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RESEARCH ARTICLE

DISTRIBUTION OF *CERCOSPORA ORYZAE*, THE FUNGUS CAUSING *CERCOSPORA* LEAF SPOT OR NARROW BROWN LEAF SPOT IN SOUTHERN BENIN (ADVANTAGES AND CONSTRAINTS OF RICE PRODUCTION)

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ABSTRACT

Southern Benin is full of potential rice growing because of its climate, pedology. Three types of rice cultivation are practiced, the most dominant lowland rice growing, rainfed rice and irrigated rice. Collections were carried out in six departments of southern Benin, thirteen villages and nine municipalities were prospected. Several fungal diseases have been observed in southern Benin at different stages of the rice development cycle. A predominance of cercospora in six villages (Docomey, Gative, Matekpo, Zoungo, Aizè, Kpodji) was recorded, curvularia observed in three villages (Gative, Matekpo, Houeli-Gaba), blast disease observed in five villages (Docomey, Matekpo, Kpodji, Zoungo, Aizè). No symptoms of fungal disease were observed in the rice fields of five villages: Awokpa, Kode-Agu, Gouti, Odja-Igbagi, Ouinhi. The IR841 is the most cultivated variety. Producers as a whole did not know how to differentiate fungal diseases from other diseases (bacterial, viral) of rice. They recognize for some the symptoms of blast. The necrotic appearance and color of brown spots allow growers to identify certain leaf diseases. The symptoms of fungal diseases were observed in 8 of the 13 sites surveyed at different stages of the rice development cycle. Cercospora leaf spot disease caused by *Cercospora oryzae* is observed from the panicle phase to maturity. Producers have a lack of knowledge of Cercosporiosis, which can cause losses ranging from 40% to 60% of production. The rice sector in southern Benin will be better able if the actors could benefit from training, supervision in the direction of plant protection.

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INTRODUCTION

Rice is attacked by several fungal diseases such as Cercosporiosis (*Cercospora oryzae*= *Sphaerulina oryzae*), narrow brown spot disease, helminthosporiosis, blast fever, small gray or greenish spots, curvulariasis (Mani, K., et al., 2016). Most pathogens are able to cause severe field damage after sowing (Lepoivre et al., 1989). Some of them affect seed quality (Harman, G.E., 1983). To effectively fight against these microorganisms, it is necessary to take into account the contaminants and their biological peculiarities. Over the past ten years, there has been renewed interest from both the Government and donors in the rice sector in Benin. At the same time, there is a lot of enthusiasm on the part of producers

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who are increasingly interested in rice production. The craze for rice was accelerated in 2007/2008 due to soaring world rice prices, following the global food and economic crises. In terms of rice potential, Benin has more than 205,000 ha of lowlands spread over the entire national territory to which should be added the floodplains evaluated at more than 120,000 ha (ABIASSI, E., 2006). On the other hand, a cripple only part of these potentialities is highlighted for the rice production (Duy-Jean, A., 2009). But over the last five years, rice production has declined, especially in southern Benin. Characterized by an abandonment of developed surfaces, a deficit of the pluviometry. The lack of agricultural credit that will allow producers to buy the inputs needed to enrich the soil increasingly poor in nitrogen and potassium. The water stress and the poverty of the soils in Nitrogen and potassium, is the cause of the appearance of numerous fungal diseases including the cercosporiosis caused by *Cercospora oryzae*. These in this

context that the present study which is "to assess the prevalence and distribution of cercosporiosis of rice in southern Benin (advantages and constraints of production)" makes sense. The objectives of this study are to make a state of the place of the various fungal pathologies of rice in southern Benin: Case of *Cercospora oryzae*, to make a state of location of the strengths and constraints of rice production in southern Benin, to list the varieties of rice grown in southern Benin and the choice of these varieties, Make a state of place of cultural practices and types of rice growing in southern Benin. This study will shed light on the difficulties encountered by producers in southern Benin, as well as the state of health of the rice fields.

