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Contribution of New Korean Rice Varieties to Food Security for Households in the Senegal River Valley

Amadou Abdoulaye FALL, Ph D*

Researcher at the Senegalese Institute of Agricultural Research (ISRA), CRA de Saint-Louis, Senegal

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***Corresponding author:** : Amadou Abdoulaye, Researcher at the Senegalese Institute of Agricultural Research (ISRA), CRA de Saint-Louis, Test Garden, Saint-Louis, Senegal

Abstract

Rice farming in Senegal relies on small family farms and plays a crucial role in meeting food needs. However, local supply is insufficient and threatens food security in terms of availability, stability and accessibility. This justifies the generation and dissemination of Korean technologies aimed at increasing rice production. The objective of this study is to assess the impact of the project on small hold farmers' food security. The treatment effect method was used with the double difference approach following a baseline study in 2015 on a random sample of 1200 households in the Senegal River Valley. The study shows that the project led to a 22% increase in yields and an 18% increase in rice production, with an impact of 19% on income from rice cultivation, which accounts for 62% of total household income. This produced an impact of 236,087 CFA francs or an increase of 34% on average household income with a very significant statistical difference. This impact is 22,256 CFA francs per capita and 31,371 FCFA per equivalent adult (UEA). The impact on food consumption is 293 kcal/UEA per day and induces a reduction of 10% in households at risk. The impact on income has also increased the means of managing health needs. As a result, the producers have benefited greatly from the productivity gains in rice production induced by technologies. This highlights the crucial role of bringing innovations into rice production. The policy decision makers must develop strategic options for the widespread dissemination of these innovations in order to improve income and reduce food insecurity in rural areas.

Keywords: Impact; Income; Rice production; Yield; Food security; Target households; Witness; Technology

Context and Justificatifs

Rice has become the staple diet of Senegalese people. The change in the country's rice consumption has increased from 70 kg per head in 2008 to 90 kg in 2016 [1]. Now, the gap between domestic rice production and demand has negated efforts to seek self-sufficiency and even food security. Rice farming plays a major role in meeting the food needs of a population that is growing at a rate of 3% per year [1]. However, it relies on small family farms with a medium cultivated area ranging from 0.25 to 1 ha [1] and representing more than 85% of producers [2]. Thus, it is a major strategic commodity in the state's macro-economic policy options to ensure domestic demand, but also to increase the income and level of food security of small hold famers. It is in this context that ISRA, in collaboration with Africa Rice and the KOICA Cooperation Program, introduced and released 15 new varieties and good farming practices in 2015. This research program, which aims to strengthen the varietal portfolio and good farming practices, aims to increase the income and well-being of small hold producers in the Senegal River Valley.

Food security is defined as everyone's access to a healthy and sufficient diet at all times as to live healthy [3]. The complexity of this concept lies in the fact that it involves both national and international scale, starting from the capacity and political will of the state to deal with it. With the globalization of markets, food security relies on tripod whose first ensures adequate availability of food supply at both national and local levels. This availability is used for domestic consumption or to generate export earnings. The second is the stability of this availability in time and space. The last is the accessibility of food, materially (whether produced or available in the locality) or in monetary terms (access to products through income). National governance or agricultural policy frames this. These dimensions show that food insecurity can result from a combined effect of several factors. In other words, food security revolves around national food production in healthy conditions and that disadvantaged sections of the population retain adequate access to food. This is why ISRA/KOICA project introduced innovations to maximize the level of productivity whose purpose is to seek food security for small hold famers.

The goal of this study is to assess the impact of these Korean innovations on income and food security of targeted populations.

Methodology

Sampling

With the extent and heterogeneity of the study area, multi-stage sampling method was used. These stages are elaborate steps to select basic observation units (household) where the requirements of representativeness are respected. The first stage is devoted to the identification of study areas and sites with a reasoned choice based on the knowledge acquired (target areas of the KOICA project and control areas with the same features).Thus in the Senegal River valley, the areas of delta and lower-middle valley were chosen. At the delta zone, project targeted villages are Mboubène, Mbagame, Ndombo Thiago and Dagana, while Gaya and Bokhol represent the control villages. In the lower-valley, the village of Guia is the site of the project, while Ourro madi, Fanaye and Donaye represent the control villages. Following the reasoned choice on study areas and sites, the second step is to randomly select 1200 households at a rate of 600 per zone, 50% of which are for target villages and 50% for control villages. For each zone, the sample size in each group is distributed among the selected villages in proportion to their size. The overall size of the study sample is divided between 600 households having access to project innovations (demonstration tests, field visits or training session and/or access to varieties, seeds and equipment) and 600 households without access to the project's innovations. A questionnaire geared towards the collection of information on new technologies released was administered to household's head (technology-exposed) and control (unexposed) as to assess the impact of the adoption of improved technologies on income and food security.

