varieties are given in Table 2.

Table 2: effects of the systems on the varieties according to the parameters studied.

Settings	Humidity level	Dry matter	Fat	Mineral matter	Protein level	Carbohydrate level	Yield
System (S)	0,023*	0,023*	0,572^{NS}	0,035*	0,030*	0,001**	0,000**
Varieties (V)	0,171^{NS}	0,171^{NS}	0,032*	0,000**	0,069^{NS}	0,002**	0,051^{NS}
S X V	0,002**	0,002**	0,939^{NS}	0,013*	0,276^{NS}	0,117^{NS}	0,019*
CV (%)	8,98	0,46	11,91	6,17	12,03	1,13	20,41
CVM (%)				8,73			

*** Highly significant difference (threshold of 1%)*
** Significant difference (5% threshold)*
NS: Not significant difference.

It can be seen from this table that between the systems there is a significant difference in terms of humidity and protein, dry matter and mineral matter; a highly significant difference for carbohydrate content and yield and a non-significant difference for fat. On the other hand, at the system level, between varieties it is significant only in terms of fat and highly significant for mineral matter and the level of carbohydrates. However, the interaction between these two phenomena does not reveal any significant or highly significant difference between these treatments for fat, protein and carbohydrate levels. The CV of high yield relative to other parameters shows a wider dispersion of means between systems and varieties. These variations in content between treatments are believed to be due to the effect of the systems on the physiological processes of rice grain filling and ripening on the one hand and on the other hand to the genetic potential of each variety and the effects of their interaction.

3.2 Average of biochemical parameters by variety and system

The classification of the means of the results of the biochemical composition of the parameters (grain moisture, dry matter, fat, mineral matter, proteins and carbohydrates) studied and their standard deviations are shown in Table 3.

Table 3: means of the biochemical parameters of paddy in percentage (%).

System	Varieties	Humidity level	Dry matter	Fat	Mineral matter	Protein level	Carbohydrate level

SRI	Bintyana	5,53±0,08a	94,47±0,08b	1,30±0,04a	5,02± 0,12a	6,08±0,11a	82,08±0,10b
	CK211	4,72±0,07b	95,28±0,07a	1,43±0,08a	4,66± 0,06b	5,81±0,15a	83,40±0,21a
	Diana	4,72±0,02b	95,28±0,02a	1,45±0,10a	4,70 ±0,02b	5,13±0,29b	84,01±0,39a
	Soronkadi	4,97±0,15b	95,03±0,15a	1,53±0,06a	4,80± 0,14ab	6,08±0,13a	82,64±0,08b
	Moyenne	4,99±0,08	95,02±0,08	1,43±0,04	4,79±0,04	5,77±0,14	83,03±0,16
SRT	Bintyana	4,50±0,11a	95,50±0,11a	1,28±0,06a	5,11±0,03a	5,27±0,27a	83,85±0,24a
	CK211	5,13±0,33a	94,87±0,33a	1,38±0,08a	4,22±0,05c	4,91±0,49a	84,37±0,43a
	Diana	4,62±0,22a	95,38±0,22a	1,38±0,09a	4,60±0,04b	5,24±0,38a	84,17±0,48a
	Soronkadi	4,58±0,01a	95,42±0,01a	1,55±0,10a	4,75±0,06b	5,80±0,26a	83,33±0,39a
	Moyenne	4,71±0,08	95,02±0,08	1,39±0,04	4,67±0,04	5,30±0,14	83,93±0,16

This table shows a slight increase in moisture, fat, mineral and protein content of SRI compared to SRT. However, the reverse is true for the level of carbohydrate and dry matter, which have the same average values in both systems. These results can be explained by the influence of the rice cultivation system on the biochemical composition of the rice grain and the improvement of certain organic compounds mentioned above by the intensive rice cultivation system to the detriment of others.

4.3 Correlation matrix

The coefficients of the effects of the dependence between all the parameters studied taken in pairs are annotated in Table IV.