MATERIALS AND METHODS

The survey conducted during the 2017 and 2018 crop years was carried out in six out of seven departments in Southern Benin and in nine municipalities. The seventh department is that of the coast where there is no rice field because essentially consists of serviced land for housing. Thirteen villages where rice is produced have been covered in the six departments, namely Awokpa, Docomey, Gative, Matekpo, Kodé-Ague, Gouti, Odja-Igbagi, Houeli-Gaba, Kpodji, Aizè, Ouinhi, Zaloko, Zoungo. Religion and ethnicity are parameters that were not taken into account during the survey. The exits were made three times at each site, during the vegetative phase, the panicle phase and the maturity to observe the different symptoms of fungal diseases present at each development cycle. The parameters analyzed are: cultivated rice varieties, observed fungal pathologies, marketing, access to agricultural credits and inputs, areas exploited, type of rice cultivation. A fact sheet consisting of 30 questions developed was used for the field survey. All the departments of Southern Benin were prospected, all the municipalities were prospected and all the villages were prospected. The interviewees are presidents or members of the bureau for associations and producer groups. The producer himself was questioned about a family or individual production.

Description of survey sites

ATLANTIC Department

Village of AWOKPA: The village of Awokpa is located in the district of Hèkanmè in the municipality of Zè in southern Benin. With latitude: 6°47'00" North and longitude: 2°18'00" East (www.wikipedia.org). An average altitude of 35m and a population of 72,814 inhabitants for the municipality, on an area of 54,300 hectares (<https://www.db-city.com/Benin-department-commune>). It is a municipality with strong agricultural potential. The climate is tropical, with a rainfall of 1093 mm, an average temperature of 27.1°C (www.climate-data.org). Rice production is organized by the ALLODOGNINOU association with a total area of 10 hectares exploited. The interview was done with the president of the association, he has the secondary level.

DOCOMEY village: The village of Docomey is located in the district of Zinvié in the municipality of Abomey-Calavi in southern Benin. With latitude: 6°26'55" North and longitude: 2°21'20" East (www.wikipedia.org). An average altitude of 12m and a population of 307,745 inhabitants for the municipality over an area of 65,000 hectares (<https://www.db-city.com/Benin-department-municipality>). The climate is of

tropical type, marked by rainfall heights of 1137 mm, an average temperature of 27.2°C (www.climate-data.org). The production of rice is related with a total area of 4 hectares operated on 7 hectares developed. The interview was done with the producer himself. He has the university level.

Department of MONO

Village of GATIVE: The village of Gative is located in the district of COME in the municipality of Comé in southern Benin. With latitude: 6°24'00" North and longitude: 1°53'00" East (www.wikipedia.org). An average altitude of 2m with a population of 58,396 inhabitants for the municipality on an area of 16,300 hectares (<https://www.db-city.com/Benin-department-municipality>). The climate is tropical, with rainfall of 969 mm, an average temperature of 27.3°C (www.climate-data.org). The production of rice is related with a total area of 3 hectares exploited. The interview has been done with the producer himself. He is illiterate.

Village of MATEKPO: The village of Matekpo is located in the district of Grand Popo in the municipality of Grand-Popo in southern Benin. With latitude: 6°17'00" North and longitude: 1°50'00" East (www.wikipedia.org). An average altitude of 4m with a population of 40,335 inhabitants for the municipality on an area of 28,900 hectares. (<https://www.db-city.com/Benin-department-commune>). The climate is of tropical type, marked by rainfall heights of 983 mm, an average temperature of 27.4°C (www.climate-data.org). The production of rice is related, with a total area of 40 hectares operated carefully managed by the producer who has drained water from Lake Ahémé to its rice paddy. The interview was done with the producer himself. He has the university level.

Department of OUEME

Village of KODE-AGUE: The village of Kodé-Agué is located in the district of Kode in the town of Adjohoun in southern Benin. With latitude: 6°41'44" North and longitude: 2°28'52" East (www.wikipedia.org). An average altitude of 79m with a population of 58,396 inhabitants for the commune on an area of 56,455 hectares (<https://www.db-city.com/Benin-department-municipality>). The climate is tropical, with a rainfall of 1155 mm, an average temperature of 27.3°C (www.climate-data.org). The production of rice is made by the FINAGNON association, with a total area of 140 hectares exploited. The interview was made with the president of the association, he has the primary level.

Village of Gouti: The village of Gouti is located in the district of Kode in the municipality of Adjohoun in southern Benin. With latitude: 6°4'44" North and longitude: 2°28'52" East (www.wikipedia.org). An average altitude of 79m with a population of 58,396 inhabitants for the municipality, on an area of 56,455 hectares. (<https://www.db-city.com/Benin-department-commune>). The climate is of tropical type, marked by rainfall heights of 1134 mm, an average temperature of 27.7 ° C (www.climate-data.org). The rice production is made by the association MASSAVO, with a total area of 15 hectares exploited. The interview was done with the president of the association, he has the secondary level.