Analysis framework

The analysis of food security uses a structural dimension that reflects the ability of people to meet their food needs, either through sufficient and sustained local production or by the possibility of generating in a sustainable manner income stake allowing them to acquire food. The food must therefore be available and accessible in a sustainable way. Therefore, the inability of populations to independently compensate for the effects of a cyclical imbalance is linked to an environment that demonstrates the inherent vulnerability of the considered populations. This is measured by the degree of permissiveness to food, health and/or resource allocation in the environment due to the combination of negative physical-climatic, economic and/or social factors. Thus, the complexity of the factors requires a three-tiered vulnerability analysis:

a. the level of satisfaction of the household's food consumption needs or consumption profile,

b. health care needs or health profile and

c. the state of the property conditions -be expressed in terms of the endowment of equipment and real estate sustainable strengthen the household's investment and production capacity.

Table 1: Standard for calculating adult-equivalent units per household.

	Sex	
Age	Male	Fémale
0-<1 ans	0,27	0,27
1-<2 ans	0,39	0,39
2->3 ans	0,45	0,45
3->4 ans	0,52	0,51
4->5 ans	0,57	0,56
5-> 6 ans	0,62	0,60
6->7 ans	0,67	0,63
7->8 ans	0,71	0,67
8->9 ans	0,75	0,70
9->10 ans	0,79	0,74
10->13 ans	0,87	0,78
13->16 ans	0,97	0,83
16->20 ans	1,02	0,77
20+ ans	1	0,73

Source: ORANA, 1993 in Kelly et al. 1998s.

The consumption profile of each household is determined by its nutritional calorie consumption requirements (kcal) per adult equivalent unit (UEA). It is a question of assessing the calorie consumption requirements of each household member by age and gender (Table 1). According to the African Food and Nutrition Research Office (1993), the required standard is estimated at 3000

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kcal corresponding to the real need for a healthy life per equivalent adult per day under Senegal's conditions. However, 80% of this standard (or 2400 kcal) is considered a minimum acceptable requirement. Thus, after estimating the resources available at the household level to achieve this standard, is declared a household at risk, any household that will be below this threshold of 2400 kcal/UEA/day.

The second level is the coverage satisfaction of health needs, while the last indicator assesses the level of endowment of equipment and sustainable goods that shows the state of the household's living conditions. These three strata combined with available household resources are used to analyze the effect of meeting food security needs. The resources available at the household level are the level of agricultural production, income of all sectors including agricultural, and equipment and real estate in the year under review. This allows us to estimate the level of real household income decomposed per capita and per equivalent unit, etc. Thus, the household's real income level determines its potential capacity to meet its multiple needs, including calorie satisfaction for a healthy and normal life, but also good health coverage. The analysis is at the community level of beneficiaries and control households.

Evaluation method

The basic problem with the impact assessment is the construction of unobserved counterfactuals. The introduction of the ISRA/KOICA research project cannot affect all potential populations in the valley. Thus, individuals in the target population are divided into two categories: (1) individuals treated by the project or beneficiaries and untreated individuals who did not have access to project innovations. In order to describe this situation econometrically, the treatment effect method is used. This is to specify a binary variable w that will take the value 1 when an individual is treated and 0 when it is not treated. When an individual is treated, we will denote the outcome result by Y-Y1, while when the individual is not treated, we will have Y-Y0 [3, 4]. The impact and adoption of innovations of the ISRA/KOICA project are estimated with the average treatment effect (ATE).The binary variable w=1 represents the case where the individual is being treated and is not treated w=0. The average impact of adoption in the treated subpopulation is given by conditional value, which is by definition the average treatment effect on the treaties (ATT). Since we observe y_1 for households treated or exposed to project innovations [5].

$$ATT=Ey\_1=P(w=1)\times ATE1+(1-P(W=1))\times E(y\_1 \mid w=0) \quad (1)$$

Where P(w=1) is the probability of access to technology. Thus, once ATE, ATT and the probability of exposure, P(w=1) are estimated, we can obtain from (1) the non-exposure bias =P(w=1)×ATT-ATE; the expected bias using the sample's average adoption rate based on knowledge and access to the technology. The doubly robust regression method was also used to estimate both the average effect of the program on beneficiaries and the average effect of the treatment. In the project frame, a baseline study was conducted on two populations with the same characteristics, one of which was targeted and the other a control or untreated group. Thus, the second passage (end of the project) allows to use the double difference approach. The method is to compare a treatment group with a control group (first difference); and both before and after an intervention (second difference) [6]. The impacts of the intervention, according to this method, are estimated by calculating the average difference in outcomes between treatment and control groups after the intervention minus the average difference in outcomes between treatment and control groups before intervention (Table 2).

Table 2: Estimating the impact of the treatment effect in the double difference..

Survey Level	Target Group (group I)	Control group (group C)	Difference between Group
Reference-Draft	I_0	C_0	I_0-C_0
Follow-up investigations - After project	I_1	C_1	I_1-C_1
Difference in difference (DD)		DD=[I_1-C_1]–[I_0-C_0]	

Results and Discussions

Impact on rice yield and production

Several technologies have been disseminated as part of the ISRA/KOICA research project. It consists of 15 new ISRIZ varieties, seed production and distribution, the introduction of small agricultural equipment for tillage, transplanting and protection. It also focused on technical capacity building sessions on good cultural practices with the "School Fields" approach or demonstration fields at the five-level target villages: Guia, Mbagame, Dagana, Ndombo Thiago and Mboubène. This two-year project (2015- 2017) had an overall goal of contributing to rice self-sufficiency by developing new rice technologies that could boost the productivity of small hold farmers.

