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Analysis of the Dynamics and Obstacles to the Adoption of Technological Innovations: the Case of Rice Farming in Togo

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Summary

Technological innovations have been developed to help boost agriculture and contribute to food security in developing countries. In Togo, emphasis has been placed on the development of technologies and the introduction of those generated in the area shared by Togo with the other countries of the Economic Community of West African States (ECOWAS). In order to analyze the dynamics and obstacles of adoption of technological inovations in the real environment the ‘’ Program of Accompaning Research for Agricultural Innovation (PARI) under the sponsorship of Agricultural Forum for African Research (FARA) funded this study. To do this, information was collected from a sample of rice farmers through a formal survey and focus groups. The formal survey was conducted with six hundred and fifty two (652) rice farmers in four (04) regions and focus groups with 45 rice farmers in the Central Region.The study thus looked at the case of Togolese rice farmers in order to enlighten the decision-makers and to better guide them in the decision-making for the actions to come and to formulate proposals of solutions. These technologies mainly concern the use of improved rice varieties and technologies related to good cultural practices and post-harvest. From these surveys it follows that innovative technologies introduced in rice-growing areas are variously appreciated. If some introduced improved varieties are adopted by most of the producers, it is not the same for the case of good agricultural practices Technology : Fertilizer application techniques, nursery practice, number of recommended plowing before planting, deep placement of urea, burial of crop residues, intensive rice system, transplanting to one (01) or two (02) strands,participatory learning action research on integrated soil fertility management (APRA-GIFS), participatory learning research action on integrated pest management (l’APRA-GIR) which are less practiced by farmers. This is also the case for post-harvest technologies. The analysis of this low adoption rate, shows that the lack of equipment, the high cost of technologies, the lack of manpower, the harshness of the producers' implementation of the technologies and the lack of information on the performance of the technologies being disseminated are the main reasons. Thus, the actions to be taken to improve the probability of adoption of these technologies must take these elements into account.

Key words:

Adoption, technological innovations, rice farmers, ecology, Togo

Introduction

The population of sub-Saharan Africa increased from 578.5 million in 1995 to 659 million in 2000 with annual growth of about 2.5 percent (World Bank, 2001).It continues to grow, following the projections of the World Bank, this figure of 1010 million in 2010 will increase to 1500 million inhabitants in 2020.This growth will create a strong demand for food needs, especially rice. In fact, in many developing countries, the real unemployment rate would be 40 to 50%, ie 400 to 500 million people (GERM, 2001) and 792 million people suffer from undernourishment in developing countries (SEDES, 2002). Over the coming years, African agriculture will be challenged to meet the needs of a rapidly growing population. It will need to increase food production and income sufficiently to ensure food security in sub-Saharan Africa. The challenge of Agricultural Research is huge. It must increase the productivity and competitiveness of agriculture by improving crop yields, product quality while conserving the environment.Among the main crops that can lead to this food security is rice, the main imported commodity.Rice is produced in all regions of Togo on mostly individual farms (Kombate, 2008) and occupies an important place in the diet of the population.The quantities produced are still insufficient to meet the needs of the country. The causes of these low yields of rice are mainly related to non-control of water, unsuitable traditional farming practices leading to soil degradation and declining fertility, increased pressure of weeds, and loss of soil use of traditional varieties.With the promotion of rice growing in recent years, several development projects have introduced technological innovations in rural areas.However, there is little use of these technologies. This study has examined the dynamics and obstacles to the adoption of technologies introduced in rice farming in Togo.

Objective

Main objective

The general objective of this study is to foster the improvement of rice in order to increase income of rice farmers and ensure food security in Togo.

Specific objectives

1. To identify the factors of the dynamism of rice farming
2. To determine the rate of adoption of the introduced technologies
3. To identify major constraints to the adoption of technologies available to rice farmers
4. To make proposals for solutions.

Material and Methods

Study area

The study took place in the five regions of Togo namely the Maritime, Plateaux, Central, Kara and Savanes regions.The map of Togo is shown in Figure 1.

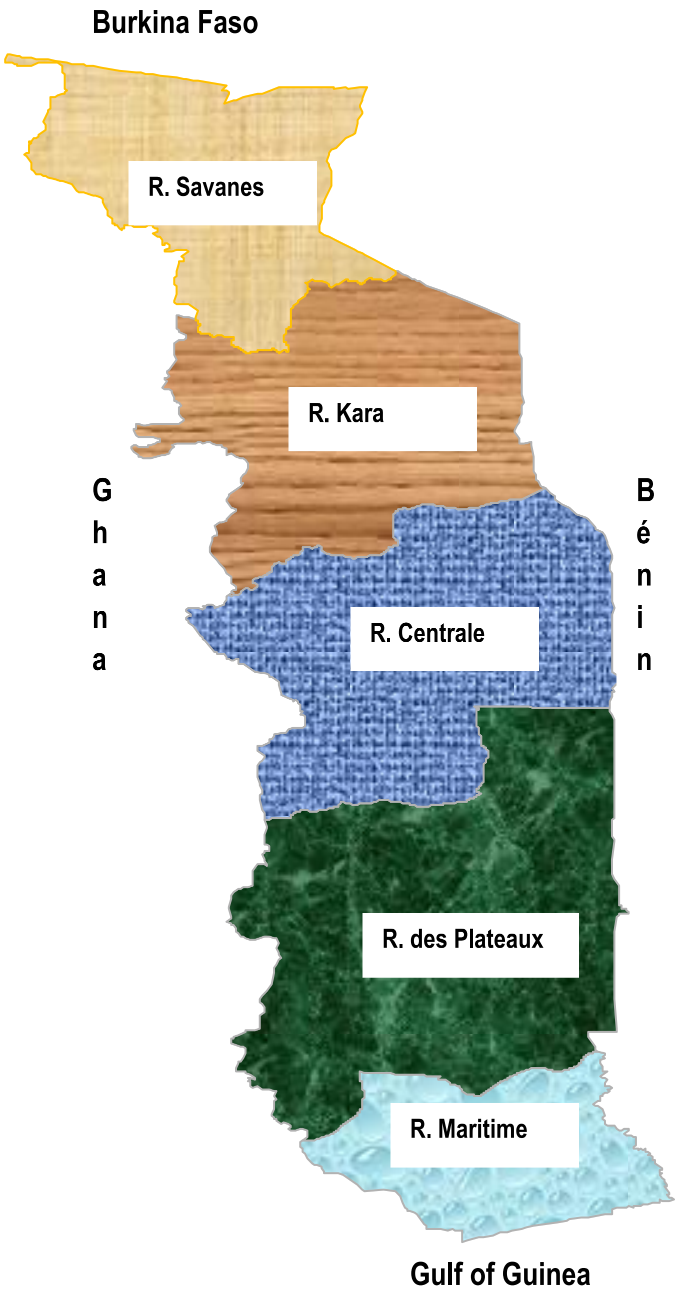

Figure 1 : The map of Togo

Maritime Region

The Maritime region lies between meridians 0 ° 40 'and 1 ° 50' east longitude and parallel 6 ° and 6 ° 50 north latitude (MERF, 2014). It covers an area of 6397 km², or about 11% of the national territory according to the statistics of the Directorate General of Statistics and National Accounts (DGSCN) from 2011. The Maritime Region represents nearly 42% of the national population in 2011 (DGSCN, 2011).Its climate is Equatorial Guinean with alternating rainy seasons and dry seasons. Rainfall it characterized by poor distribution during the year.The total annual rainfall varies between 1000 and 1200 mm.The study was conducted on the rice development poles of Mission-Tové and Agome-Glozou located respectively in the Zio and Mono valleys at about 35 km and 90 km from Lomé respectively.The rice-growing areas of Mission-Tové and Agome-Glozou represent the two largest irrigated rice production areas in Togo.On these perimeters, the irrigation system is of gravity type and the irrigated areas are currently 360 ha for Mission-Tové and 20 ha for Agome-Glozou.The irrigable areas are, however, 660 ha at Mission-Tové and 60 ha at Agome-Glozou.These two perimeters currently benefit from redevelopment and extension actions through the Project Tové Agricultural Land Development and Rehabilitation Project (PARTAM) and the Mono Low Valley Project (PBVM).rice husking units are installed close to the rice-growing areas.

Plateaux Region

The study area is the low-lying Rice Pole located on the Kpalimé-Atakpamé road and extends over the prefectures of Kpélé and Amou.Les rainfall heights vary between 1300 and 1600 mm per year with 2 to 3 months of dry season. The dominant vegetation is the wooded savannah. The population density of the area is quite high with a high proportion of ethnic immigrants Kabyè. The dominant ethnic groups are Ewe and Akposso. The population is predominantly rural.Lowland rice cultivation is important. The lowlands are rich in silt and flood quickly enough.In this zone, the exposed land is used for cash crops (coffee, cocoa), forcing farmers to develop the lowlands (FAO, 2005).Access to lowland lands is through inheritance, loan or rental for indigenous male and female, by purchase or lease for non-indigenous people. The lowlands are exploited more than 80% of the available land and mostly by female (FAO, 2005). Local people have a long tradition of rice growing and rice is a staple food.

Central Region

The Central Region occupies, as its name indicates, the central part of the country and lies between parallels 8 ° and 9 ° 15 north latitude and meridians 0 ° 15 and 1 ° 35 east longitude. Limited to the north by the Kara Region, to the south by the Plateaux Region, to the east by the Republic of Benin and to the west by the Republic of Ghana, the Central Region covers an area of 13,470 square kilometers.Le The central region's climatic regime is of the semi-humid tropical type, in the Sudano-Guinean case, characterized by two distinct seasons:

- A great rainy season from April to October with a cruise regime in July-August. Rainfall varies between 1,000 mm and 1,300 mm and the number of rainy days on average per year is between 80 and 120 days, (the most watered areas are the heights of Alédjo, Fazao and Adélé)
- A very rigid dry season from November to March, undergoing the effects of the northeastern trade wind, the harmattan during the months of November to February.