PLATEAU Department

Village ODJA-IGBAGI: The village of Odja-Igbagi is located in the district of Issaba in the municipality of Pobè in southern

Benin. With latitude: 6°58'00" North and longitude: 2°41'00" East (www.wikipedia.org). An average altitude of 124m with a population of 82,910 inhabitants for the municipality over an area of 40,000 hectares (<https://www.db-city.com/Benin-department-municipality>). The climate is tropical, with rainfall of 1155 mm, an average temperature of 27.0 ° C (www.climate-data.org). The production of rice is related with a total area of 5 hectares exploited divided between three brothers. The interview has been done with three brothers who are all illiterate.

Village HOUELI-GABA: the village of Houeli-Gaba is located in the district of Adja-Ouere in the town of Adja-Ouere in southern Benin. With latitude: 7°00'00" North and longitude: 2°37'00" East (www.wikipedia.org). An average altitude of 64m with a population of 81,497 inhabitants for the municipality over an area of 55,000 hectares (<https://www.db-city.com/Benin-department-municipality>). The climate is of tropical type, marked by rainfall heights of 1123 mm, an average temperature of 27.4 ° C (www.climate-data.org). The rice production is made by the SEGBEYA association, with a total area of 386 hectares exploited on 839 developed hectares. The interview was done with the president of the association, he has the secondary level.

Department of COUFFO

Village KPODJI: The village of Kpodji is located in the district of Deve in the town of Dogbo in southern Benin. With latitude: 6°48'00" North and longitude: 1°47'00" East (www.wikipedia.org). An average altitude of 80m with a population of 103,057 inhabitants for the municipality over an area of 47,500 hectares (<https://www.db-community.com/Benin-department-commune>). The climate is tropical, with a rainfall of 1022 mm, an average temperature of 27.4 ° C (www.climate-data.org). The rice production is made by PAID association, with a total area of 150 hectares exploited. The interview was made with the representative of the president of the association, he has the secondary level

interview was made with one of the producers of the association, he has the primary level.

Village of OUIHI: the village of Ouinhi is in the district of Ouinhi Center in the municipality of Ouinhi in southern Benin. With latitude: 7°05'00" North and longitude: 2°29'00" East (www.wikipedia.org). An average altitude of 24m with a population of 48,300 inhabitants for the municipality on an area of 38,319 hectares (<https://www.db-city.com/Benin-department-municipality>). The climate is of tropical type, marked by rainfall amounts of 1075 mm, an average temperature of 27.8°C (www.climate-data.org). The production of rice is related with a total area of 5 hectares exploited on a developed area of 12 hectares. The interview was made with the producer himself, he is illiterate.

Village of ZALOKO: The village of Zaloko is located in the district of Ouinhi Center in the municipality of Ouinhi in southern Benin. With latitude: 7°05'00" North and longitude: 2°29'00" East (www.wikipedia.org). An average altitude of 24m with a population of 48,300 inhabitants for the municipality on an area of 38,319 hectares (<https://www.db-city.com/Benin-department-municipality>). The climate is of tropical type, marked by rainfall amounts of 1075 mm, an average temperature of 27.8°C (www.climate-data.org). The rice production is made by the ODO-AWELEOUNKE association, with a total area of 12 hectares exploited. The interview was done with the president of the association, he has the secondary level.

Village of ZOUNGO: The village of Zoungo is located in the district of Ouinhi Center in the municipality of Ouinhi in southern Benin. With latitude: 7°05'00" North and longitude: 2°29'00" East (www.wikipedia.org). An average altitude of 24m with a population of 48,300 inhabitants for the municipality on an area of 38,319 hectares (<https://www.db-city.com/Benin-department-municipality>). The climate is of tropical type, marked by rainfall amounts of 1075 mm, an average temperature of 27.8°C (www.climate-data.org).