Impact on acreage: The acreage analysis shows that the average usable area is 2.77 ha in raining season and 1.17 ha in the hot dry season. Nevertheless, the project had no impact on usable areas with a non-significant statistical difference (Table 3). However, a positive and relatively significant impact was achieved on the areas actually exploited in 2017. The project had to improve the area exploited by 69% with a level of significance of 6.3%. This indicates a positive result with a relatively significant statistical difference (less than 10%) [7]. The descriptive acreage statistics show the positive evolution of the areas exploited in previous years compared to the areas that can be exploited at the target zones between before and after project (Table 4). In terms of usable areas, there is a decrease between the two periods, on average from 8.06 ha to 7.5 ha, for respectively before and after

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the project. This produces the same trends between target and control households during the raining season. However, the study reveals an increase of 24% in usable lands in hot dry season for target households after the project (from 0.89 ha to 1.13 ha). This highlights the general trends of more embalming acreage in hot dry season in the Senegal River valley at the expense of the raining season that used to be the main rice-cropping season. Several reasons were raised, including the high presence of pest birds, delays in input credits access, long periods of heat, etc. This debate raises a call for research. In terms of cultivated land, there is a dynamic increase in both target and control households across both periods. The area exploited increased by two percentage points among control households and by four percentage points among project beneficiaries. This increase justifies the impact of the project on rice acreage with a statistically significant difference of 1%. For control households, the difference in averages is not significant. This shows that innovations induced for target households have motivated the expansion of the rice-cultivated area leading to intensification.

Table 3: Impact levels on areas.

Indicators	Average	Standard Deviation	Coefficient (p-values under Coefficient)
Area that can be used in raining season	2.77	2.68	0.76 -0.18
Area that can be used in hot dry season	1.168	3.82	0.33 -0.46
Areas operating in 2017	1.88	1.004	0.69 -0.063

Source: ISRA, 2018.

Table 4: Level of usable acreage (ha) by pre- and post-project campaign and with target and non-target households.

Surface in ha	Pre-project period			Period after project		
	Overall	Non-target	Target Household	Overall	Non-target	Target Household
Area usable in raining season	2,06	2,43	1,52	1,7 (-0,03)	1,89 (-0,001)	1,51 (-0,06)
Area usable in hot dry season	1,19	1,40	0,89	1,20 (0,065)	1,28 (-0,012)	1,13 (0,01)
Area exploited in Previous campaign	1,55	1,64	1,46	1,58 (0,06)	1,66 (0,07)	1,5 (0,01)

Source: ISRA, 2018. NB: P-values in brackets.

Impact on yields and production: In the areas of the ISRA/KOICA project, rice production increased by 18% in the target areas compared to the control areas with a statistically significant difference of 4%. Similarly, rice yield levels increased by 22% from 5.5 t/ha to 6.72 t/ha on average in target households (Table 5).This difference is statistically significant at 4%. This suggests that technologies introduced on rice have affected acreage expansion, production and yield. These small hold famers had an average yield of 5.72 t/ha below the valley average estimated at 6.5 t/ha. With the various initiatives, they were able to level and even be above the regional average in two years. Thus, the project has had a strong impact on yields and has encouraged the extension of the embalming and thus to the improvement of production. These producers have benefited greatly from the increase in rice productivity induced by the technologies and good agricultural practices introduced by the project as to improving level of production and food security [8].

Table 5: Impacts on production (t) and yield (t/ha).

Indicators	Average	Std-deviation	Coefficient (p-value under coefficient)
Rice production (t)	10,08	15,37	0.18 (-0.037)
Rice yield (t / ha)	6,72	6,90	0.22 (-0.04)

Impact on income

The results of the project recorded an estimated average household income of 694,372 CFA francs (Table 6). The study reveals that the ISRA/KOICA research project improved the average household income level by 34% with a very significant statistical difference to 1%. This result confirms that the project's progress has greatly improved the average household income in its actions to improve the households' livelihood and to fight poverty. The net effect of the project reveals an increase of 19% in rice income to targeted populations with a statistically significant difference. This is justified by the increase in rice production and acreage induced by the project. In fact, rice income accounts for 62% of the total household income and any increase has a positive effect on overall income. This shows the importance of rice in the composition of household income. Thus, the improvement drivers in real household income need to be more focused on rice farming activities. On the other hand, other types of income (farm incomes other than rice, non-farm incomes) are not statistically different between target and control households. This indicates that the

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contribution of the project's innovations has greatly benefited rice cultivation. In fact, the technologies introduced by the project open up prospects for increased revenues from rice sector through higher yield and expansion in cultivated area.

Table 6: Project impacts on revenues.