Table 4: correlation matrix between the parameters

Settings	Humidity	Dry matter	Fat	Mineral matter	Protein level	Carbohydrate level	Yield
Humidity level	1						
Dry matter	-1,00**	1					
Fat	-0,25NS	0,25 NS	1				
Mineral matter	-0,16 NS	0,16 NS	-0,06 NS	1			
Protein level	-0,05 NS	0,05 NS	0,51**	0,38*	1		
Carbohydrate level	-0,33 NS	0,33 NS	-0,40*	-0,49**	-0,89**	1	
Yield	0,28 NS	-0,28 NS	0,18 NS	0,20 NS	0,39*	-0,49**	1

***The correlation is highly significant (threshold of 1%)*
**the correlation is significant (5% threshold)*
NS: correlation not significant.

This table shows that the protein content and yield; mineral matter and protein content have a strong positive correlation; protein and fat content have a very strong positive correlation. On the other hand, moisture content and dry matter are related with a very strong negative correlation and carbohydrate content has a very strong negative correlation with yield, protein content and mineral matter. This could be explained by the interaction effect of the accumulation of nutrients in the grain which constitutes the rice organism reserve organ.

4.4 Regression equation between yield and biochemical parameters

In Figure 2 presented below, the interdependence between yield and each of the biochemical parameters of paddy rice results in a regression equation which quantifies parameters showing a significant or highly significant correlation with the yield.