Table 1. Results of the survey on the Awokpa and Docomey sites

	Awokpa's site	Docomey's site
Varieties of cultivated rice	IR841	IR841
Fungal diseases observed	Any	<i>Cercospora, Pyricularia</i>
Type of rice cultivation	Low background	Low background
Area exploited	10 hectares	7 hectares
Seed used	From CARDER	From previous harvests
Type of sowing	transplanting	Transplanting
Access to credits	No access to agricultural credit	No access to agricultural credit
Constraints of rice production	Lack of financial means, working tools, supervision, market for sale.	Lack of financial means, and this marketing circuit
Assets for rice production	Exploitable land available, motivation of producers	Available exploitable land, motivation of the producer

Department of ZOU

Village of AIZE: The village of Aizé is located in the district of Sagon in the municipality of Ouinhi in southern Benin. With latitude: 7°05'00" North and longitude: 2°29'00" East (www.wikipedia.org). An average altitude of 24m with a population of 48,300 inhabitants for the municipality on an area of 38,319 hectares (<https://fr.db-city.com/Benin-Department-common>). The climate is tropical, with rainfall of 1055 mm, an average temperature of 27.9°C (www.climate-data.org). The rice production is made by the SEDJRO association, with a total area of 7 hectares exploited. The

The production of rice is related with a total area of 4 hectares exploited on an area; the variety of rice grown is the IR841. The interview was done with the producer himself, he has the primary level.

Analysis of statistics and data processing: The survey took into account the villages of Awokpa, Docomey, Gative, Matekpo, Kodé-Agué, Gouti, Odja-Igbagi, Houéli-Gaba, Kpodji, Aizé, Ouinhi, Zaloko, Zoungo. The tabulation of the information in the survey cards helped to build a database in Excel. The diagrams interpreting the collected information were obtained through a descriptive statistical analysis.

RESULTS

Department of ATLANTIC

Village in the ATLANTIC: Table 1 summarizes the results of the survey conducted at the Awokpa and Docomey sites during the 2017-2018 crop of the year.

Department of MONO

Village in MONO: Table 2 summarizes the results of the survey conducted on the Gative and Matekpo sites during the 2017-2018 crop of the year.

Department of OUEME

Village in the OUEME: Table 3 summarizes the results of the survey carried out on the Kodé-Agué and Gouti sites during the 2017-2018 crop of the year.

PLATEAU Department

Village in the PLATEAU: Table 4 summarizes the results of the survey conducted on the sites of Odja-Igbagi, Houéli-Gaba during the 2017-2018 crop of the year.

Department of COUFFO

Village in the COUFFO: Table 5 summarizes the results of the survey conducted on the Kpodji site during the 2017-2018 crop of the year.

Department of ZOU

Village in the ZOU: Table 6 summarizes the results of the survey conducted on the sites of Aizè, Ouinhi, Zaloko, Zoungo during the 2017-2018 crop of the year.

Severity of Cercosporiosis disease in production sites in southern Benin

Cercospora wilt caused by *Cercospora oryzae* was observed in six villages in southern Benin with varying degrees of severity from site to site (Figure 1). According to the IRRI 1977 scale (1, 3, 5, 7, 9). The site of Gative recorded the highest score of severity with a score of 9, follows the site of Docomey with a note of 7, the sites of Kpodji and Matekpo registered a note 5, the site of Aizè a note of 3 and on the site of Aizè we recorded the score of lowest severity with a score of 1.

Table 2. Results of the Gative, Matekpo Site Survey

	Gative's site	Matekpo's site
Varieties of cultivated rice	IR841	IR841
Fungal diseases observed	<i>Cercospora</i>	<i>Cercospora, Curvularia</i>
Type of rice cultivation	rainfed	irrigated
Area exploited	3 hectares	40 hectares
Seed used	From previous harvests	From the previous harvests
Type of sowing	transplanting	Direct
Access to credits	No access to agricultural credit	No access to agricultural credit
Constraints of rice production	Lack of financial means, work tools, supervision, lack of rain during the 2017-2018 season	Lack of supervision
Assets for rice production	producer motivation	Available exploitable land, motivation of the producer

Table 3. Results of the survey of the Kode-Agué and Gouti sites

	Site of Kodé-Agué	Site of Gouti
Varieties of cultivated rice	IR841	IR841
Fungal diseases observed	Any	Any
Type of rice cultivation	Low background	Low background
Area exploited	140 hectares	15 hectares
Seed used	From CARDER	From CARDER
Type of sowing	transplanting	transplanting
Access to credits	No access to agricultural credit	No access to agricultural credit
Constraints of rice production	Lack of financial means, working tools, supervision, market for sale.	Lack of financial means, working tools, supervision, market for sale.
Assets for rice production	Exploitable land available, motivation of producers	Exploitable land available, motivation of producers