Two types of landscape characterize vegetation: a forest landscape and a savanna landscape. The forest landscape is located on the mountainous axis of the Atakora: hill areas of Adélé, Foukpa, the Fazao Mountains, Malfakassa, Alédjo, etc.

All Togolese ethnic groups are represented in the region with a predominance of Tem-Cotokoli, Kabyè, Losso, Tchamba and Adélé -Agnanga. The density of the population is 47 inhabitants per Km2. The region is composed of five prefectures (Tchaoudjo, Tchamba, Sotoboua, Blitta and Mô). It has an estimated population of 617,871 inhabitants in 2010 with a high concentration in the prefecture of Tchaoudjo.

The Central Region is characterized by an economy based mainly on agriculture, which is still in the traditional family-type stage with rudimentary farm implements and small farms. The technical conditions of development do not allow a strong production. the main activity of men in rural areas is work on the farm, female also work the land and are present at all levels, from production, marketing and processing.They play a particularly important role in food production (yams, millet, sorghum, maize, peanuts, beans, rice, condiments and various vegetables).Indeed, there is a sawtooth evolution of yields between 1990 and 2007.The yields of the main cereal crops are decreasing.Rice farming is particularly focused on the rain type with the exploitation of the lowlands by the producers. The activities were carried out in the prefecture of Blitta, Sotouboua and Tchaoudjo.

Kara Region

The activities of the study were carried out in Dankpen prefecture located about 90 km from Kara, capital of the region. The climate is semi-arid Sudanese where only two seasons can be distinguished: a rainy season between May and October, and a dry season between November and April. Temperatures and rainfall vary more: between 18 ° C and 40 ° C and between 100 and 900 mm / year.During the rainy seasons, the monsoon winds coming from the South-West progress towards the North bringing a little freshness. Between December and February, the harmattan winds from the Sahara also cools temperatures.The air is then more dusty and dry.In addition, this season also corresponds to the time of burning in preparation for planting, which increases the amount of particles in the air. The population of the prefecture is estimated at 130 723 inhabitants (RGPH, 2010).In this zone, rice production is done only in the lowlands in a traditional way.There are, however, some rice farmers who have received training on the Rice Intensive System (IRS). The total area of lowlands is about 3500 ha of which about 800 are exploited in rice production.

Savannah Region

The Savannah Region covers an area of 8,470 km² with a population of 828,224 inhabitants according to data from the Directorate General of Statistics and National Accounts (2011). According to these data, the population of Savannah represents 13.4% of the total population of Togo with a density of 96 inhabitants / km². The Savannah region has seven prefectures and its capital is Dapaong. The economy of this region is mainly based on the agricultural sector which occupies 80% of the total labor force. Although the region is full of enormous potential, agricultural practice (field work and family farming) is characterized by: the very extensive soil degradation in the western zone of the region, erratic rains and very infertile land.Among the major crops, rice and maize occupy a prominent place in the production and in food.The study area concerned four cantons distributed in three prefectures of the region of Savannas namely: the canton of Dapaong in the prefecture of Tône, the canton of Nano in the prefecture of Tandjoaré, the canton of Mango and the canton of Sadori in the prefecture of Oti. In these cantons are developed for rice farming either an irrigated perimeter, Tantigou in Dapaong, or a planned agricultural development zone (ZAAP), Sadori, Mango and Nano.

Study methods

The methodology adopted for this study has three components: (i) the documentary review; (ii) formal and informal surveys of rice farmers and (iii) data analysis.

Document review
It consisted mainly in the collection, exploitation and analysis of the monograph documents available on Togo in general and the study area in particular. The data collected relate to production statistics, demography and information related to the nature of the soil, climate, introduced technologies and adoption constraints.

Formal and informal investigations
For the collection of primary data and information, structured and semi-structured surveys were conducted.These include in-depth surveys of individual rice farmers and focused focus groups. For this survey a sample was carried out and a questionnaire developed. The questionnaire focused on the socio-economic characteristics of farms (age, sex, educational level, main activity of household head, technology introduced, technology used, technology abandoned, reason, abandonment factors, difficulties / constraints, area cultivated, annual production, rice production sold, etc ...). The focus group was in the Central Region and was conducted with 45 producers in three prefectures. Interviewers were recruited and trained to manage the survey. A total of 652 rice farmers were interviewed individually, including 150 in the Maritime region, 200 in the Plateaux, 150 in the Kara and 152 in the Savannas. Regarding the informal survey, the methodological approach consisted in organizing discussion groups of up to 10 people among the rice producers and interviews with the seed producers and the institutions involved (Seeds and Plants Directorate). Producers with less than seven years of experience in rice farming were excluded. The collection tool used was a maintenance guide.

Data analysis
The data collected from rice farmers were entered and processed in the Excel spreadsheet.

Results

The results of the study were presented in four parts: (i) analysis of the dynamics of adoption; (ii) identification of barriers to adoption of technological innovations; (iii) the discussion of the most important results and (iv) a proposal of solutions to improve the adoption of technological innovations.The summary of the main results on the adoption of technological innovations by region is presented in the appendix of this document.

Analysis of the dynamics of adoption of technological innovations

The analysis in Figure 2 shows that the evolution of the rice areas planted has an upward trend from 2001 to 2012.In fact, the area cultivated with rice, which was 32,413 ha in 2001, fluctuated slightly between 2003 and 2009. From 2009, the area under rice has initiated strong growth to reach the peak of 47 403 ha in 2010 and then remained stable until 2012.

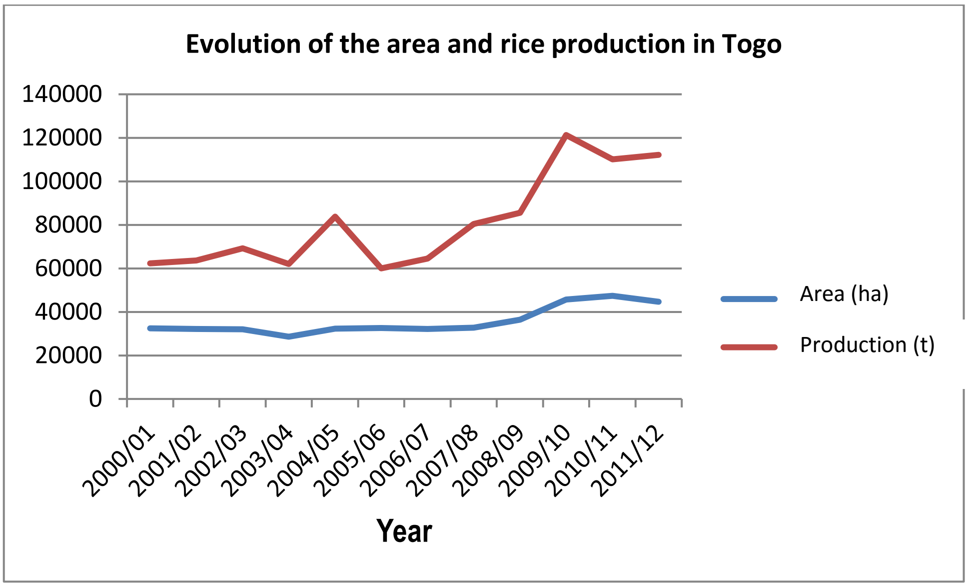

Figure 2: Evolution of the area and rice production in Togo

Rice production in Togo also experienced strong fluctuations from 2001 to 2012 with an upward trend. Rice production was estimated at 62 307 tonnes in 2001, rose to a peak of 121 294.716 tonnes in 2010 and then remained stable until 2012.The analysis of the evolution of these two curves shows that there is a correlation between the evolution of the cultivated area and the rice production in Togo. From this observation, it appears that the increase in rice production in Togo is obtained in part by the extension of cultivated areas. The observation of the yields presented in Figure 3 confirms this conclusion. In fact, paddy rice yields in Togo remained almost constant from 2001 to 2012.

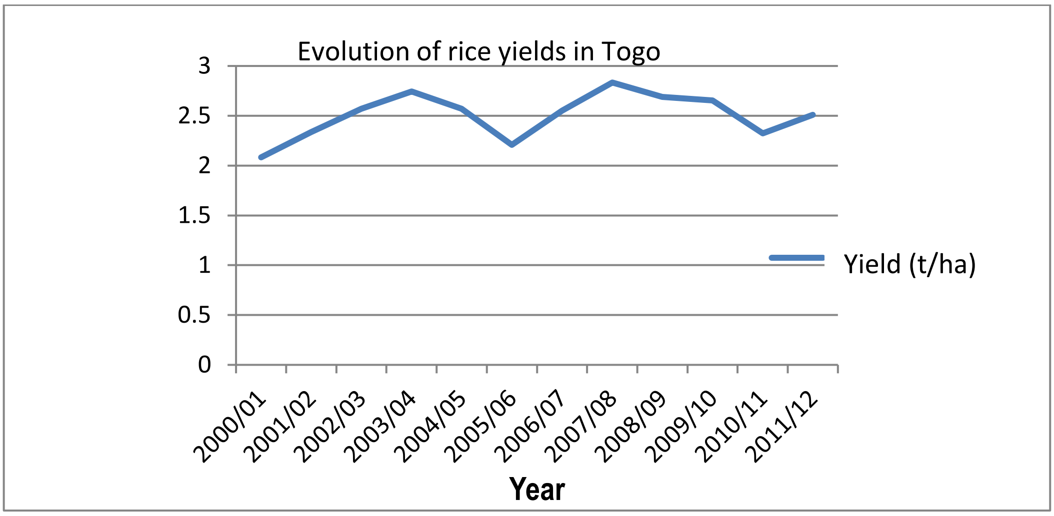

Figure 3: Evolution of rice yields in Togo

From 2.083 tonnes / ha in 2001, the yield rose to 2.743 tonnes / ha in 2004 before falling to 2.209 tonnes / ha in 2006. Then, this yield fluctuated until 2012 while remaining below 3 tonnes / ha.

Obstacles to adopt technological innovations

The results are presented by region in this section of the document. This presentation is structured in three points: (i) the socio-economic characteristics of rice farmers; (ii) the level of adoption and (iii) the adoption constraints of technological innovations.

