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# Impact of Marketing Contracts on the Rice Yield of Senegal River Valley Producers



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## Abstract

Rice is a strategic commodity for Senegal. However, local supply covers only 20-30% of domestic demand. The paradox is that this local rice has difficulty being marketed. Thus, agricultural marketing contracts could be an excellent lever to address this problem of rice marketing. The purpose of this study is to analyze the impact of these agricultural marketing contracts on the performance of producers in the Matam region using the LATE/LARF method. The data was collected in the Matam region in 2016-2017. The average local effect of treatment (LATE) has reduced the selection bias generated by observable and unobservable characteristics. The results of the estimate of the impact of the agricultural contract on the income of rice producers show that the participation of producers in the agricultural contract has increased their yields by about 2305.31 kg and income to 219,527.5 FCFA. The study allowed us to affirm that agricultural marketing contracts represent a resilient system of rice marketing in the Senegal River valley, as they can be a lever to link all the rice value chain's stakeholders, for the benefit of everyone, especially small producers.

**Keywords:** Impact; Agricultural marketing contracts; Rice; Yield; LATE; PRODAM

## Introduction

With an estimated annual consumption of 90kg per capita (CIRIZ, 2018), rice is a strategic commodity in Senegal. Despite its importance in the national economy and in household food consumption, the country is forced to resort to imports to meet domestic demand, which is growing due to the dual effects of urbanization and population growth. Critical analysis of the local rice value chain in Senegal has highlighted the fragmented organization of the Value Chain, which limits the effective transfer of relevant information (market signals); provides weak incentives for agglomeration strategies and an improved quality product and limits importer engagement (Fall, 2018). The major constraint of the value chain of rice is related to the difficulties related to the marketing of local rice. On the one hand, due to poor sales, producer unions for the repayment of the input credit hold large stocks of paddy. At the same time, the rice millers do not have access to the paddy and so do the traders for lack of means. Vertical coordination constraints indicate that the value chain is atomized and dominated by the informal (idem, 2018). This showed the paradox of local rice in Senegal, whose total production covering only 20-30% of demand is struggling to be marketed. There are many uncertainties and risks despite high levels of performance. This

leads to a self-sustaining orientation of producers to manage risk (low and intermittent sales volumes) with low contractualization between sellers and buyers resulting in insecurity on both sides of the players who are interdependent. All of this indicates that marketing is one of the weakest links in the Value Chain and that processors are "restricted" to service delivery.

Since 2014, with the rice self-sufficiency program, the State and donors have introduced incentives to restructure the rice value chain in five main issues. The first one concerns the establishment of a national marketing platform for local rice involving importers who should buy first local rice before being authorized to import. The second issue is the establishment of a National Economic Development Bank (BNDE) to finance activities, including post-harvest and rice fields. The third issue is to upgrading processing industries for quality rice with subsidized state funding through LocAfrique (MAER, 2017). With USAID/Nataal Mbay supported program, it is introduced a third-party detention program with for the ease of the flow of paddy with the tripartite contract between the Farmers' Union, rice millers and the Bank-CNCAS. Finally, it is the introduction of warehouses by the State facilitating the storage of good quality paddy (MAER/PNAR, 2017). The lack of small hold

farmers' support requires a restructuring of the stakeholders and their level of involvement in the marketing of local rice. The assumption is that with contracting, producers and traders ensure the security of supply and demand. The functionality of the value chain revolves around an efficient and efficient marketing system that would best manage the costs of organization, production, collection and processing, distribution and financial transactions. A standardized marketing system where excess quality on the commercial product and on the fluidity of the operations associated with it is awarded. A parallel system that will create the conditions for arbitration, readjustment and balancing of the main system in terms of the equitable distribution of the surplus of added value, and thus better organize the sector and guarantee an advantageous price that would improve the well-being of rice farmers and reduce the import bill. It is precisely at this level where participation in contract farming becomes interesting for farmers who face enormous difficulties in the flow of their production. This justifies the need to capitalize on the contractual arrangements between stakeholders and on the improvement of local supply. The objective of this study is to assess the impact of contractual arrangements on the productivity of rice farmers in the Senegal River Valley.