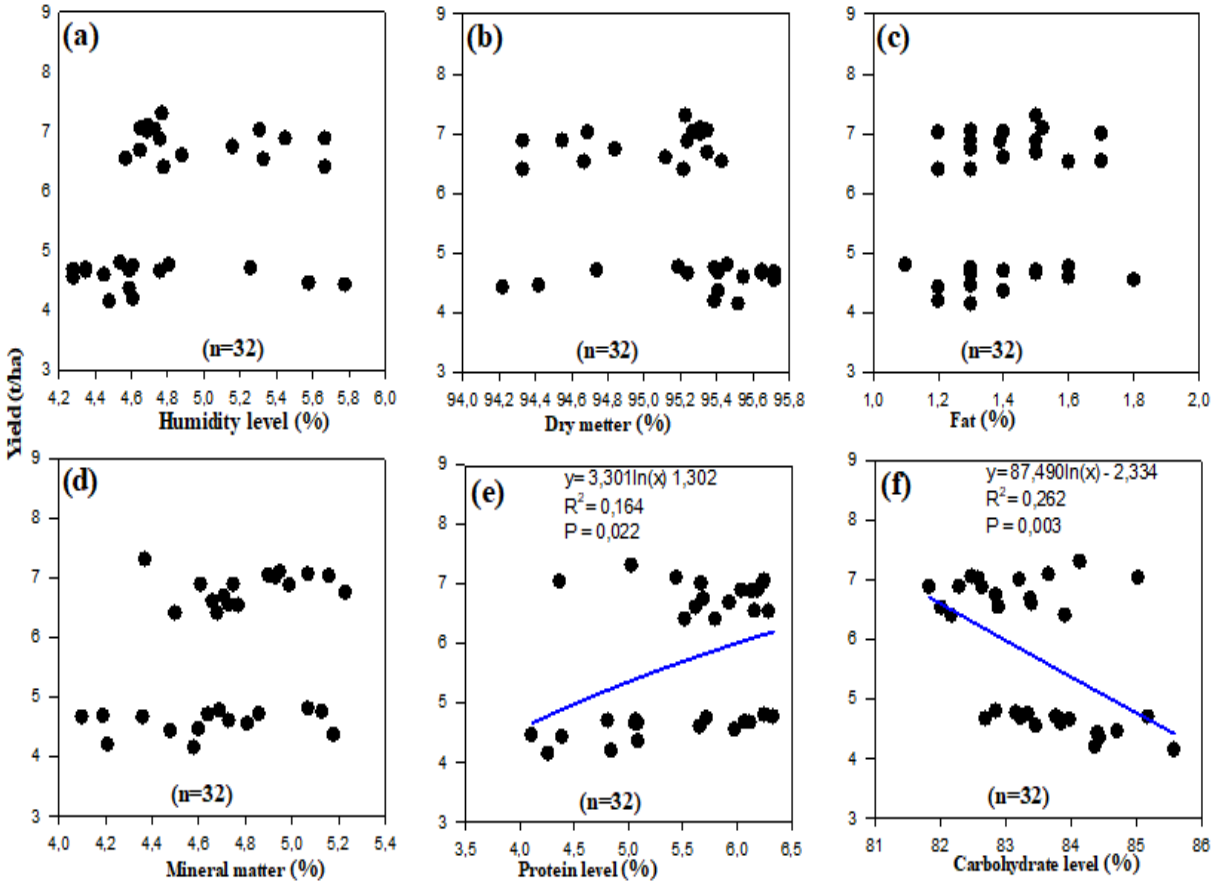

Figure 2: Interdependence between yield and other parameters

Figure 2 shows a markedly significant difference between the means between SRI and SRT for yield with high SRI. However, this difference cannot be read on the biochemical parameters of the rice grain of four varieties studied. Despite this, we find that performance is related to protein and carbohydrate levels with a logarithmic equation. The first equation shows an increase in the level of protein by the SRI and the second, a decrease in the level of carbohydrate by the same system. On the other hand, there is a weak connection with the other biochemical parameters. These results could be justified by the impact of the rice cultivation system on the biochemical composition of the rice grain.

4.5 Comparison of the means of the parameters with the two systems by variety

The comparison of the means of the parameters studied by variety for the two systems is shown in Figures 3, 4 and 5 below with their respective vegetative cycles.

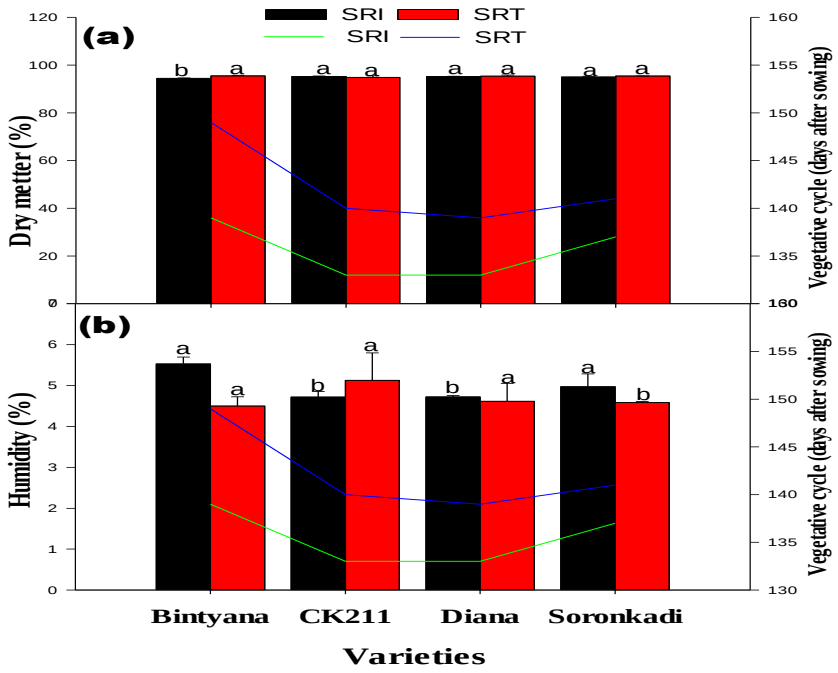

Figure 3: Variation in moisture and dry matter content of paddy grains of the four varieties subjected to the two systems.
NB: Varieties bearing the same letters indicate a non-significant difference while those bearing different letters indicate a significant difference ($P<0.05$).