Maritime Region

Socio-demographic characteristics

Rice production in the Maritime region is mainly held by men (68.3%). Female represent 31.7% of the sample. The average age of the sample is 43 years with a standard deviation of 9.9.Table 1 also shows that men are on average older (45 years old) than female (38 years old). As for the size of households, the average observed is 8 people with a standard deviation of 3.4 persons.

Table 1: Age of average household size by gender

Gender	sample		Age		Household size	
	Number	%	Average	Standard deviation	Average	Standard deviation
Female	48	31,7	38,8	5,4	7,5	2,4
Male	102	68,3	45,9	10,7	8,4	3,8
Total	150	100,0	43,7	9,9	8,1	3,4

Table 2 shows that most respondents live in unions (77%), compared with 11% of single people and 8% who lost their spouse.

Table 1: Marital status of respondents according to gender

Gender	Marital status			
	Married	**unmarried**	**Widower/ widow**	**Divorced**
Female	23,7	3,0	5,0	0,0
Male	53,3	8,0	3,0	4,0
Total	77,0	11,0	8,0	4,0

The overall level of education in the area is 84%. 15% of rice farmers are uneducated.About 22% of respondents are educated through informal education (literacy), 36% attended primary school, 25% attended college (Table 3).From a gender perspective, female are less educated than men. In fact, 11% of female have no education compared to 4% of men. Likewise, only 7% have reached primary school and almost none at the secondary or high school level.

Table 3 : Respondent's educational level by gender (%)

Gender	Level of education					
	None	**Literate**	**Primary**	**Secondary**	**High School**	**University**
Female	11,0	13,4	7,3	0,0	0,0	0,0
Male	4,9	8,5	29,3	25,6	0,0	0,0
Total	15,9	22,0	36,6	25,6	0,0	0,0

Association life is highly developed among rice producers in the study area. 87% of rice farmers belong to farmer organizations as shown in Table 4. The essential role of these farmers' organizations is to facilitate access to members for various types of training, technical support and access to agricultural credit.These training and technical support come from extension and research institutes, as well as some NGOs working in collaboration with productions.Access to agricultural credit is provided by traders (26%) and decentralized financial structures (65%).With regard to the experience of respondents in the practice of rice cultivation, the overall average duration is 14 years with an average duration of 16 years for men and 9 years for female.

Table 4: Producer Organization and Years of Experience of the Respondents

Gender	Membership in a PO		Year of experience	
	No	Yes	Average	Standard deviation
female	1,2	30,5	9,5	3,7
Male	11,0	57,3	16,7	11,0
Total	12,2	87,8	14,4	9,9

Table 5 shows the characteristics of the farms of the rice producers. The average sample size is 1.21 ha with 1.42 ha for men and 1.15 ha for female.

Table 5: Characteristics of rice farms

Gender	Area (ha)		Production (tons)	
	Average	Standard deviation	Average	Standard deviation
Female	1,15	0,6	1,18	2,7
Male	1,42	0,9	2,07	3,4
Total	1,26	0,7	2,13	3,3

The smallest area encountered was 0.18 ha and the largest was 4 ha.The average production of white rice for the entire sample is 2.13 tonnes or 3.6 tonnes of paddy. This observed production gives an average yield of 2.5 tons / ha of paddy rice with a distribution of 1.5 tons / ha for female and 2.2 tons / ha for men.

Level and constraints of adoption of rice technological innovations

The national research system, with the support of its technical and financial partners, has developed many technologies (improved varieties and good agricultural practices).The analysis in Table 6 shows that 100% of the respondents adopted the improved varieties.However, when these varieties were integrated into the production systems, 65% of the respondents reported the low yield of certain varieties, 27% the poor tillering and 71% the lack of aroma. Note that the aroma (fragrance) of rice is a crucial factor in the choice of varieties in the Zio Valley and Mono.

Table 6: Knowledge and adoption of improved seeds (%)

Adoption	Gender		
	Female	Male	Total
No	0,0	0,0	0,0
Yes	31,7	68,3	100,0

As for the good practice technologies presented in Table 7, they are variously appreciated and adopted by rice farmers. However, they are known to the majority of producers.We can categorize these technologies according to their rate of adoption and identify the reasons or causes of non-adoption.In the category of technologies adopted more than 50%, we can mention: two plowing before transplanting. 68% of respondents say they have adopted this technology. However, they face certain challenges such as the lack of equipment (tiller) at the right time to do the plowing. Which activities are delayed. Some producers are using traditional tools like daba to overcome this problem and set up their field over time. Nursery practice: this is a technology practiced by 100% of rice farmers surveyed. Fertilizer supply four bags of NPK and two bags of urea: adopted by 69% of producers. This technology tends to be irrelevant due to the decline in soil fertility due to overexploitation of the land (83% of cases). In this context, the increase in the quantity of fertilizer becomes a necessity without which the producer would not obtain any appreciable yield. Fractional contribution of urea in two stages: the technology is adopted by 95% of rice farmers. This is best understood by the decline in soil fertility and the need to efficiently fertilize the seedlings at key stages of the growing season.

NPK supply during transplanting or 7 to 10 after: 82% of the rice producers surveyed adopted this technology.

- Use of herbicides: all rice farmers surveyed claim to use herbicides to control weeds. In fact, rice farmers are facing the pressure of certain weeds, especially of the family of sedges and poaceae requiring the action of herbicides without which the yields are considerably affected. However, most of these herbicides are not registered. Indeed, a 2008 ITRA study showed that 80% of the pesticides used on the perimeter are not registered. Seed treatment before transplanting: this technology has been adopted at 60%.

The cropping pattern 20 cm x 20 cm is adopted by 89% of rice farmers. Indeed, during transplanting, rice farmers use knotted strings respecting at least this spacing. In the second category (Table 8), we find technologies adopted at less than 50%. It is : transplanting to 1 or 2 strands: 15.9% of respondents say they have adopted this technology. This technology is poorly adopted for reasons that it increases working time (88%), and is expensive (100%).

Deep urea placement (PPU) or urea briquette: this is the least adopted technology of all (1.2%). Rice farmers mention the lack of equipment (98%), requiring a lot of investment (92%), 63% the non-availability of fertilizer briquettes and 6% lack of technical support.

Burying crop residues: 13% of respondents buried their crop residues in the soil. However, 73% find that this technology is not adapted to the equipment (tillers) used for plowing; 42% say that with this technology, the cost of plowing increases.

- The intensive rice cultivation system (SRI): it is the second least adopted technology (6%). The reasons given are the extension of working time (57%), the high cost of technology (98%).

Table 7: Adoption of good practice technologies (%)

Technology	Adoption	female	Male	Total
2 plowing before transplanting	No	0	0	0
	Yes	31,7	68,3	100
Transplanting 1 or 2 strands	No	28	56,1	84,1
	Yes	3,7	12,2	15,9
Cultural patterns 20cm * 20cm	No	1,2	9,8	11
	Yes	30,5	58,5	89
Seed treatment	No	15,9	23,7	39,6
	Yes	15,9	44,5	60,4
SRI	No	29,3	64,6	93,9
	Yes	2,4	3,7	6,1
Supply 4 NPK bags and 2 bags Urea	No	6,1	24,4	30,5
	Yes	25,6	43,9	69,5
PPU	No	30,9	67,9	98,8
	Yes	1,2	0	1,2
fractional supply of urea in 2 phases	No	0	4,9	4,9
	Yes	31,7	63,4	95,1
Herbicide use	No	0	2,4	2,4
	Yes	31,7	65,9	97,6
Burying crop residues	No	27,2	59,3	86,4
	Yes	4,9	8,6	13,6
Nursery	No	0	0	0
	Yes	31,7	68,3	100
Contribution NPK transplanting or 7-10 days after transplating	No	6,1	11	17,1
	Yes	25,6	57,3	82,9

The analysis in Table 8 shows that post-harvest technologies are widely known by 95% of producers.

For mechanical winnowing: 30% of producers win their rice harvest mechanically. Within this percentage, 84% do it without any measures taken, 16% after observing at other producers.

Table 8: Recognition and adoption of post harvest technology (%)

Technology	Adoption	Female	Male	Total
winnowing mechanical	No	20,1	49,9	70
	Yes	12	18	30
Mechanical threshing	No	30,9	67,3	98,2
	Yes	1,2	0,6	1,8

Concerning mechanical threshing: very few producers have adopted this technology, ie 1.8%. However, 82% implement it without any prior measures and 17% have observed other producers before adopting it.

Plateaux Region

Sociodemographic characteristics

The allotment by gender shows that 58% of rice farmers are men and 42% are female as shown in Figure 4. This representativeness of female in rice production indicates its importance for the food security and income of local populations.

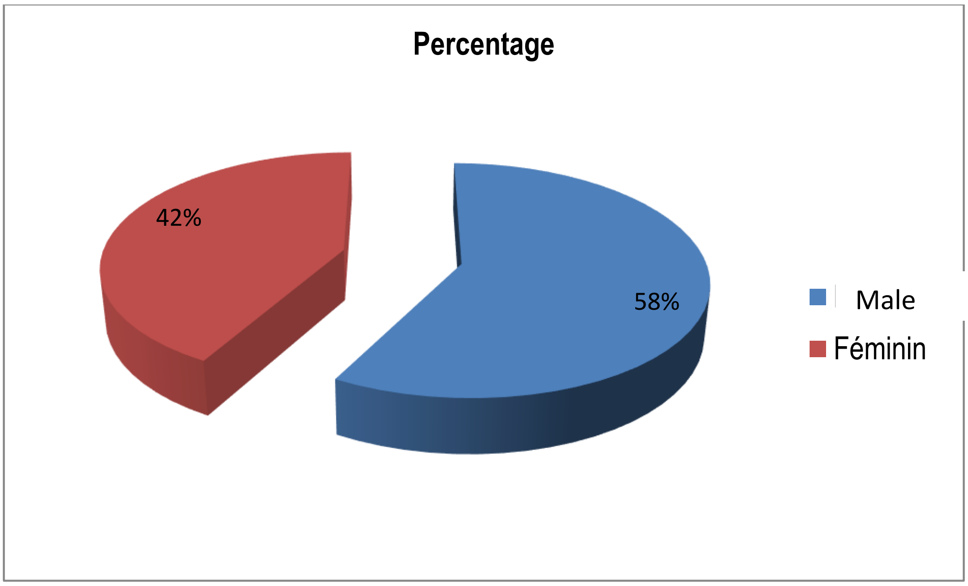

Figure 4: Distribution of respondents by gender

The average age of rice farmers is 48 years with a standard deviation of 5 years, which reflects a low dispersion of the age population around the average.This age is an asset for rice farmers in the conduct of production activities. In general, rice farmers surveyed have an age ranging from 20 to 80 years as shown in Figure 5.