Table 4. Results of the survey of the Odja-Igbagi and Houéli-Gaba sites

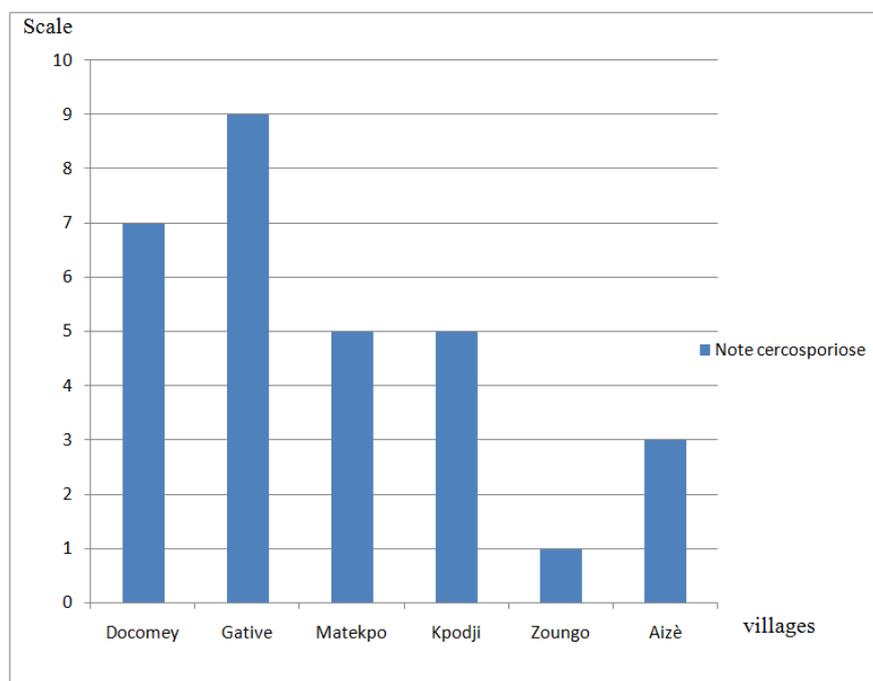
	Site of Odja-Igbagi	Site of Houéli-Gaba
Varieties of cultivated rice	IR841	IR841
Fungal diseases observed	Any	<i>Pyricularia, Curvularia</i>
Type of rice cultivation	rainfed	flooded
Area exploited	5 hectares	386 hectares
Seed used	From CARDER	From CARDER
Type of sowing	transplanting	transplanting
Access to credits	No access to agricultural credit	No access to agricultural credit
Constraints of rice production	Lack of financial means, working tools, supervision, market for sale.	Lack of financial means, working tools, supervision, market for sale.
Assets for rice production	Exploitable land available, motivation of producers	Exploitable land available, motivation of producers

Table 5. Results of the survey on the Kpodji site

Site of Kpodji	
Varieties of cultivated rice	IR841, Wita4
Fungal diseases observed	<i>Cercospora</i> , <i>Pyricularia</i> , <i>Curvularia</i>
Type of rice cultivation	Low background
Area exploited	150 hectares
Seed used	From the previous harvest
Type of sowing	Direct sowing
Access to credits	No access to agricultural credit
Constraints of rice production	Lack of financial means, working tools, supervision, market for sale.
Assets for rice production	Exploitable land available, motivation of producers

Table 6. Results of the survey on the sites of Aizè, Ouinhi, Zaloko, Zoungo

	Site of Aizè	Site of Ouinhi	Site of Zaloko	Site of Zoungo
Varieties of cultivated rice	IR841, Jolf	IR841	IR841	IR841
Fungal diseases observed	<i>Cercospora</i> , <i>Pyricularia</i> ,	Any	<i>Pyricularia</i>	<i>Cercospora</i> , <i>Pyricularia</i>
Type of rice cultivation	irrigated	rainfed	rainfed	rainfed
Area exploited	7 hectares	5 hectares	12 hectares	4 hectares
Seed used	From CARDER	From the previous	From the previous	From the previous
Type of sowing	transplanting	transplanting	transplanting	transplanting
Access to credits	No access to agricultural credit			
Constraints of rice production	Lack of financial means, working tools, supervision, market for sale.	Lack of financial means, working tools, supervision, market for sale.	Lack of financial means, working tools, supervision, market for sale.	Lack of financial means, working tools, supervision, market for sale.
Assets for rice production	Exploitable land available, motivation of producers			

**Figure 1. Degree of severity of Cercosporiosis**

DISCUSSION

Rice fields are observed in the six departments of southern Benin. We can therefore say that rice production is widespread in all departments in southern Benin. With a predominance of lowland rice cultivation, these results are consistent with those of FAO / NEPAD (2005). Rice is the most consumed cereal after maize in southern Benin, so it occupies a preponderant place in the daily food of Beninese. Thus, several rice fields are observed everywhere with various cultural practices, from the use of chemicals to organic rice cultivation. Rainfed and irrigated rice comes after lowland rice cultivation. Rice farmers are organized in association for some.