Figure 3 (a) shows that the values of the mean dry matter content strongly approximate not only between the two systems but also between the four varieties. On the other hand, for the humidity level in Figure 3 (b), there was a more significant demarcation between the varieties in the two systems where the rate is higher in IRS for the three local varieties. This would denote the indifference of the system to dry matter and the specific nature of varieties to grain moisture.

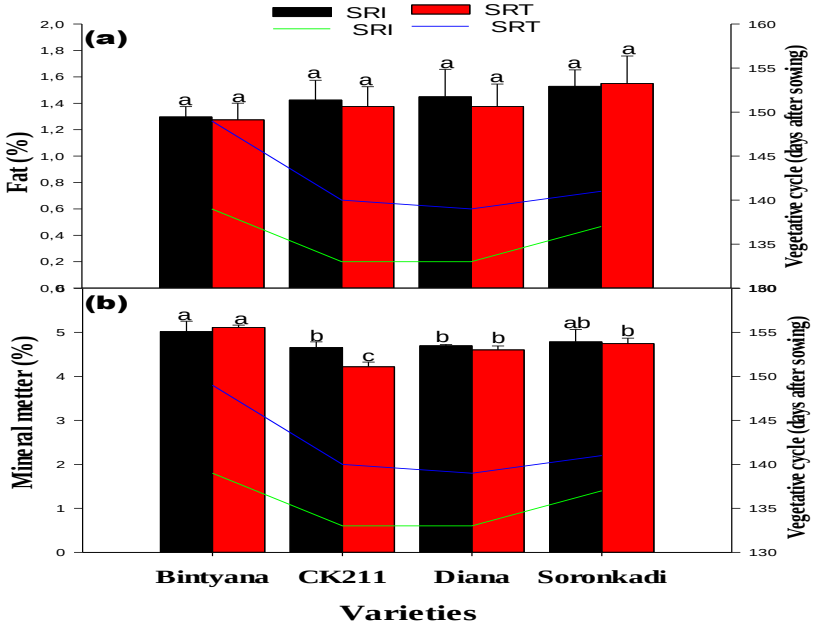

Figure 4: Variation of the mineral and fat content of paddy grains of the four varieties subjected to the two systems.
NB: Varieties bearing the same letters indicate a non-significant difference while those bearing different letters indicate a significant difference ($P<0.05$).

From this figure 4 (a), we notice that the fat content is higher in SRI for the varieties Bintyana, CK211 and Diana, unlike Soronkadi. However, for mineral matter (Figure 4b), SRI only recorded the lowest content compared to SRT with the Bintyana variety. These results would be due to varietal characters and probably to rice growing systems.