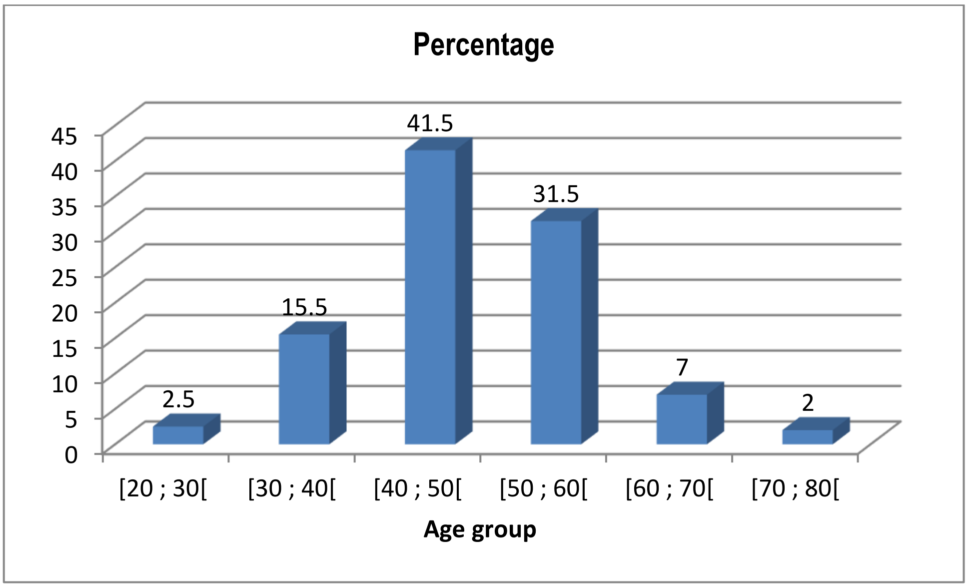

Figure 5: Distribution of rice farmers by age group

The distribution of rice farmers by age group reveals a large number of respondents aged between [40; 50 [with a percentage of the workforce of 41.5%. The average experience in rice cultivation is 12 years with the sample studied. The distribution of rice farmers by marital status and by level of education is shown in Table 9.It shows that a significant number of rice farmer (85%) are married persons and 68% have a secondary level of education. Of the 200 rice farmers surveyed, 169 (84.5%) are married; 15 (7.5%) are single; 8 (4%) are widowed as well as 8 (4%) divorced.

Table 9: Distribution of rice farmers by marital status and educational attainment

		Number	**Percentage**
Marital status	Married	169	84,5 %
	Divorced	8	4 %
	Widower/ widow	8	4 %
	Single	15	7,5 %
Level of education	None	10	5 %
	Primary	45	22,5 %
	Secondary	135	67,5 %
	University	1	0,5 %
	Literacy	9	4,5 %

According to the level of education, 135 of the 200 rice farmers surveyed (67.5%) have secondary education; 45 (22.5%) have primary level; 10 (5%) have no level of education; 9 (4.5%) are literate and only one person is 0.5% at the university level.

The distribution of rice farmers as their main occupation in Figure 6 shows that agriculture is the main activity of rice farmers surveyed. In fact, 90.5% of these rice growers are mainly engaged in agriculture; 7.5% have livestock as the main activity and only 1% of the respondents practice the trade.Trade is practiced mainly by female. The other main occupations of rice growers are hairstyling and sewing, which are practiced by 1% of respondents.Moreover, for these rice farmers, livestock farming is the most popular secondary activity, ie 72% of respondents.

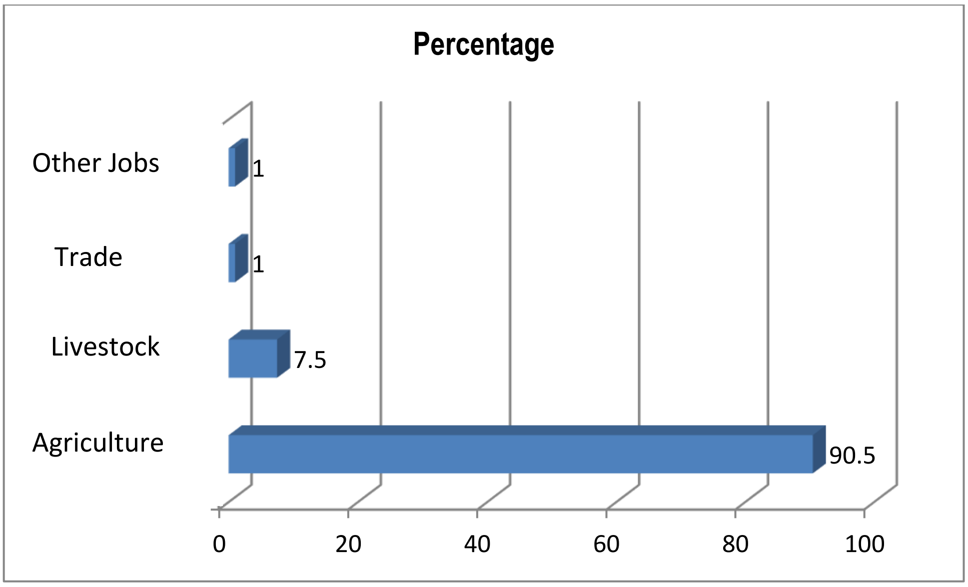

Figure 6: Distribution of rice farmers as their main occupation

Among the farmers whose main activity is agriculture, 81% of them belong to a peasant organization, notably a cooperative.

Level of adoption of rice technology innovations

The innovations introduced in the study area are presented in Table 10.

Table 10: Inventory of Technologies Introduced in the Study Area

Varieties introduced	introduced cultivation technics	Equipment
IR841	Système de Riziculture	Tractor
NERICA	Intensive (SRI)	
	APRAGIR	
	Treatment technics	

	Phytosanitary
	Transplanting
	Chemical fertilizer
	Pesticide

The technologies identified are grouped into three categories: varieties, cultivation techniques and introduced equipment. Among the varieties, IR841 is adopted 100% by the respondents whereas the variety NERICA is adopted by only 5% of the respondents. For cultivation technics, it is the use of chemical fertilizers (NPK and urea) which is more observed in 97% of cases as shown in Table 11.

Table 11: Level of adoption of technologies introduced in 2015

Technology	Level of adoption
Intensive Rice Farming System (SRI)	12%
APRAGIR	0%
Phytosanitary treatment technics	8%
transplanting	60%
IR841	100%
NERICA	5%
Tractor	18%
Chemical Fertilizer	97%
Pesticide	100%

As for the tractor, it is used by only 18% of respondents. The analysis of adoption rates shows that when technological innovations are introduced, rice farmers use them during the period when incentives (seeds, fertilizer) exist. Once the technology promotion project ends, rice farmers will abandon the technology because of a number of constraints.

Main constraints to the adoption of technological innovations

The main constraint to the adoption of technological innovations mentioned by 75% of respondents is the inadequacy of the salaried workforce. Then, 25% mentioned the hardness of work as shown in Figure 7.

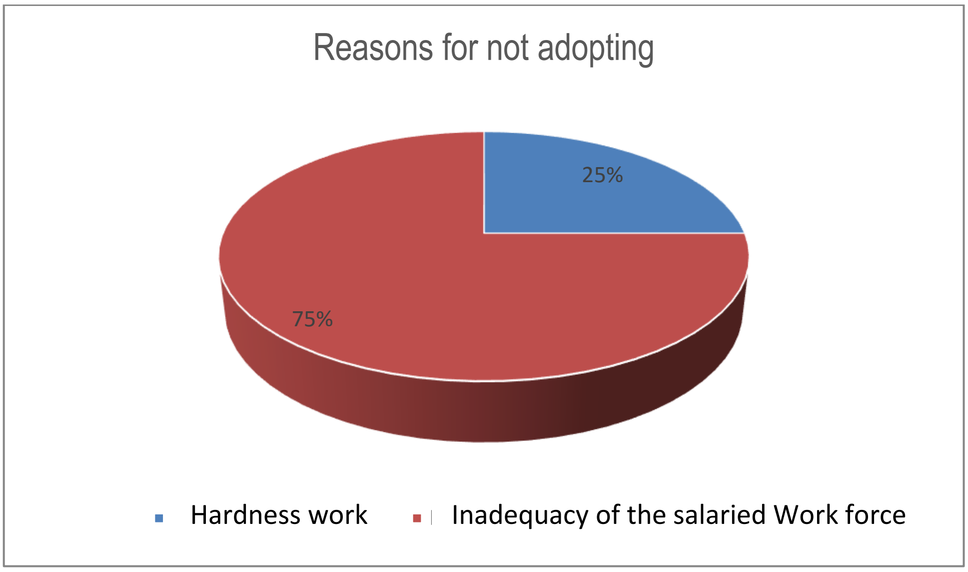

Figure 7: Reasons for No Adopting of Technological Innovations

The scarcity of hired labor because of the rural exodus of young people who no longer want to be farmers. They leave rural areas to live in the surrounding towns where they mainly engage in motorcycle taxi activity. Thus the countryside is empty and it is increasingly difficult for rice farmers to seek maneuvers. In addition, the remaining wage labor force in the village is becoming more expensive, which increases the costs of rice production and thus hinders the adoption of labor-intensive technologies.As regards the arduousness of work when using technological innovations, mentioned by rice farmers, it is in fact a lack of motivation. Rice farmers for the most part want to get good profitability without putting the necessary physical and financial effort into their activities.