Indicators	Average	Std deviation	Coefficient (p-value under Coefficient)
Total average income	694 372,9	1 385 377	0,34 (0.001)
Income from rice production	429 360	1 062 919	0.19 (0.004)
Farm income other than rice	188 037,6	442 390,2	2.52 (0.06)
Non-farm income	145 000	129 000	0.6 (0.77)

Source: ISRA, 2018.

With an estimated average household income of 694,373 CFA francs, the driven income from rice farming has increased by 19% with a significant statistical difference induced by the project. Reported per capita (Table 7), the average income of the target group is 246,825 CFA francs, slightly higher than the national average income estimated at 244,000 CFA francs [9]. The control group has a lower income of 201,427 CFA francs per capita. This implies 18% difference, or less than 46,398 CFA compared to treated group with a relatively significant statistical difference. However, compared to the poverty line estimated at about $1.25 per day (228,125 CFA francs/year), it appeared that the majority control households still live below threshold poverty. The average income per equivalent adult (UEA) is 249,904 FCFA in 2018 for the project beneficiaries and 244,904 FCFA for non-beneficiaries with relatively significant statistical difference. This means that the UEA income for project beneficiaries is 5,182 FCFA or 3% higher than non-target populations with a statistically significant difference. The overall analysis showed that the project has had a positive impact of 236,087 FCFA or 34% more than the average household income with a significant statistical difference. The impact is 20,637 FCFA on per capita income and 27,251 FCFA on UEA income with a relatively different statistical difference significant.

Table 7: Income level per capita and per UEA between target and non-target groups.

Income type	Medium (Together)	Non-target	Targets	Différence	Impact
Income per capita	224 132	201 427	246 825	46 398**	20 637*
Income per Equivalent Adult	279 828	244 722	249 904	5 182**	27 251*

Source: ISRA, 2018. NB: ***p<0.01, **p<0.05, *p<0.1

Impact on food Security

The research project was introduced to help reduce food insecurity by sustainably increasing rice production and incomes. According to the results of the study, the project would have a positive impact. This impact is reflected in both the level of meeting food consumption needs and the ability of producers to meet their health and other non-food needs. The situation differs between target/non-target communities and indicators [10-14].

Coverage of food consumption needs

Level of caloric consumption: According to the results, households across the study area consume an average of 2,964 kcals per adult equivalent unit per day in 2018 (Table 8). The consumption level was 2,777 kcals in 2015 before the project starts. As a result, the level of kcal consumption has improved by 15%. Nevertheless, it remains below the optimal standard required of 3,000 Kcal per equivalent adult per day. However, it is 13% above the minimum threshold of 2400 Kcal of acceptable satisfaction. Indeed, any equivalent adult that is at least 80% of the 3,000 kcals required, or 2400kcals, is at an acceptable minimum [15]. This shows that households surveyed overall have made a qualitative leap in improving their level of consumption. However, this overall picture masks large variations at the community level between target and no-target households of the ISRA/KOICA project.

Table 8: Calorie Consumption by UEA/Day at target and non-target household level.

Designation	Overall	Target	Non-target	Diff. Average
Average calorie consumption level				
Consumption Kcal/UEA/day in 2018	2 769	2 951	2 587	364 (0,02)
Consumption Kcal/UEA/day in 2015	2 355	2 390	2 319	69,8 (0,13)
Level of variation in kcal/UEA/day				
Minimum	1 874	2 106	1 874	232 (0,06)
Maximum	5 050	5 050	4 325	725 (0,03)
CV (%)	53	62	45	

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Food security situation				
At-risk household(less 2400Kcal/UEA/day)	52%	47%	57%	-0,10 (0,004)
Satisfactory household (2400-3000 kcal/UEA/day)	21%	22%	19%	0,029 (0,011)
Very satisfactory household (3000 kcal/UEA/day)	27%	31%	24%	0,07 (0,002)
Source of intake kcal (%)				
Share of own production	52%	53%	51%	0,02 (0,157)
Share of purchase	48%	47%	49%	-0,02 (0,16)
Composition by origin (%)				
Commodities (cereals)	56%	58%	54%	0,04 (0,08)
Animal/fish products	21%	19%	22%	-0,03 (0,004)
Condiments (vegetables ...)	23%	23%	24%	-0,01 (-0,176)

Source: ISRA, 2018. (P in parenthesis).

Coverage of food needs has varied widely between households benefiting from the ISRA/KOICA project and non-beneficiaries (Table 8). At the time of the baseline situation in 2015, the level of coverage of food needs had no significant statistical difference between target and non-target households. This indicated good targeting of the sample with target and target households characteristically similar. With the introduction of new technologies in the project, surveys show a significant improvement in Kcal consumption of beneficiary households compared to non-beneficiaries. Indeed, the study shows that beneficiary's households consume an average of 2,951 kcal per UEA/day. This induces an increase of 19% in calories compared to before project (2,390 kcal/UEA/day in 2015). Non-target households consume on the other hand, 2587 kcal per UEA per day. Although they have improved their level of consumption since the baseline study by 10%. However, the consumption level is less than 14% of the required optimal standard of 3000 kcal. The beneficiary's households are below 2% of the optimal standard and well above the acceptable standard of 2,400 kcal.