## Methodology

### Echantillonnage

The data used in this study come from a survey carried out by the research consortium formed by Gaston Berger University (UGB), Assane Seck University in Ziguinchor (UASZ) and the Senegalese Institute for Agricultural Research (ISRA) in 2016-2017. The survey covers three agroecological areas in the Matam region (Middle upper valley of the Senegal River) that are Ferlo, Diéri and Walo. In the context of data collection, a multi-degree sampling technique was used. In the first degree, it is the villages chosen based on their representativeness in relation to the ecology and cultural practices of the area. Within each village, households were randomly drawn. A sample is made up in each agro-ecological zone in order to have a representative size. A statistical power of 80% and a degree of significance of 5% are retained for all three zones. The selection of villages was random: 16 villages benefiting from the Matam Agricultural Development Project (PRODAM) and 16 other non-beneficiaries are retained in ferlo. In Diéri, 13 PRODAM-supported villages and 13 other unsupported villages are drawn. As for the Walo, 18 PRODAM beneficiary villages and 18 other non-recipients are selected. Thus, this study covers a total sample of 981 agricultural households, after the purification of the base.

### Method of Analysis

The impact and adoption of marketing contracts on rice are estimated with the average treatment effect (ATE). Under this model, everyone has potentially two rated results  $Y_1$  and  $Y_0$  depending on whether they are treated or benefiting from a

marketing contract ( $A=1$ ) or not benefiting from a contract ( $A=0$ ). The causal effect of contract participation for an individual ( $i$ ) is the difference between  $Y_1$  and  $Y_0$

$$\Delta_i = Y_{1i} - Y_{0i} \quad (1)$$

However, in the evaluations, we are faced with a problem of missing data. In other words, when a change in behavior changes, we can no longer observe what the different results would be without the change. Similarly, if the change does not occur, the impact assessment cannot be observed in the case of the impact assessment if the change had taken place. The effect of participation is unobserved and heterogeneous (Pariénté, 2008; Fern, 2010). We are therefore faced with a missing data problem or counterfactual (Rubin, 1977). In addition, there is the selection bias caused by the fact that the results are not independent of treatment [2] (Heckman, 2010). When a producer decides to participate in a contract ( $A_1=1$ ) if ( $Y_{1i} > Y_{0i}$ ). This means that his expected income will be higher than his actual one. This is a decision that is partly in the realm of rationality that deserves to be considered if non-biased estimates are to be produced (Fern, 2010).

The result observed for a person,  $Y_i$  assuming that the results  $Y_0$  and  $Y_1$  are defined for the entire population and that they are also independent through individuals so that there are no interactions between agents (Heckman and Vytlačil, 1999), can then be expressed as follows:

$$Y_i = A_i Y_{1i} + (1 - A_i) Y_{0i} \quad (2)$$

Moreover, for everyone, we will only be able to observe one of the situations but never both. The statistical solution replaces the impossible-to-observe causal effect of the treatment on a specific unit with the possible-to-estimate average causal effect of [the treatment] over a population of units (Holland 1986). The treatment effect (ATE) is defined:

$$\Delta^{ATE} = E(Y_{1i} - Y_{0i}) \quad (3)$$

To avoid selection biases, the local mean effect (LATE) method is used. In this research, the local instrumental variable (LIV) approach was used to identify and estimate (LATE). In the case of agricultural contracts, each farmer anticipates the yield he would get with or without the participation. From this point of view, participation in a contract is voluntary generating what is called self-selection. In this case, we are faced with the problem of selection bias and endogeneity (self-selection) of the participation status variable, Imbens and Angrist [3] use the instrumental variable (VI) to eliminate both the bias induced by observable and unobservable characteristics and to treat the problem of endogeneity of the treatment variable. These methods assume the existence of at least one variable that explains treatment status. The role of this instrumental variable is to introduce an exogenous variation into the treatment variable by proposing a

causal interpretation [4]. Thus, it will be a question of finding a variable Z that meets two conditions:

**Condition of monotony**

1. Z is correlated with A:  $\text{corr.}(Z, T) \neq 0$  ---Z and A are correlated, or Z predicts a portion of A. This means that there is no disobedient, either there are no households undergoing treatment and not obeying the application of the instrumental variable.

**Condition of exclusion by restriction**

2. Z is not correlated with  $\epsilon$ :  $\text{corr.}(Z, \epsilon) = 0$  ---In itself, Z has no influence on Y. The only way it can influence Y is because it influences A. All the effect of Z on Y passes through A. The variable Z chosen in our case is belonging to a Peasant Organization.