Central Region

Unlike other regions, the study was conducted in this one through focus groups. The participants belong to farmers' organizations and are in contractual relations with institutions such as ESOP, CECO-AGRO and AGIP.The specific objectives of the discussions were to: (i) collect rice farmers' perceptions of technological innovations; (ii) to identify the constraints and obstacles related to the adoption of innovations and (ii) to make proposals for solutions to improve knowledge and access to innovations.

Main results obtained

Rice farmers' perceptions on the importance of agricultural technological innovations

The discussions that producers have knowledge and are aware of the importance of the introduction of rice innovations in their environment. Indeed, most of them attach particular interest to it; This justifies their involvement in the majority of projects concerning the dissemination of these innovations.In addition, it is noted that in general, larger proportions of land are allocated to improved varieties. Focus group participants have a perfect knowledge of improved varieties including the variety IR841 which is most used through the Sotouboua Seed Farm or NGOs such as ESOP and CECO-AGRO.Few producers know the range of other varieties such as NERICA and TGR. They highly appreciated the transplanting technics for the yield it generates.

Knowledge of agricultural innovations

The main innovations introduced are known by the producers. They are presented in Table 12.

Table 12: Directory of technological innovations introduced in the study area

Varieties introduced	Cultural technics introduced
IR841 NERICA	Simple and participative planning through SMART-IV
	SRI Transplanting technic Soil preparation technics (plowing, sowing) Good use of fertilizer (period and recommended dose)
	Planning and management of water in rice farm Mastery and control of water Weed management
	Sowing online Use of manure and compost Use of herbicides (total and selective) to control weeds

The knowledge channels of these innovations are mainly training and information sessions, field-schools thanks to farmers' organizations, resource persons and technical support structures such as ITRA, CECO, AfricaRice, AGIP, ESOP, ICAT, and the "leaders". Apart from improved varieties introduced, producers continue to cultivate local varieties. Among these are the varieties Awini, Ibo, Datcha, Local short, Dapaong, Long grain. One of the reasons for maintaining these local varieties is their organoleptic properties (fragrance, taste).The reasons for adopting innovations are essentially economic and agronomic. The improved varieties have a high yield and are easily sold on the market. Most producers of the variety IR 841 have even already entered into agreements with the processing institutions (ESOP and CECO) which supply them with credit inputs and buy the products at predefined prices.In some localities, the known but no longer adopted innovations are the Nerica varieties and the development technic. In Tchangaide, for example, the Nerica, although known by only a few producers, are not adopted. These producers mention that the main reason is the problem of unavailability of improved seeds in their area. Elsewhere (in this case, in the village of Tchebebe) these varieties are not even known. However, some growers who have known and tried to cultivate the variety have been disappointed with these performances, including its low yield compared to the variety IR 841 and lack of aroma.Further discussion revealed that the producer who tried and later abandoned the variety had a low yield due to the No-application of technologies related to the technical itinary. On the other hand, the variety IR 841 is very appreciated by all the producers considering its high yield, its organoleptic characteristics, and especially its easy market outlet.

Constraints and difficulties related to technology adoption and mastery

The main constraints related to the adoption of the technological innovations mentioned by the producers in the group discussions concern:

- The ravage of birds
- The decline in the fertility of the lockers
- Insect attacks
- The problem of transhumance
- The non-mastery of lowland development techniques by some producers
- Land issues
- The lack of financial means to acquire inputs;
- The effects of climate change
- The high cost and the availability of manpower
- No remunerative prices
- ESOP's breach of contract terms
- Lack of equipment (tractor, cultivator)
- The difficulty of transplanting
- Lack / lack of training on the use of herbicides
- Inputs the No available on time of inputs
- The difficulty of accessing credit

Proposed solutions to foster the control of these innovations

To cope with certain constraints, producers have proposed some approaches to solutions. For them, it will be necessary:

- Provide equipment to facilitate soil preparation, sowing and harvesting;

- Organize regular training and retraining sessions;

- Destroy the existing lockers and rebuild the bunds;

- Reduce the use of herbicides;

- Use manure and compost for fertilization;

- Avoid transplanting and late sowing;

- Set up transhumance corridors;

- Introduce varieties adapted to climate change (short-cycle, high-yield and flavored varieties);

- To make seasonal information available to rice farmers.

In addition, producers believe that lowland development is a palliative to the effects of climate change.

Kara Region

Sociodemographic characteristics

Rice farming in the study area (Dankpen) is mainly held by men (90.66%). Female represent only 9.34% of the sample as shown in Figure 8.

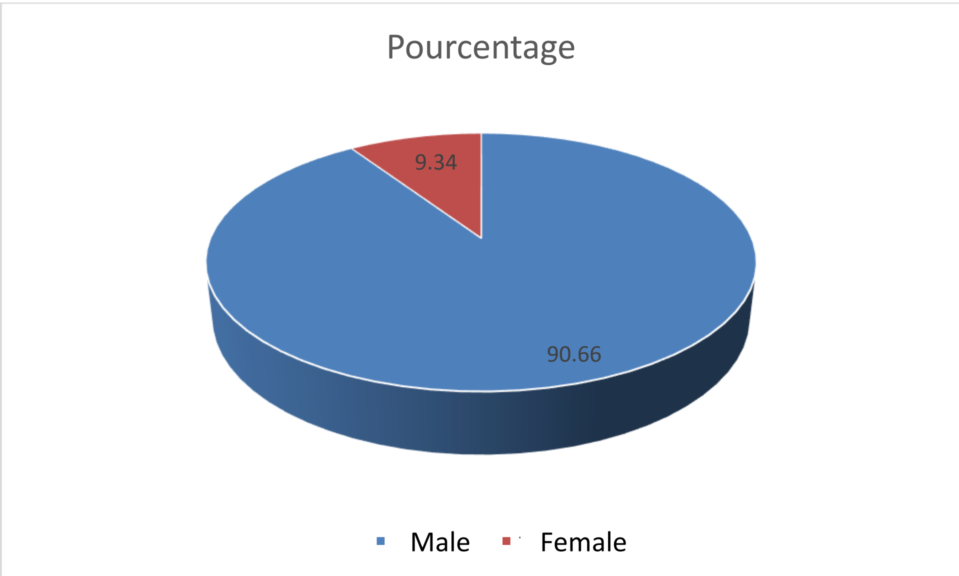

Figure 8: Distribution of respondents by gender

The average age of the sample is 39.6. On average, female are 41 years older than men (38.2 years). The experience in rice production is on average 10.6 years (11 years for men and 10 years for female). The distribution of respondents is shown in Figure 9.

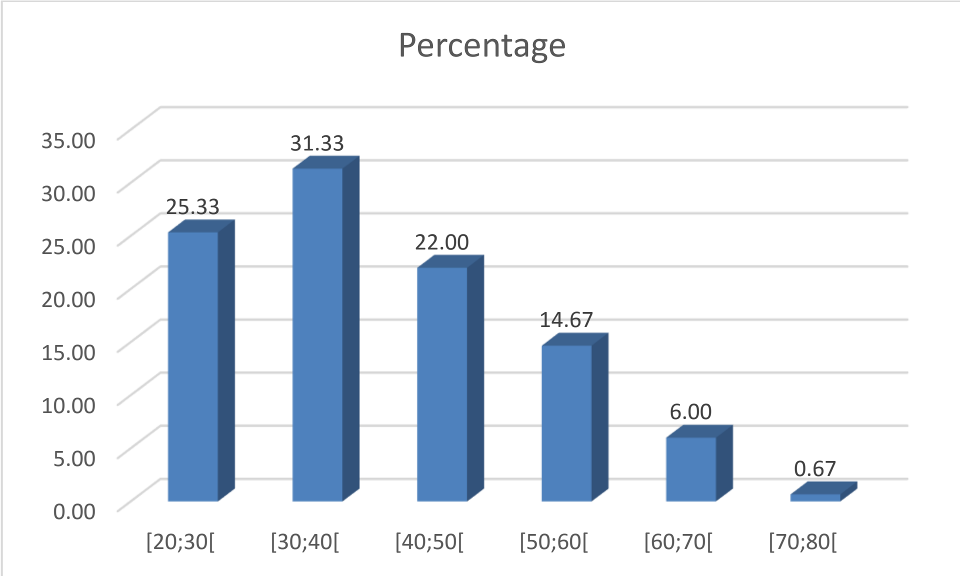

Figure 9: Distribution of respondents by age

Most respondents (31%) are between 30 and 40 years old, 25% are 20 to 30 years old and only 6% are 60 to 70 years old. The level of education in the area is very low (39.24%) as shown in Table 13.

Table 13: Respondents' level of education by gender (%)

Gender	Level of education					
	No	Literate	Primary	Secondary	Tertiary	University
Male	52,0	0,6	10,66	19,33	7,33	0,66
Female	8,66	0,0	0,0	0,66	0,0	0,0
Total	60,66	0,6	10,66	19,99	7,33	0,66

60.66% of rice farmers have received no education, 0.66% are educated through informal education (literacy); 10.66% the primary course; 19.99% college and 7.33% university. Most lowland farmers are married (90.33), 6% are single, 2.6% have lost their spouse, and 0.6% have divorced as shown in Table 14.

Table 14: Marital status of respondents by gender

Gender	Marital status (%)			
	Married	Single	Widower/Widow	Divorced
Male	83,33	6,0	0,6	0,6
Female	7	0,0	2,0	0,0
Total	90,33	6,0	2,6	0,6

According to Figure 10, almost all of the respondents (96%) have agriculture as their main activity.