The study shows a gain of 364 kcal/UEA/day of beneficiary households with a very significant statistical difference (Table 8). Recipient households have benefited from the productivity gains induced by the project to improve their level of food coverage from crops and incomes. Indeed, a good part of the needs (53%) is supported from purchases through increased income and production. Rising rice production has significantly improved coverage of household calorie consumption requirements. The intake of calories in household diets comes from basic products for 58% (mostly from harvest), condiments for 23% and animal products (19%). During the reference situation, commodities contributed 4% less, while condiments and animal products contributed 1% and 3% more, respectively, than in 2018. This rich intake of basic products (especially rice) and market garden products (onion and tomato) highlights the diversity of opportunities to satisfy food security in terms of the availability of consumption products. Although the beneficiary households are generally in favorable conditions, the fact remains that 47% of them are at risk. The minimum consumption of the beneficiary group is 2,106 kcal/UEA/day (13% above the 2400 kcals minimum acceptable). This situation is mostly induced by the low level of their resources (land, capital, inputs, etc.) and agricultural equipment to maximize the gains from the project. Thus, despite the efforts made, food insecurity niches remain at the level of recipient households that need to be further supported to mitigate their vulnerability. Nevertheless, the majority of target households (53%) are in a satisfactory situation with the introduction of innovations, 31% of which are at very satisfactory levels that are above the optimum standard. The study shows an increase of 7% in the category of households at very high levels of satisfaction compared to those who are non-beneficiaries with a highly significant statistical difference (Table 8).

Among households not benefiting from the project, the average level of consumption per UEA/day is 2,587 kcals. Although their level of consumption increased between 2015 and 2018, the vast majority of these households (57%) remains at risk with consumption levels ranging from 1,874 to less than 2400 kcal/UEA/day. This indicates that the vast majority of control households fail to ensure the acceptable minimum. In 2015, the vulnerable households in non-target group represented 55%, so roughly the same as the target group. Despite limited access to large cultivated areas, they diversify less their crops. In addition to at-risk households, the survey indicates that 19% of control households manage to meet their minimum acceptable calorie requirements (2400 kcal/UEA/day), while 24% of them are above the 3000 kcals per UEA/day required. In the non-beneficiary community, the self-consumption represents 51% of calorie intake, driven from lower yield levels induced, among other things, by the absence of innovations. In this consumption, cereals represent 54% of calories intake; and by animal/fish products (22%) and condiments (24%).

Impact of project on food consumption: The situation before and after project of beneficiary and control households shows a clear food consumption improvement induced by the project. The study reveals that the impact of the introduction of new project innovations has led to an additional 293 kcal per UEA/day (Table 9). The increase in exploited areas of 69% and rice yields

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of 22% justifies the improvement of the availability of consumer goods, particularly rice from beneficiary households. Similarly, the project has greatly improved the level of food insecurity for beneficiary households. As a result, the number of households at risk in 2015 (55%) improved with project support. Currently, only 47% of beneficiary households are still in a critical situation, while 57% remain so for non-beneficiary households. The study shows that the project resulted in a 10% reduction in households at risk and an 8% increase in moderately satisfactory households with a statistically significant difference (Table 9). However, the impact of the project on the consumption of households with very satisfactory food situation knows by the double difference, an increase of only 2% with significant statistical difference (5%). This shows a leveling in the vulnerability of households with a large reduction of households at risk to households with moderately satisfactory consumption. The introduction of innovations showed a positive effect of the project with a 10-point decrease in the level of vulnerable households.

Table 9: Impact on consumption level (kcal / / day) and household vulnerability.

Indicators	Average	Standard deviation	Coefficient (p-value under coefficient)
Consumption level UEA/day	2 951	1084	293 (0,012)
Food security situation			
- At-risk household ((>2400Kcal/UEA/day)	47%	0,091	-0,10 (0,02)
Satisfactory household (2400-3000kcal/UEA/d)	22%	0,031	0,08 (0,03)
Very satisfactory household (> 3000 kcal/UEA/day)	31%	0,055	0,02 (0,05)

Source: ISRA, 2018.

Coverage of health needs: The health status of populations is also perceived as a good indicator of quality of life or food security. It constitutes the primary condition of resources or investment capital at the household level. Thus, the level of health status of household members reveals the perception of the quality of its human resources. The survey found that in the last 4 weeks before the interview, more than 92% of households recorded sick or injured, and 75% of whom consulted in the whole area (Figure 1). This indicates a high rate of patients for a period of one month. These results vary, however, depending on the beneficiary status. At the community level, 97% of the control households had to report sick and injured patients against 86% of the beneficiaries. Unlike in 2015, they were in the same proportions, for respectively 94 and 93%. In care, the beneficiary households consult the most a health agent (79% among beneficiary households against 71% among non-beneficiaries). This indicates an increase in the level of health agent consultations for 15% of beneficiary households and 10% for non-beneficiaries compared to the reference year. Although the average consultation rate has changed positively, the fact remains that, overall, nearly 25% of patients did not consult a health agent. The main reasons (Figure 2) that justify the lack of consultation of households that have registered patients in the whole study area, are for the most part the lack of resources (43%), followed by the use of traditional practitioners or non-treatment drug availability (14%). These results show the vulnerability of rural populations with the constant increase of diseases during raining season, but also the relatively low level of consultations. At the community level, the lack of means and the unavailability of drugs contributed significantly to the lack of consultation among non-beneficiary households, while lack of resources and consultation to traditional practitioners are the main raison for the target households. The non-availability of drugs and their high cost represent respectively 14 and 11% in the whole sample. The absence of consultation also results from long queues at the level of the health posts.