**Results and Discussions**

**Socio-economic characteristics**

The average age remained almost constant, among both participants and non-participants in agricultural contracts, with 52 years among non-participants and 53 years among

participants. This reflects the maturity of the producers. The Pulaar ethnic group is the most common among producers in this area. Other ethnic groups are poorly represented. Household size is roughly the same in the two subgroups on average 8 people. It is 7.84 individuals for non-participants 8.11 for participants. The education level is very low among the surveyed producers (7.74% of contractors reached the primary level compared to 4.14% among non-contractors). In most of the sample, agriculture represents the main farmers' activity (78% of participants and 61% of non-participants). The difference between the two groups is statistically significant at 1%. Trade is the most common secondary activity among these individuals, whether or not they participate in agricultural contracts. This variable secondary-trade activity affects 53% among participants in agricultural contracts and only 38% among non-participants with a significant difference at the 1% threshold. In terms of capacity building, only 12% of non-participants compared to 18% of participants received agricultural training, and of these, 63% were trained in farming practices [5-7]. In the same vein, 34 % of contractors are members of farmer's union (OP). The latter variable has a very significant difference at 1%.

**Table 1:** Household Land and Material's Grants by Status of Agricultural Contract Participants.

Variables	Non-participants (average)	Participants (average)	Total	Test Difference
Cultivated area (ha)	4,51 (2,58)	3,42 (0,49)	4,19 (1,85)	1,09 (4,08)
Possession of agricultural equipment**	1,56 (0,004)	24,92 (0,03)	8,27 (0,08)	-23,35 (0,01)***
Bunds in the plot	8 (0,13)	94,73 (0,02)	93,02 (0,03)	-14,74 (0,08)*
OP has received assistance	49,27 (0,04)	51,78 (0,05)	50,4 (0,03)	-2,51 (0,06)

\*\* The agricultural equipment consists of tractor, mill, store storage, well, depending on the household's possession.

Table 1 presents producers' land and equipment allocations to improve their agricultural productivity. On average, participants have 4.5 hectares of cultivated land and non-participants have 3.2 hectares of cultivated land. For possession of agricultural equipment, the group of non-participants does not have enough of it compared to that of the participants (24.92% of participants versus 2% of non-participants); this reflects a significant difference at 1%. The same impression is observed with the presence of dikes in the plots, 95% of participants have dikes in their plots compared to only 8% among non-participants, with a slightly significant difference at the 10% threshold.

Table 1 also highlights the status of membership in a producer organization. The presence of producers is a characteristic feature of the valley's producers, which provide them with access

to technical research and extension services, NGOs and other partners. This also allows access to collective credit. In this study, only 52% of the producers surveyed were affiliated with OPs among participants compared to 49.27% of non-participants. The difference is not statistically significant. This shows the vulnerability of these farmers to access key basic services [8-10].

**Determining factors in contract participation**

The overall analysis of the table above reveals the existence of three (3) variables, exerting some influence on participation in agricultural contracts, with significant differences of 1% or at the 5% threshold. These factors include the gender of the household head, the level of his education (no education, primary level, and Koranic study), and his ethnicity (Pulaar). They are the most important factors in producers' participation in agricultural

contracts. These are essentially variables that affect the likelihood of treatment (participation in agricultural marketing contracts). The level of education (primary) and ethnicity (Pulaar) variables are positively significant at 5% threshold. The marital status variable (Married) is negatively significant at the 10% threshold. Referring to the values of the marginal effects of each variable on the probability of participating in agricultural contracts (Table 2), we note that the sex variable (man) has the best performance (0.20). It is followed by the variable Education level (primary) with 0.14; the variable Ethnics (Pulaar) represents 0.12. Finally, the variable Marital Status is -0.10.