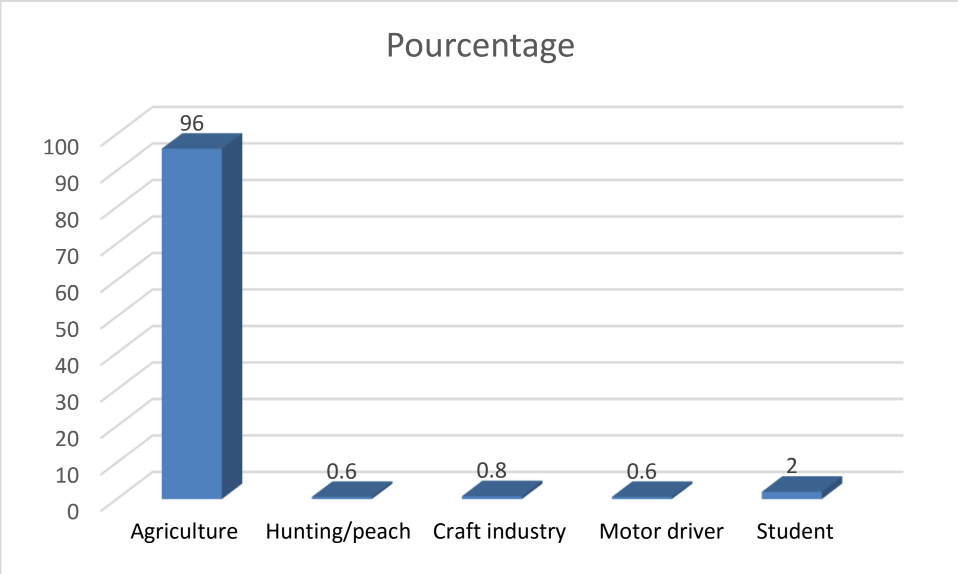

Figure 10: Distribution of rice farmers by main occupation

More than half (58%) belong to farmers' organizations. The rest (42%) work individually. Most lowland farmers, male and female, are owners, which is not a development issue.

Table 15: Distribution of respondents according to belonging to a peasant organization

Gender	Belonging to a peasant organization	
	No	Yes
Male	38,66	52
Female	3,33	6
Total	41,99	58

The essential role of these groups is to facilitate access to members for various types of training, technical support and access to agricultural credit. These training and technical support come from extension and research institutions, as well as some NGOs working in collaboration with producers.

Level of adoption of rice technology innovations

Many technologies generated by the research and made available to the producer have made it possible to increase the productivity level of most crops, in this case rice. These technologies concern varieties as well as cultural practices. Table 16 summarizes the listed technologies introduced in the survey area.

Table 16: Directory of Technologies Introduced in the Study Area

Varieties introduced	Introduced technologies
IR841	Flat plowing
	Plowing in square pose
	Plowed labor
	Zero plowing
	Band culture
	Using compost
	Certified seeds
	Use of fertilizer
	Herbicide use
	Phytosanitary products
	Variety use
	Harnessed culture
	SRI
	Planning summary
	Stony cords

The different technologies introduced have been adopted to varying degrees, the adoption level results are presented in the table.

Table 17: Level of adoption of technologies introduced in 2015

Technology	Level of adoption in 2015 (%)
Locker labor	14,6
Flat plowing	0
Plowing in square pose	0
Plowed labor	100
Zero plowing	0
Band culture	0
Using compost	0
Certified seeds	15
Use of fertilizer	90
Herbicide use	100
Phytosanitary products	100
Variety use	10
Harnessed culture	0
SRI	15
Planning summary	5
Stony cords	0

The technologies introduced in the study area have not all reached the same level of adoption by rice farmers.Some technologies namely logging, the use of plant protection products and herbicides have been adopted by 100% of rice farmers while other technologies (stony cord, harnessed culture, band culture, use of compost, zero plowing, flat plowing, plowing in the square) have not been adopted at all.For some technologies, the adoption rate is low. These include: summary management (5%), SRI (15%), use of improved varieties (10%), use of certified seeds (15%) and plowing locker (14.6%). Fertilizer use is a technology that has been adopted by 90% of rice farmers surveyed. However, it is important to note that this technology is not fully used by adopters. Which means, the recommended dose is not respected.

Main constraints to the adoption of technological innovations

Based on the results of the technology adoption and diffusion studies, some socio-economic variables are found to be critical in the adoption of technology (Rogers, 1983).They include the agro-ecological area, age, gender, household size, farm equipment, farm size.It is not so easy. In this case, the constraints to the adoption of new technologies are threefold: economic, social and institutional.

Economic constraints

Nursery and transplantation are time, human, and financial resources consuming. Therefore, due to lack of financial resources, farmers with insuffiscient family labor and inadequate equipment, hardly seed and transplant big farms using the recommended practices. Fertilisers are also perceived as expensive so that farmers hardly apply recommended quantities.

Social constraints

The villages today are emptied of their valid arms. Young people looking for a better tomorrow prefer to leave their place of origin to seek a better job. This phenomenon is accentuated by the theft which is rife in the villages, discouraging young people from staying there.

Institutional constraints

Institutional constraints boil down to inadequacy staffing services.

Savannah Region

Sociodemographic characteristics

The survey results reveal that the majority of households in the study area (62.5%) are male while female make up 37.5% of the sample as shown in Figure 11.

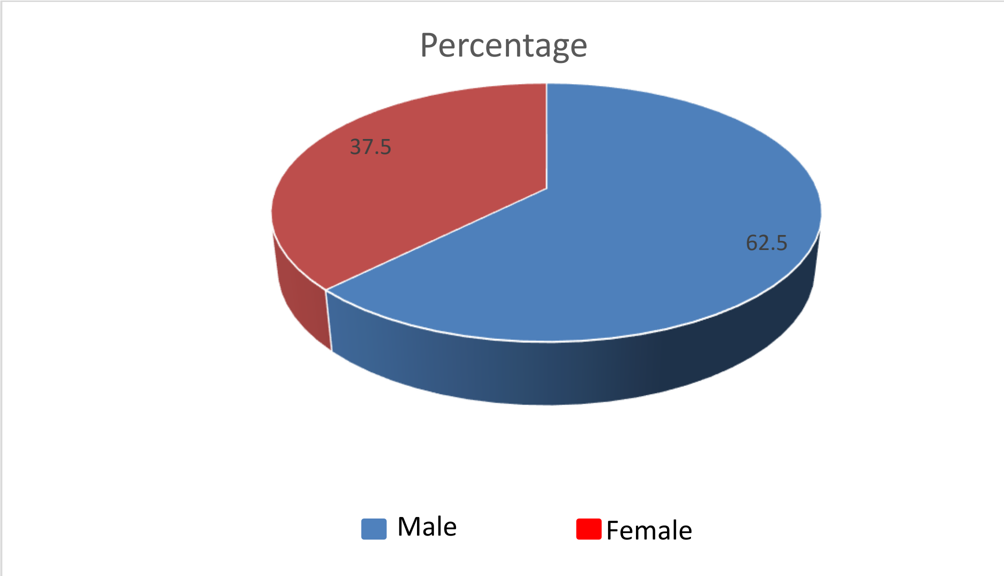

Figure 11: Distribution of rice farmers by gender

Overall, the average age of surveyed rice farmers is 42 years old with a minimum of 22 years and a maximum of 66 years. The average age per sex is 40 years for female with extremes of 22 years and 59 years and then 43 years for male with extremes of 28 years and 66 years.

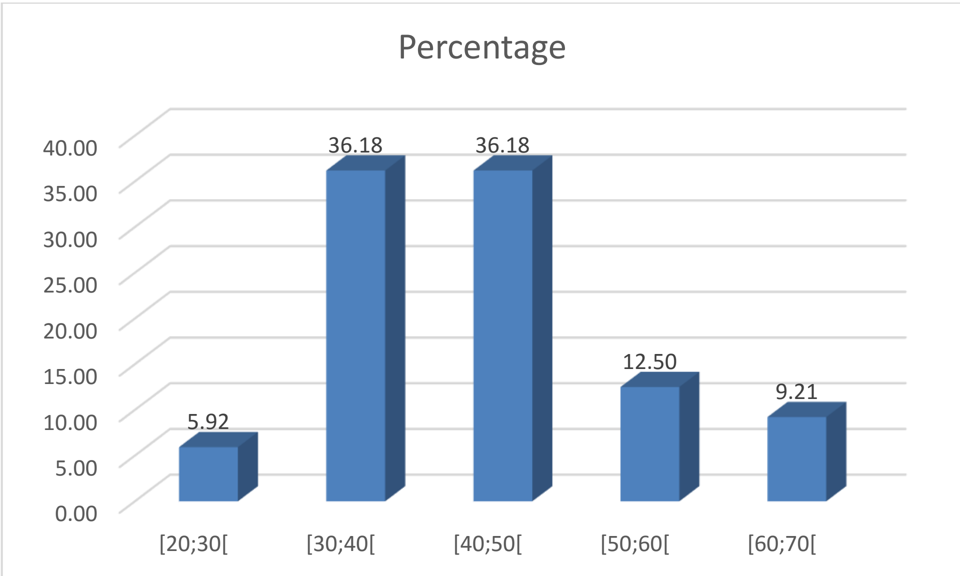

Figure 12: Distribution of respondents by age

The analysis in Figure 12 shows that the majority of respondents (89.47%) are married and 10.53% are widowed. Taken by sex, we can observe that the majority, both men and female, is married. As for the level of education, the results of the survey reveal that 36.18% reached primary, 32.89% secondary and 1.97% typical of female with university level. There is also a high rate of out-of-school attendance (20.39%).