For fungal diseases, various characteristic symptoms have been observed, including Cercosporiosis, blast disease, helminthosporiosis and curvulariasis. These results are in agreement with those obtained by HODE (2014) who identified *curvularia*, *helminthosporium* at Awokpa. *Cercospora* is dominant in six villages: Docomey, Gative, Matekpo, Zoungo, Aizè and Kpodji. With a score of 9 in the village of Gative on the IRRI scale. *Cercospora* occurs under conditions of low soil nitrogen and potassium and significant water stress (Sutton et al., 1982). At Gative the rice growing is of rainy type yet the rains were not abundant during the season 2017-2018 what can explain in part the proliferation of the *Cercospora* on the site. The non-use of certified seed by the

producer may justify the abundant proliferation of *Cercospora* disease in Gative and Docomey. A note of 7 *Cercospora* was recorded at Docomey. The low score of 1 was recorded in Zoungo, followed by a score of 3 for Aizè and 5 for Kpodji and Matekpo. These notes justify the presence of *Cercospora* in southern Benin with varying degrees. Symptoms of *cercospora* are observed at different stages of the rice development cycle, from panicle to maturity for the sites surveyed. Producers who have used certified seed have fewer symptoms of *Cercospora* disease. *Cercospora* can lead to a yield reduction of up to 60% of production. *Cercospora* occurs when there is water stress, soil deficient in Nitrogen, Potassium and non-use of resistant varieties with low resistance. These findings are in agreement with those of Mani, K., (2016). It is therefore important to take an interest in *Cercospora* to propose control methods adapted to the ecosystem.

It is noted that different varieties of rice are grown in southern Benin according to the demand of the population. Indeed we found that the variety IR841 "fragrant rice" is the most cultivated in the 6 departments. Because of its parfum and flavor. In some localities the NERICA L20 is cultivated because of its good productivity and the habit of the producers. The production of IR841 is regulated by consumer demand which justifies the abundant cultivation of this variety. A great lack of knowledge of the symptoms of fungal diseases by producers has been noted. It promotes the maintenance of pockets of infection and the spread of fungal diseases that are transmitted either by seeds or by the rates left on the soil for *Cercospora* (Groth, D. E, 2007), (Mani K., et al 2016). Indeed, we have found that southern Benin is full of significant rice potential with developed lowlands, associations organized around the rice sector in agreement with those of CCR-B (2004). The areas exploited remain well below the developed areas or even available, for lack of means and support. The rice sector will be able to take flight south of the Benin if all the actors put themselves there and that the state accompanies the producers.

Conclusion

The study of the situation of rice production, the various fungal diseases, notably Cercosporiosis, and varieties of rice cultivated in southern Benin, revealed some very interesting elements. We can say that the rice sector is a promising sector for southern Benin. It contributes to the country's food security, so it is a source of income for the actors who have committed to it. Southern Benin in general has a rich and varied potential for exploitation due to its geology, soil composition (mineralogical) and the permanent presence of water. But the rice sector in southern Benin is currently very poorly organized. The state no longer accompanies producers for growing rice. NGOs and funding structures no longer accompany the producers of this cereal. It is noted a lack of supervision of producers as it was the case in the past with the

current CARDER DDAEP (Departmental Directorate of Farming Agriculture and Fisheries), a lack of working materials, a lack of access to agricultural loans, a lack of post-harvest monitoring because several of the producers met have rice stock for the 2015-2016 season. Even some seed growers accredited by CARDER can no longer resell their products. Inputs and pesticides are bought at the end of the field at the market, most of them coming from Nigeria, where neither concentration nor actual components are known. Some producers' associations try to survive by offering their cheap harvests to merchants from North or Niger. Overall, we found a decline in cultivated area at the expense of maize, because the actors cannot sell their products, developed basements not exploited or neglected. The production of rice from southern Benin has become a family production on a small area, where each actor tries to exploit a small area for his own food.

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