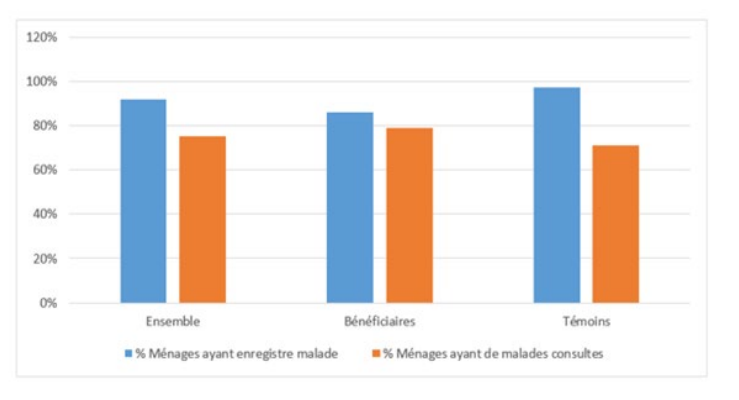

Figure 1: Characterization of the level of patients and use of medical consultations.
Source: ISRA, 2018.

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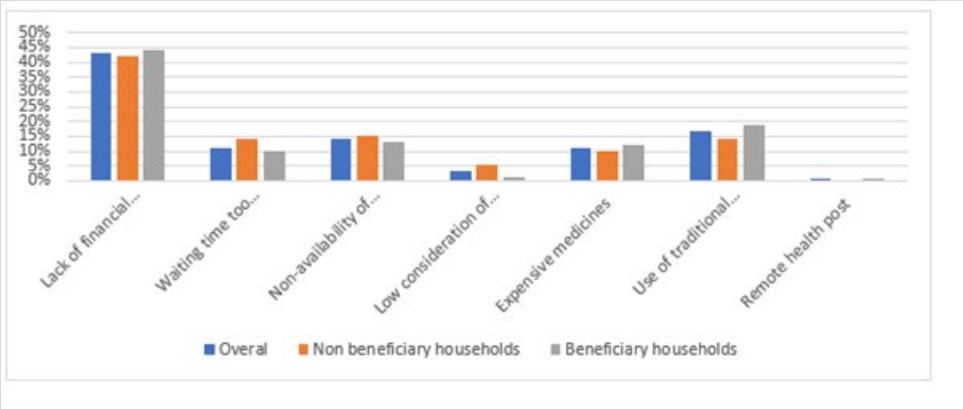

Figure 2: Main reasons for not consulting patients.
Source: ISRA, 2018.

The health expenditure analysis shows a relatively average cost of 8,480 CFA francs per month per household in all communities. This level shows more sustained patient management compared to the baseline year when it averaged 6,043 CFA francs. This expenditure ranges from an average of 8,650 F for target households to 8,310 CFA francs for non-target households. This estimate made it possible to make a household typology based on the satisfaction of the level of coverage of health expenditure per patient at the level of targets and non-target households (Table 10). The majority of target and non-target households manages to cover their health needs moderately. More than a third of all households are adequately covered. Although health costs have increased, households have improved their health coverage. Overall, 28% of households are at risk with fewer households at risk in target households (26%). The satisfaction of health needs was greatly facilitated by the 19% increase in income generated by rice production. Indeed, the level of health spending has increased, as has the level of consultation. It is recalled that the ISRA/KOICA research project has not focused on health. However, the induced effects of the project contribute to the improvement of production and income that can support health needs. Indeed, health conditions contribute to a better quality of life and therefore food security. It is shown that care appears to be reported in at least one-third of households. However, from one-third to a quarter of households as well targeted as that non-target, fails to cover properly their health needs. This trend is also similar to that of baseline in 2015.

Table 10: Coverage of health needs of target and non-target households (%).

Situation	Overall	Non-target Households	Target Households
% of households with low coverage	28	30	26
% of households with average coverage	37	36	38
% of households with satisfactory coverage	35	34	36
Total	100	100	100

Source: ISRA, 2018

Nevertheless, there is a slight improvement in the case of households at risk at the project target household level (26%). This indicates that rising incomes and the level of employment in households are factors of stability in people's living conditions. However, much remains to be done for a significant change in the correct management of health needs. Nevertheless, measures such as the Generic Bamako Initiative have indirectly contributed to the decline in health spending. Indeed, lower drug costs are a factor in the proper management of diseases. Indeed, lowering drug costs is one factor that contributes to the correct management of diseases. There is also the strong presence in the area of traditional medicine. The use of the latter with low costs access, especially in rural areas, also leads to reductions in health expenditure.