Table 18: Distribution of rice farmers by sex, marital status and educational attainment

		Sex		Total	
		Male	**Female**	**Number**	**%**
Marital status	Married	95	41	136	89,47%
	Divorced	0	0	0	0,0%
	widower/widow	0	16	16	10,53%
Level of education	Non	6	25	31	20,39%
	Primary	46	9	55	36,18%
	Secondary	33	17	50	32,89%
	University	0	3	3	1,97%
	Koranic school	10	3	13	8,55%

The main activity that occupies the rice farmers surveyed is in 95.39% of cases agriculture. These respondents have proven experience in rice farming, 16.47 years on average (18.13 years for men and 13.7 years for female). The average household size is 10 people with a standard deviation of 6 people. The exploitation of rice farmers is also characterized by the combined use of family and salaried labor in 98.03% of cases against 1.97% using only family labor. The rate of access to credit is 63.16% among rice farmers surveyed. Regarding the use of fertilizers, it is commonplace (80.26% of producers surveyed) but the recommended doses are not often respected. However, the use of herbicides is very high (77.63% of respondents). 90.13% of producers belong to farmers' organizations. The main activity of rice farmers in the zone is agriculture in 95% of cases, as shown in Figure 13.

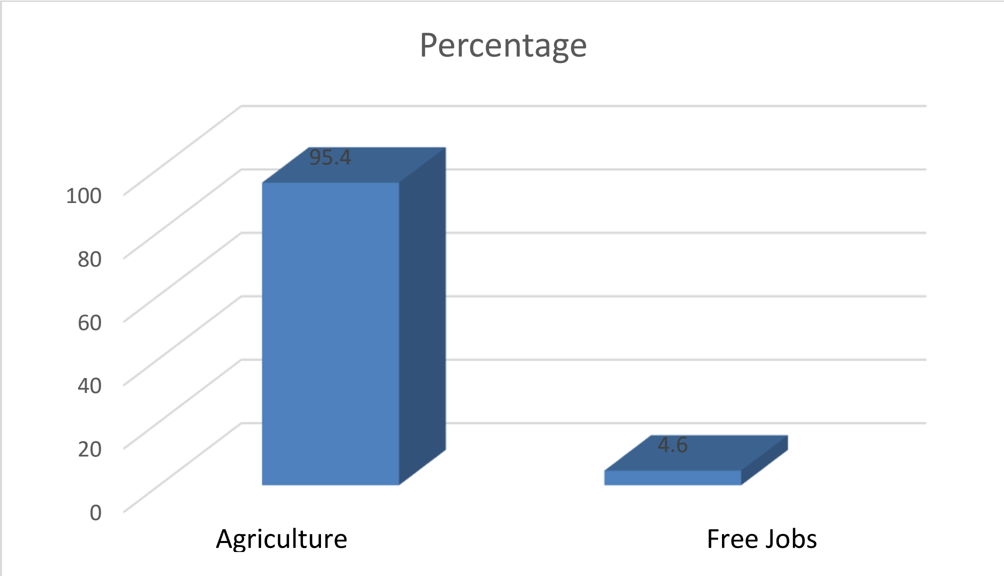

Figure 13: Distribution of respondents by main occupation

The area exploited by rice farmers in the Savannah region is highly variable. As shown in Table 19, it should also be noted that the average area exploited by female (1.68 ha) is lower than that of men (3.28 ha).

Table 19: Area of rice harvested by sex in ha

Sex	Moyenne	Standar-deviation	Minimum	Maximum
Male	3,28	2,57	0,25	12
Female	1,68	0,9	0,25	3
Together	**2,68**	**2,24**	**0,25**	**12**

The average production of paddy rice for the entire sample is 5,896 tons for an average area of 2.68 ha. This equates to a yield of 2.2 tonnes / ha.

Level of adoption of rice technological innovations

In order to solve the problem of the low productivity of Togolese agriculture, technologies have been developed and introduced in the peasant environment. These technologies concern varieties as well as cultural practices. Table 20 summarizes the listed technologies that were introduced in the survey area.

Table 20: Inventory of Technologies Introduced in the Study Area

Varieties introduced	Cultural technic introduced
IR841	Nursery and transplanting
NERICA	Online transplanting
	Sowing online
	Use of fertilizers
	Use of pesticides
	SRI (Intensive Rice Farming System)
	Use of mechanical winnowing machine

It should be noted that not all introduced technologies are adopted by all producers. The level of adoption of different technologies is presented in Table 21.

Table 21: Level of adoption of technologies introduced in 2015

Technology	Level of adoption by female	Level of adoption by Men	Total adoption level
IR841	57 (37,5%)	95 (62,5%)	152 (100%)
NERICA	3 (1,97%)	15 (9,86%)	18 (11,84%)
Nursery and transplanting	31 (20,39%)	68 (44,73%)	99 (65,13%)
Online transplanting	9 (5,92%)	27 (17,76%)	36 (23,68%)
Sowing online	0%	0%	0%
Use of fertilizers	57 (37,5%)	95 (62,5%)	152 (100%)
Use of pesticides	57 (37,5%)	97 (62,5%)	152 (100%)
SRI	0%	0%	0%
Use of mechanical winnowing machines	2 (13,15%)	4 (2,63%)	6 (3,94%)

The high rate of adoption of technologies in the survey area is observed in the use of pesticides, fertilizers and the variety of rice IR 841 where the adoption rates are 100% for these technologies among farmers producers surveyed. 65.13% of producers do the nursery followed by transplanting. However, the recently introduced intensive rice-growing system and online seeding do not yet have a member in the study sample.

Main constraints to the adoption of technologies

The adoption of any innovation is most often restricted to constraints of all kinds. Regarding the technologies introduced in rice growing in the survey area, the constraints are economic, social.

Economic constraints

The lack of financial means to acquire certain materials (mechanical winnowing for example) is one of the main obstacles to the adoption of technologies. In addition, the cultivation practices (sowing or transplanting online, the SRI) involving more labor face a reluctance to adopt because of the financial means for renting this workforce.The use of chemical fertilizers is accepted by the producers however, the recommended doses are not respected because of the cost of these fertilizers.

Social constraints

The phenomenon of rural exodus, which leads to the flight of both family and salaried workers to cities for more remunerative activities, results in a lack of availability of labor and, in turn, technologies requiring a large work force are not welcome to rice farmers. This phenomenon is accentuated in female who must use second-hand family labor after their husbands. The lack of involvement of some producers in the process of introduction of technology creates jealousy and reluctance to adopt technology.

Institutional constraints

The devices used for the transfer of introduced technologies have sometimes sins on some appearence related to the way of bringing the technology to the peasant environment. Also, most of the technologies were introduced without training of the big peasant mass. The lack of agents for the supervision of rice farmers is one of the most important institutional constraints to the adoption of technologies.

Discussion

The low adoption rate of some technologies (deep placement of urea, SRI, infeed of crop residues) is explained by their costly practice, long working time, lack of equipment and the high cost of Workforce. As a result, there is insufficient information on the performance of innovative crop systems. Transplanting to 1 or 2 strands per bag is a technology designed to reduce seedling application from 80 kg / ha to 40-50 kg / haThe application of this technology requires a great deal of care during the transplanting process, which is manual and the local workforce is not used to this practice, which increases the cost of labor by two to three times. Labor. One of the difficulties facing producers is financial. It is therefore obvious that, in order to reduce the cost of production, the producer always tends to adopt the least expensive practices. These findings also apply to the Intensive Rice Farming System (IRS) which, in addition to transplanting to 1 or 2 strands, recommends that nursery plants be transplanted five to ten days after sowing. During this operation, there is a good chance that the transplanting seedlings are damaged and thus their recovery capacity decreases. Given the area planted (1.2 ha on average), the application of this technology can be very costly for producers. Deep urea placement has a great advantage in providing the plant with efficient use of urea and thus reducing the cost of buying fertilizer. However, it is a less adopted technology. Indeed, it requires in the first place, to have small brick. But-on the local market, these small brick do not exist, which makes it difficult to implement. Studies have shown that there is a high level of organic matter in rice straw. This is to return this significant amount of organic matter in the soil, which research has recommended the enfessment of crop residues. Despite the poor soil in the study area and the need for restoration, producers rarely adopt this technology. This is explained by the fact that during the plowing, straws roll in the wheels of the tractor sometimes causing serious breakdowns. Thus, tractor drivers no longer like to plow with straws scattered on the plot or increase the cost of plowing.This technology also has an intrinsic disadvantage. In fact, during periods of rain, when the straw is buried, its decomposition leads to acidification of the soil causing chemical reactions that lead to the production of methane, a greenhouse gas that contributes to global warming. In these conditions of climate change, this technology must be redesigned and better oriented for rice farmers.The introduction of mechanical vanners and threshers on irrigated perimeters was intended to improve post-harvest practices. However, producers are facing a lack of this equipment. Rice growers also report that many loose machine parts are not available on the local market. As a result, when a machine breaks down, its repair takes time and creates further problems for lack of maintenance. One of the important factors in improving a crop is the seed. Producers, in a comparison of seed acquisition prices, are more easily turning to the most affordable seeds of any quality. The no- associavity of rice growing with livestock is the main cause of the low use of compost. The use of nurseries in rice cultivation has a considerable advantage, that of reducing the quantity of seed used. This technology requires the use of a workforce that, unfortunately, is not available. If producers do not adopt technologies enough, this is partly due to lack of information. Indeed, the lack of information available on the performance of innovative cropping systems leads farmers to evaluate these systems based on their experience and knowledge (Roosy et al., 2015).They make their choices based on their perception of innovation and their own constraints. An innovation perceived as riskier by farmers therefore has a lower probability of being adopted. In addition, depending on their production context, rice growers develop preferences for certain characteristics of the innovation. This is the case when producers put the technology into practice with some modification on their part. The adoption of an innovation generates additional uncertainties for rice growers in addition to the many risks incurred in the current production context: price volatility, regulatory constraints, etc. Risk preferences, specifically farmers' risk aversion, have been highlighted as a significant barrier to the adoption of innovations on the farm (Binswanger and Sillers, 1983, Couture et al., 2010). Marra et al., 2003). It should also be pointed out that on the irrigated perimeters of the Maritime Region, especially in the Zio Valley, there is this ego of the producers who think they have been in rice cultivation for years and have mastered everything about this crop. This is also a stumbling block to the adoption of technologies in the Zio Valley

Suggestion

For the improvement of rice production in Togo we propose the following:

- ✓ Strengthen farmers' capacity on Good Agricultural Practices in rice cultivation;
- ✓ to offer producers of different improved varieties of rice;
- ✓ develop lowlands to control the water that carries rice plants;
- ✓ strengthen the capacity and staff of producer coaches;
- ✓ introduce rice machinery and equipment to reduce the use of labor
- ✓ introduce rice machinery and equipment to reduce the use of labor
- ✓ improve access to agricultural credit, especially for the purchase of fertilizer and the relaxation of repayment terms.