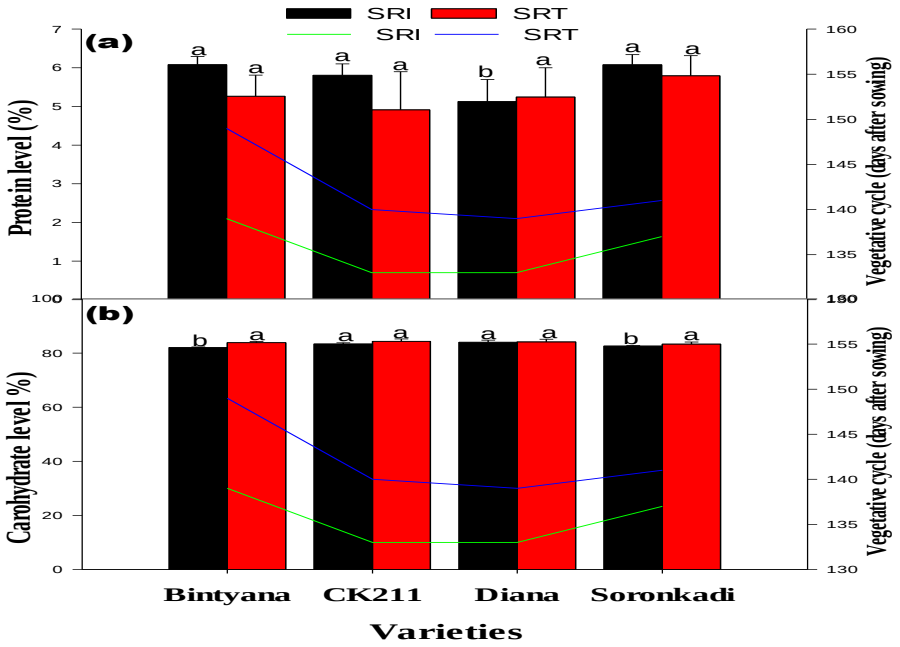

Figure 5: Variation in the protein and carbohydrate content of paddy grains of the four varieties subjected to the two systems.
NB: Varieties bearing the same letters indicate a non-significant difference while those bearing different letters indicate a significant difference ($P<0.05$).

In this figure 5 (a), there is a more obvious variation in the average protein content between the two systems on all varieties giving the better SRI except the Diana variety. Likewise, Figure 5 (b) shows that the SRT recorded the highest carbohydrate content with a weak demarcation at the level of the SRT. This could be due to the systems and the varieties, which proves an improvement in the protein content by the SRI to the detriment of that of the carbohydrates. In short, we find that in all of the figures that the variation in content does not obey the vegetative cycle. So the biochemical composition of these varieties could be independent of their cycle.

5. DISCUSSIONS

The study of the effects of intensive and traditional rice cultivation systems on the yield and biochemical composition of rice grain has helped to understand the limits of the performance of the intensive rice cultivation system on the nutritional quality of rice. The objective of this research is to specifically study the content of the main organic components contained in the rice grain obtained from two systems and to compare them with that obtained previously by other researchers.

The results of the biochemical analyzes provided by the LCVD show the average contents of four varieties per system varying between 4.99% ± 0.08 and 4.71% ± 0.08 for humidity; 83.03% ± 0.16 and 83.93% ± 0.16 for carbohydrates and 5.77% ±% 0.14 and 5.30% ± 0.14 for proteins. These values show that the moisture and protein contents are much lower than that of VERMA and SRIVASTAV (2017) unlike those of carbohydrates which are slightly above their results, which shows that the rice grain is made up of from 12% water, 75% to 80% starch and only 7% protein.

For the four varieties, the average carbohydrate content varies depending on the system and is 83.03% ± 0.16 for the SRI and 83.93% ± 0.16 for the SRT. These results are within the range of values obtained by ISABELLE in 2004, which states that carbohydrates constitute the largest weight fraction of cereal grains (77 to 87% of their dry matter). On the other hand, the fat contents obtained from these varieties in the two systems (1.43% ± 0.04 in SRI and 1.39% ± 0.04 in SRT) are below those found by ABDANI and BAKHTI in 2017 according to which, the lipid contents recorded for the six varieties of soft wheat vary between 2.2 and 2.5%.

6. CONCLUSION

The study of the effects of intensive and traditional rice cultivation systems on the yield and biochemical composition of the rice grain of four varieties has provided scientific knowledge useful for the rice cultivation sector. The local varieties can thrive better under our ecological conditions with the intensive rice cultivation system, as they all had a higher yield than those improved in SRI. The system had significant and highly significant effects on yield and biochemical parameters studied for all varieties except dry matter. The average dry matter obtained was 95.02% with a standard deviation of ± 0.08 in SRI and SRT. The averages of the biochemical parameters of the paddy show an increase in values by SRI except for dry matter (with averages identical to the two systems) and carbohydrates (where the SRT recorded the greatest value compared to the SRI).

Protein level has a strong positive correlation with yield; the rate of carbohydrates, for its part, has a very strong negative correlation with performance. The biochemical composition of the rice grain has been influenced by the variety and the system used.