Coverage of durable goods needs: The characterization of household equipment and durable goods levels is illustrated in Table 11. This information shows that most households are of modest to poor type. The most striking element is that house materials are less than 4% made of concrete / cement for all households. At the study area level, the strong presence of zinc materials (54% of households) and zinc (37%) shows the peculiarity of rurality in Senegal. This is also evident in wall materials made of banco for 43% of houses and straw for 17%. These particular signs are those of the rural habitat. Households in the study area retain this rurality with a strong presence of zinc roofing and mud wall materials. In overall study areas, most households are poorly endowed with durable goods. The average

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number is 10 durable goods at the household level (Table 11). Thus, in the sample as a whole, control households have an average of 10 durable goods against 11 households in target households. This information shows that most households are modest to poor.

Table 11: Characterization of Household Equipment and Durable Goods by Household (%).

Material of the roofs of the house	Overall	Non-target	Target household
Concrete / cement	4	4	4
Tile / slate	2	1	4
Zinc	54	52	55
Zinc	37	43	32
Thatch / straw Other	3	0,6	5
Materials of the walls of the house			
Cement bricks	34	33	35
Bricks in banco	43	36	48
Wood	0,8	1	0,5
Metal sheet	2	4	0,8
Pisa	2	2	3
Straw / Stem	17	23	12
Other	0,6	0,6	0,5
Durable goods			
real estate of house, agricultural equipment	10	10	11

Source: ISRA, 2018

For target and non-target households, this particularity in sustainable equipment and goods remains almost the same. There was no change between the two passages (baseline and current study). In roofing materials, it is noted that 55% of target households are in zinc, 32% in straw, while in non-target households, only 52% are zinc and 43% are straw. In terms of wall materials, the majority of target households (48%) are in banco and 35% in cement. This shows a slight habitat format to modernity in target households. In non-target households, the dominance of banco walls is still observed, but for 36% of households. The rest constitutes of is shared cement wall materials for 33% of households and straw for 23% households. The nature of these types of habitat most often characterizes the poverty profile. Indeed, households, the wealthiest of these localities, are gradually adapting to the type of so-called modern or "urban style" housing. However, housing per se is not the most important for many rural populations who maintain the traditional architectural aspect for principles of cultural beliefs and amenities. This only shows, that this indicator can mislead in stratification according to wealth. However, it is one of the indicators of the level of assets for several experts. The level of endowment of capital and durable goods is another pillar in living conditions (Table 12). In target households, those with low equipped households account for 49%, while those with high durable goods account for 20%. Medium-equipped households make up one third of this group. However, in non-target households, the low-durable goods are 50%, while well-equipped households are 23%. Medium-equipped households account for 27% of this non-target group. This balanced distribution between the two types of rural communities provides a fairly homogeneous and representative mapping of the target and non-target households in the sampling. It is noted that the project introduced two equipment per grouping in the target villages. This equipment is collective and not individual and aims to facilitate ploughing and harvesting rice.

Table 12: Level of household satisfaction in resource endowment by household.

Situation	Overall	Non-target	Target household
% of low-coverage households	50	50	49
% of medium-coverage households	29	27	31
% of households with satisfactory coverage	21	23	20
Total	100	100	100

Source: ISRA, 2018.

Learned lessons about food security: By analyzing the three food security indicators, it is noted that the level of coverage of primary needs has been significantly improved at the target household level. Project innovations spurred a 293kcal improvement in consumption levels and increased the means to address health needs. It is noted that in consumption, most of

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the kcal comes from own production (53%). The households that emerge are those that benefit from the strong contribution of rice production and induced income. This highlights the crucial role of the contribution of innovations in rice production. Thus, access to agricultural extension services, technical support, inputs and technological innovations leads to net improvement in production. These types of programs will help weak households to increase their investment capacity and survival strategies. However, the endowment level in durable goods is quite low in the study area. Thus, the low endowment of durable goods remains a concern. This requires programs to support agricultural equipment to strengthen rice farmers' productive capacity. In sum, while income levels are improving, the majority of households are still at risk in the allocation of durable goods in all communities. This reveals the vulnerability of these households in order to maximize the opportunities offered by technological innovations. These results also show that households are not homogeneous in rural areas. This diversity forges differentiated dynamics and trajectories of development support.