Conclusion

The study revealed that Togo has a lot of potential for rice production. But it should be noted that apart from a few rice producers, other rice farmers have no access to research innovations. The adoption of technologies is very low, producers use "their equipment." This study shows that several technologies have been introduced to improve the productivity of Togolese rice growing. However, not all technologies have been adopted and the productivity of rice cultivation is still low. The study also revealed that the constraints to the adoption of these technologies are more the constraints of economic order (lack of financial means, high cost of labor), social (the No availability of labor). Work, family labor, the heavy burden on the few agricultural assets) and institutional (few NGOs frequent the environment).

Appendix

Appendix 1: Summary of rates and main constraints of adoption of technological innovations

Maritime Region

Innovation	Adoption rate in 2015	Reason of No adoption
Two plowing before transplanting.	68 %	Lack of equipment (tractor) at the right time to do the plowing
Practice of the nursery	100 %	
Fertilizer supply four bags of NPK and two bags of urea	69 %	Decreased soil fertility due to overexploitation of the land
Split intake of urea in two stages	95 %	
NPK supply during transplanting or 7 to 10 after	82 %	
Use of herbicides	100%	
Cultural diagram 20 cm x 20 cm	89 %	
1 or 2-strand transplants	15,9 %	Increases working time (88%) and is expensive (100%).
Deep Placement of Urea (PPU) or Urea Briquette	1,2 %	Lack of equipment (98%) Requires a lot of investment (92%) the No-availability of briquette fertilizers (63%) Lack of technical support (6%)
Infeed of crop residues	13 %	Technology No adapted to the use of equipment tractor) (73%) Cost of plowing increases (42%)
Intensive rice cultivation system (IRS)	6 %	Extended working time (57%) High cost of technology (98%)
winnowing mechanical	30 %	
Mechanical threshing	1,8 %.	

Plateaux Region

Innovation	Adoption rate in 2015	Reason of No adoption
Intensive Rice Farming System (SRI)	12%	Insufficient wage labor High cost of hired labor Work hardness
APRAGIR	0%	Lack of technical support

Phytosanitary treatment techniques	8%	Lack of protective equipment
Transplanting	60%	Insufficient wage labor High cost of hired labor
IR841	100%	
NERICA	5%	Lack of aroma
Tractor	18%	Limited number of tillers No planning lowlands Difficulty accessing some lowlands
Chemical fertilizer	97%	
Pesticide	100%	

Kara Region

Table 22: Reasons for abandoning technologies introduced since 2011

Technology	Level of adoption in 2015 (%)	Constraint
Locker labor	14,6	No manpower
Flat plowing	0	Take too much time
Plowing in square pose	0	Do not serve us
Plowed labor	100	
Zero plowing	0	After using the herbicide, plow
Band culture	0	We can not skip the Band
Using compost	0	Time to make compost
Certified seeds	15	Seeds too expensive
Use of fertilizer	90	Lack of money
Herbicide use	100	
Phytosanitary products	100	
Variety use	10	We do not know that there are new varieties
Harnessed culture	0	There are tractors
SRI	15	We are not informed
Summary layout	5	No training
Stony cords	0	We do not know what it is

Savannah Rgion

Technology	**Level of adoption i**	**Reason of No adoption**
IR841	100%	
NERICA	11,84%	No flavored, less demanded by urban consumers and No availability of seeds of these varieties
Nursery and transplanting	65,13%	Work hardness, requires good soil preparation
Online transplanting	23,68%	Demand for important labor, Work hardness
Sowing online	0%	Demand for important labor, Work hardness
Use of fertilizers	100%	Lack of financial means is a constraint to the respect of doses despite the adoption of technology
Use of pesticide	100%	
SRI	0%	Demand for important labor, Work hardness
Use of mechanical winnowing machines	3,94%	Lack of resources for the acquisition of equipment

Appendix 2: Knowledge and Technology Adoption in the Maritime Region

Table: Knowledge and adoption of improved seeds (%)

parameter		Gender		
		Female	**Male**	**Total**
knowledge	No	0,0	0,0	0,0
	Yes	31,7	68,3	100,0
Measures taken before fitting	None	11,0	18,3	29,3
	Observe in others	20,7	50,0	70,7
	Experienced with modification	0,0	0,0	0,0
Adoption	No	0,0	0,0	0,0
	Yes	31,7	68,3	100,0

Table: Knowledge and adoption of good practice technologies (%)

Technology			Female	Male	Total	Technology			Female	Male	Total
Two plowing before transplanting	Knowledge	No	0,0	0,0	0,0	1 or 2-strand transplants	Knowledge	No	7,3	17,1	24,4
		Yes	31,7	68,3	100,0			Yes	24,4	51,2	75,6
	Measures taken before fitting	None	31,7	68,3	100,0		Measures taken before fitting	None	28,0	56,1	84,1
		Observe in other	0,0	0,0	0,0			Observe in other	3,7	11,0	14,6
		Experienced with modification	0,0	7,0	0,0			Experienced with modification	0,0	1,2	1,2
	Adoption	No	0,0	0,0	0,0		Adoption	No	28,0	56,1	84,1
		Yes	31,7	68,3	100,0			Yes	3,7	12,2	15,9
Seed treatment	Knowledge	No	3,7	9,8	13,4	Cultural patterns 20cm * 20cm	Knowledge	No	0,0	1,2	1,2
		Yes	28,0	58,5	86,6			Yes	31,7	67,1	98,8
	Measures taken before fitting	Aucun	20,7	45,1	65,9		Measures taken before fitting	Aucun	0,0	13,4	13,4
		Observe in other	9,8	19,5	29,3			Observe in other	30,5	47,6	78,0
		Experienced with modification	1,2	3,7	4,9			Experienced with modification	1,2	7,3	8,5
	Adoption	No	15,9	23,7	39,6		Adoption	No	1,2	9,8	11,0
		Yes	15,9	44,5	60,4			Yes	30,5	58,5	89,0
Fertilizer supply 4 NPK bag, 2 bags Urea	Knowledge	No	0,0	0,0	0,0	Intensive rice farming system	Knowledge	No	1,2	3,7	4,9
		Yes	31,7	68,3	100,0			Yes	30,5	64,6	95,1
	Measures taken before fitting	Aucun	9,7	29,3	39,0		Measures taken before fitting	Aucun	30,5	63,4	93,9
		Observe in other	22,0	39,0	61,0			Observer chez d'autres	1,2	2,4	3,7

		Experienced with modification	0,0	0,0	0,0			Experienced with modification	0,0	2,4	2,4
	Adoption	No	6,1	24,4	30,5		Adoption	No	29,3	64,6	93,9
		Yes	25,6	43,9	69,5			Yes	2,4	3,7	6,1
fractional amount of urea in 2 phases	Knowledge	No	0,0	0,0	0,0	Deep Placement of Urea (PPU)	Knowledge	No	17,1	29,3	46,3
		Yes	31,7	68,3	100,0			Yes	14,6	39,0	53,7
	Measures taken before fitting	none	9,7	24,4	34,1		Measures taken before fitting	none	30,9	66,7	97,5
		Observe in other	22,0	43,9	65,9			Observe in other	1,2	1,2	2,5
		Experienced with modification	0,0	0,0	0,0			Experienced with modification	0,0	0,0	0,0
	Adoption	No	0,0	4,9	4,9		Adoption	No	30,9	67,9	98,8
		Yes	31,7	63,4	95,1			Yes	1,2	0,0	1,2
Burying crop residues	Knowledge	No	14,6	31,7	46,3	Use of herbicide	Knowledge	No	0,0	0,0	0,0
		Yes	17,1	36,6	53,7			Yes	31,7	68,3	100,
	Measures taken before fitting	none	30,9	65,4	96,3		Measures taken before fitting	Aucun	7,3	20,7	28,0
		Observe in other	1,2	2,5	3,7			Observe in others	24,4	36,6	61,0
		Experienced with modification	0,0	0,0	0,0			Experienced with modification	0,0	0,0	0,0
	Adoption	No	27,2	59,3	86,4		Adoption	No	0,0	2,4	2,4
		Yes	4,9	8,6	13,6			Yes	31,7	65,9	97,6
Nursery	Knowledge	No	0,0	0,0	0,0	NPK supply for transplanting or 7-10 days after transplanting	Knowledge	No	1,2	4,9	6,1
		Yes	31,7	68,3	100,0			Yes	30,5	63,4	93,9
	Measures taken before fitting	None	4,9	14,6	19,5		Measures taken before fitting	None	13,4	35,4	48,8
		Observe in others s	20,7	48,8	69,5			Observe in others	18,3	32,9	51,2
		Experienced with modification	6,1	4,9	11,0			Experienced with modification	0,0	0,0	0,0
	Adoption	No	0,0	0,0	0,0		Adoption	No	6,1	11,0	17,1
		Yes	31,7	68,3	100,0			Yes	25,6	57,3	82,9

Table: Knowledge and adoption of post harvest technologies (%)

Technology			Female	Male	Total
winnowing mechanical	knowledge	No	1,2	3,7	4,9
		Yes	30,5	64,6	95,1
	Measures taken before fitting	None	24,7	59,3	84,0
		Observed in others	7,4	8,6	16,0
		Experienced with modification	0,0	0,0	0,0

	Adoption	No	20,1	49,9	70,0
		Yes	12,0	18,0	30,0
Mechanical threshing	knowledge	No	1,2	2,4	3,7
		Yes	30,5	65,9	96,3
	Measures taken before fitting	No	24,7	58,0	82,7
		Observe in others	7,4	9,9	17,3
		Experienced with modification	0,0	0,0	0,0
	Adoption	No	30,9	67,3	98,2
		Yes	1,2	0,6	1,8