The major lesson is that the fact that the producer is a man increases by 20% the probability of participating in a marketing contract (Table 2) with a very significant difference ( $P < 0,001$ ). Similarly, the level of education at least primary is crucial to the adoption of contracts with a marginal effect of 14%. The Pulaar ethnic group is also decisive with a significant difference of less than 5%. The head of the household should be male to be more able to make some rather risky decisions, have a minimum level of education that would be used to understand the attributes of the contract and certain procedures for verifying the system. The results show that married householders are more reluctant to participate in agricultural contracts. This is understandable because they are more vigilant about taking risks that could

affect the survival of the entire family. This could explain the negative result of this variable. Table 3 shows the variables most determining the instrument chosen (membership of a Peasant Organization). All variables have a positive significance on this instrument, at the threshold of 1% (ethnic group, age, level of education of the household head). However, the gender issue (male) and sex are significant at 5%. Moreover, in referring to the marginal effects we observe almost the same remarks as with the determinants factors of participating in agricultural contracts. The education level (primary) variable accounts for a preponderant share (0.31) which shows that the higher the level of education, the greater the chance of participating in certain decision-making bodies such as the Peasant Organizations. The understanding of the phenomena that surround us becomes more evident. Belonging to the Pulaar ethnic group also has the same characteristics (0.24), however this can naturally be explained by the fact that most of the study population is Pulaar, as well as by the fact that the head of household is male (0.13). The choice of the variable (membership of a Peasant Organization) as an instrument to find the LATE was encouraged by the fact that the grouping of populations around bodies could be a good way to get access to information, to extension services as to better understand what agricultural contracts really are and how their adoptions could be beneficial.

**Table 2:** Estimates for Determinant factors to Participation in Agricultural rice Marketing Contracts.

Participation in agricultural contracts (T2)	Coefficients	Standard Deviation	P> z	Confidence Interval 95%	Marginal Effect
Sex (Male)	0.76	0.21***	0	[0.35; 10.16]	0.2
Ethnicity (pulaar)	0.39	0.18**	0.032	[0.03 ;0.51]	0.12
Religion (Islam)	-0.53	0.88	0.55	[-2.27; 1.21]	-0.2
Marital status (married)	-0.28	0.19*	0.1	[-0.67; 0.09]	-0.1
Age of head of household	0.003	0.002	0.32	[-0.002; 0.008]	0.0009
Education level (primary level)	0.38	0.18 **	0.03	[0.04; 0.72]	0.14
Log likelihood			-632.75		
Observations			1076		
LR chi2(10)			28.01		
Prob > chi2			0.0001		
Pseudo R2			0.0217		

NB: STd. Err are in brackets. \*The significance of the difference at the 10%, \*\*at the 5% threshold, and \*\*\*at the 1% threshold.

**Table 3:** The Determinants of the Instrument: Membership of a Peasant Organization.

Variables	Coefficients	Standard deviation	P> z	Confidence Interval 95%	Marginal Effect
Sex (male)	0,34	(0,18)**	0,056	[-0,009; 0,698]	0,13
Ethnic (Pulaar)	0,65	(0,17)***	0,000	[0,32; 0,99]	0,24
Marital status (married)	-0,21	(0,18)	0,25	[-0,56; 0,15]	-0,08
Age of head of household	0,008	(0,002)***	0,001	[0,004; 0,019]	0,003
Education level (primary)	0,81	(0,18)***	0,000	[0,45; 1,17]	0,31
Log likelihood	-715.05				
Observations	1076				
LR chi2(9)	49.88				
Prob > chi2	0.000				
Pseudo R2	0.0337				

NB: STd. Err are in brackets. \* The significance of the difference at the 10%, \*\*at the 5% threshold, and \*\*\*at the 1% threshold.

### Impact of contracts on performance

Table 4 presents the results of the average impact of agricultural contracts, naively, on producer yields of 470 observations out of an estimated overall total of 981 observations. All parameters show a very significant difference at 1%. The study shows that the average performance achieved by participants is better than that of non-participants. It is for 2294.23kg/ha respectively against 1091.42kg. This indicates an average impact difference of 1202.81kg/ha. However, this naïve estimate suggests a large selection bias (PSB) estimated at 44% (Table 4). In order to eliminate as much as possible from the selection bias that is,

in part, due to the existence of unobservable characteristics, the LARF/LATE parameter is estimated. Its estimate shows that the impact of the participation of the compliers in agricultural contracts has an impact equal to 2305.31 kg on the yield of the rice producers. This represents a significant impact (over 2.3 t/ha) on the overall yield of rice producers in the Matam region who are below the valley average yield of 6.5 t/ha [1]. The results show the positive impact of agricultural contracts on the incentive to increase yields. This will have to be generalized in order to allow producers to better manage their production capacity and thus provide a substantial return because it is guaranteed in advance by the existence of a market.