Vulnerabilite state

Satisfying caloric intake needs is important, but it is not the only criterion for assessing the risks of food insecurity. The analysis of the state of vulnerability calls for a multiple dimension that reflects the capacity of populations to meet their food, health and endowment of equipment and durable goods needs. The results in Table 13 show a leveling of situations in the two households' group. The proper consideration of the capacity to meet health needs and the level of satisfaction of the needs of durable goods reduce the level of vulnerability of households. Thus, households at risk in the study area dropped from 52% to 43%. Overall, households at risk for meeting their calorie needs benefit by taking into account leveling in the management of health needs. Under these conditions, they ensure a less vulnerable level of global situation. This leveling affects much more the category of average households, which register an increase of 28% with all criteria of vulnerability, while it represents 21% in the satisfaction of consumption food needs. At the community level, the state of vulnerability has fallen sharply with the inclusion of the other components. The leveling of the situations has contributed to the decline in households at risk of non-target and target households. At the level of beneficiary households, those at risk decrease by 47 to 40% or by 15% (Table 13). Less than a third of households are at risk in meeting health needs. Good coverage of the consumption needs of the majority of beneficiary households (53%) and durable goods (51%) has improved the overall level of food security. This leveling affects much more the category of average households, which register an increase of 24%. Thus, average households meeting all criteria represent 29% of beneficiary households while they were 22% with the sole criterion of satisfaction of food consumption needs. The contribution of improved income from rice production has had a significant impact on the leveling of this situation. The very high level of satisfactory household has not changed and remained represented by 31% of households.

Table 13: Level of household vulnerability between target and non-target households.

Overall	Cons Calorie	Health	Dowry. Resources	Weighted criteria	Actual level satisfaction
% Low satisfactory	52%	28%	50%	4,72	43%
% Relatively satisfactory	21%	37%	29%	3,11	28%
% Very satisfaying	27%	35%	21%	3,17	29%
Weighting coefficient	5	4	2	11,00	100%
Non-target households	**Cons Calorie**	**Health**	**Dowry. Resources**	**criteria weighted**	**Actual level satisfaction**
% Low satisfactory	57%	30%	50%	5,05	46%
% Relatively satisfactory	19%	36%	27%	2,93	27%
% Very satisfaying	24%	34%	23%	3,02	27%
Weighting coefficient	5	4	2	11,00	100%
Target households	**Cons Calorie**	**Health**	**Dowry. Resources**	**criteria weighted**	**Actual level satisfaction**
% Low satisfactory	47%	26%	49%	4,37	40%
% Relatively satisfactory	22%	38%	31%	3,24	29%
% Very satisfaying	31%	36%	20%	3,39	31%
Weighting coefficient	5	4	2	11,00	100%

Source: ISRA, 2018.

In the non-target households, the situation of households at risk also fell sharply. From 57% in terms of meeting food consumption requirements, they are currently readjusted to 46% with all the other criteria. Although there is progress, almost half of the non-target households remain vulnerable. They were more affected by the high level of households at risk in consumption needs (57%). In addition, 50% of non-target households have very little equipment and durable goods. The slight increase is largely attributable to health needs coverage issues for 70% of households. The provision of resources to address health needs has improved the level of household vulnerability. In both communities, levelling is done from the compression of at-risk households to the benefit

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of households moderately satisfied with their food security needs. The coverage rate of health needs contributes to the relative decline in the vulnerability rate. However, the risk rate remains high for the endowment of durable goods because half of the households in the study area are not immune to the crisis effects. The ownership profile of capital and durable goods tradable in a crisis is vulnerable in both communities. This shows the need to strengthen programs to support rural equipment.

Conclusions and Recommendations

The results of this study showed that households by community are at varying degrees of satisfaction with food security. With the introduction of Korean technological innovations, recipient households have been able to increase their level of yield, production and rice income. This has reduced the level of vulnerability to food insecurity. It emerges gain of 364 kcal / UEA / day of beneficiary households. The latter benefited greatly from the rice productivity gain induced by the project to improve their food consumption needs from crops and incomes. Thus, the level of households at risk decreased by 10% with an improvement in the living conditions of moderately satisfactory food consumption households. The level of project-induced rice production and income has enabled beneficiary households to improve their level of food consumption and health needs coverage. This is not accompanied, however, satisfactorily by the endowment of durable goods, which may serve as a palliative for cyclical crises. Thus, these goods can be sold for the acquisition of consumer goods or as incentives for increased rice productivity. The majority of targeted as non-target households lack durable goods. While it is recognized as necessary (e) facilitating access to technological innovations to drive productivity momentum for the rice sector, it is also crucial to improve the potential for equipment and other incentives for local wealth creation. The State must intervene to reverse the trend (access to inputs, basic infrastructure, credit (for self-financing) and equipment...).

In addition to political reforms, a long-term solution to food and hunger issues will depend, to a large extent, on agricultural, agro-food research successes, and farmer empowerment. Significant increases in spending on research and technology transfer will be required. Improving the technical coefficients of rice production should be a priority in order to increase the availability of producers' resources. Increasing rice productivity through access to technological innovations is a fundamental aspect of the combating against food insecurity. However, beyond technical aspects, food security levers must also be based on the promotion of incentives to strengthen factor endowments. Investments in basic social factors (access to health posts, market, credit, etc.) are prerequisites. This will participate to the contribution of an environment conducive to development, the creation of rural jobs and opportunities, therefore, the fixation of populations at the level of their terroir. The territorial nature of most of these policies does not take into account local development dynamics and trajectories. The results of this study on the existence and the level of vulnerability of rural households are an issue in the formulation of homogeneous and appropriate policies and development hubs.

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