REFERENCES

1. CORINNE L., 2008 : Système de Riziculture Intensive (SRI) face à la crise alimentaire mondiale. Exemples appliqués à Madagascar et au Cambodge. Institut Catholique de Paris France p37-40.
2. DIAKITE Y., 2010 : Transmission des fluctuations et calcul des prix de parité à l'importation du riz et du maïs en Guinée. SIPAG BP 5146 Conakry- Rép. Guinée.
3. DIAWARA S. et CONDÉ A., 2011 : Etude sur la compétitivité du riz local en Guinée IRAG p9.
4. ERIKA S. et DEVON J, 2014 : Amélioration et mise à échelle du Système de Riziculture Intensive en Afrique de l'Ouest SRI sriafriqueouest.org/projet Tombouctou Mali p 3.
5. FAO, 2009: The state of the food and agriculture 2009: livestock in the balance, Rome, 180p.
6. WIDYOBROTO B. P. 1989 : valeur alimentaire des issues de riz distribuées aux animaux domestiques université de rennes I. U.E.R. sciences de la vie et de l1 environnement (D.E.A. D 1 agronomie) 116p.
7. AGRIDAPE, 2013: Revue sur l'agriculture durable à faibles apports externes; avril 2013-volume 29n°1. p5.
8. SECK P., TOURÉ A., COULIBALY J., DIAGNE A. and WOPEREIS M., 2013: Africa's Rice Economy Before and after the 2008 Rice Crisis. Book chapter. In Realizing Africa's Rice Promise. Forthcoming, 138p.
9. JOELIBARISON O., 1998 : Perspective de développement de la region de Ranomafana : les mécanismes physiologiques du riz sur de bas-fonds: cas du SRI. Mémoire de fin d'études. Antananarivo (Madagascar): University of Antananarivo, 103 p.
10. LAGACE, J. 2011 : Comment j'ai vaincu la douleur et l'inflammation chronique par l'alimentation, Montréal, Éditions Fides, 278 p.
11. AFNOR, 1991**.** Recueil de normes- contrôle de la qualité des produits alimentaires céréales et produits céréaliers. AFNOR/DGCCRF. 3ème édition. Paris. 360 p.
12. SHEWRY P.R., NAPIER J.A. et TATHAM A.S., 1995: Seed storage proteins: Structures and biosynthesis. Pla/If Cell. 7, 945-956.
13. FAO et OMS 2007: Céréales, légumes secs, légumineuses et matières protéiques végétales Codex Alimentarius Rome, 2007
14. ANDIANKAJA A. H., 2002: Mise en évidence des opportunités du développement de la riziculture par adoption du SRI, et évaluation de la fixation biologique de l'azote à l'Université d'Antananarivo, Madagascar.
15. ISABELLE L. 2004 : Contribution à l'étude de la biodisponibilité du fer et du zinc dans le grain de mil et conditions d'amélioration dans les aliments de complément Université Montpellier II sciences et techniques du languedoc discipline : Sciences des aliments Ecole doctorale : Science et Procédé Biologiques et Industriels
16. ABDANI I. et BAKHTI A. 2017 : Composition biochimique et nutritionnelle de différentes variétés de blé commercialisé en Algérie Université Abdelhamid Ibn Badis-Mostaganem ; Faculté des Sciences de la Nature et de la Vie ; Master en Sciences agronomiques.
17. Verma, D.K., Srivastav, P.P. 2017: Proximate Composition, Mineral Content and Fatty Acids Analyses of Aromatic and Non-Aromatic Indian Rice. Rice Science, 24, 21-31
18. AFNOR, 1982 : Aliments des animaux. Détermination de la teneur en eau. NF V 18-109, 5 pp.
19. BASTIANELLI D., HERVOUET C., 1998. Dosage de l'humidité. CIRAD–EMVT. Rapport interne, 24 pp.
20. AFNOR, 1997, Aliments des animaux. Dosage de la matière grasse. NF V 18-117, 11 pp.
21. HERVOUET C., 1998 : Dosage des matières grasses - Extracteur Behrotest. CIRAD-EMVT. Rapport interne, 6 pp.
22. SUREL J., 2000 : Dosage de la matière grasse des graines oléagineuses. CIRAD-EMVT. Mémoire BEPA, 29 p.