**Table 4:** Results of the Impact of Participation in Agricultural Contracts on Yield.

Performance	Coefficients	Standard deviation	P> z	Confidence 95%
MCO LARF (LATE) Method				
LARF / LATE	2305.31	217.41***	0	1879.19; 2731.43
Naive method				
Difference	1202.81	240.29 ***	0	731.84; 1673.78
Participants	2294.23	200.11***	0	1902.03; 2686.43
Non-participants	1091.42	133.04***	0	830.67; 1352.18
PSB	-0.44	0.03	0	-.52; -0.37
Observations	981 including 470 Participants			

NB: STd. Err are in brackets. \* The significance of the difference at the 10%, \*\*at the 5% threshold, and \*\*\*at the 1% threshold.



### Impact of contracts on rice farmers' income

The impact of rice producers' participation in the Matam region in agricultural contracts on income is shown in Table 5. With the LARF method, participants have an impact of 219,527 FCFA with a significant difference. With the naïve method, there is a negative sign of selection bias, both in estimating annual yield and the overall annual income of rice producers. The first explanation would come from differences in observable and unobservable characteristics between individuals in the study population (economic and material allocations) as well as the different characteristics of the study population. The supervision of individuals on agricultural contracts has multiplier's effects.

There are situations where there are non-participants in coaching training who benefit from the information and benefits of this training through the rub with of their relatives or friends who have indeed participated in training on agricultural contracts. Thus, it benefits almost as well as those who participated in them, and this represents an important point that can induce the existence of selection biases, in favor of non-participants in agricultural contracts and training on these agricultural contracts. On the other hand, the existence of large producers in the study population may also contain disparities in the ability of producers to appropriate good yields. Sometimes we find ourselves in situations where there is a large presence of producers with the means and skills to ensure an excellent annual production.

**Table 5:** Results of the Impact of Participation in Agricultural Contracts on the Income of Rice producers in the Matam region.

Total income	Coefficients	Standard deviation	P> z	95% Confidence Interval
MCO LARF (LATE) Method				
LARF / LATE	219 527.5	49132.57***	0	123229.4; 315825.6
Naive method				
Difference	-9 729 419	2 525 294***	0	-1.47e-07; -4779934
Participants	9 719 202	1 932 463***	0	5931645; 1.35e-07
Non-participants	1.94E-07	1 625 638***	0	1.63e-07; 2.26e-07
PSB	-0.37	0.03***	0	-0.44; -30
Observations	981 including 470 Participants			

NB: STd. Err are in brackets. \* The significance of the difference at the 10%, \*\*at the 5% threshold, and \*\*\*at the 1% threshold.

It is clear from most rice stakeholders, particularly importers, are committed to getting involved in the distribution of local rice so that the market is more transparent with the efficient transfer of information. The main stakeholders have a real-time need for information on availability of the offer and its quality (humidity, type of variety). Then follow the location of the rice, and the transaction price. For producers, solvent demand information is their main interest, while traders focus on the availability and quality of rice. All actors (93% of respondents) are also interested in types of contracts to secure good quality demand and supply. However, they differ on the content or attributes of the contract (quality agreement, type of control, pricing modality, payment method, etc.).

### Conclusion and Recommendations

The study revealed very interesting results in terms of yield growth (2305.31kg) and incomes to the level of 219,527.5 CFA francs from rice producers in the Senegal River Valley. Rice cultivation should be done under secure conditions by contracts guaranteeing both the producer of income and ensuring the availability of rice for the trader. There is no point in increasing production without assured marketing. The use of these agricultural contracts should be widely generalized in agriculture,

particularly in the cultivation of rice. Ideas should focus on ways that might be able to meet the challenge of contracting by making attributes (duration, pricing, and payment, etc.) more attractive to small producers. However, it requires considerable efforts to meet conditions regardless of the likely fluctuation of crop prices.

Efforts must be made on the part of the government to support the producers of the Senegal River valley in storage stores, roads and other basic infrastructure so that they can ensure a certain quality (nutritious, clean, productive and resistant) and thus enable traders to meet consumer demand. Traders also need reliable information on stocks (quality, humidity, etc.). This will further strengthen the mutual trust of the two actors. It would also be necessary to raise awareness among stakeholders about the mutual benefit of contracts between actors. All these market needs should be generated by a market information platform in a known frequency and appropriate mode of dissemination. This requires the establishment of a device in partnership with a private structure specializing in the marketing of agricultural products via the networks and web services applied.

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