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Effect of Fertilizer Subsidy on Rice Production in Tillabery Region of Niger: Propensity Score Matching Analysis

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Abstract

This study is devoted to evaluation impact of the fertilizer subsidy on rice production. It's divided into two stages: determining the observable characteristics influencing the adoption of subsidized fertilizers and determining the effect of the fertilizer subsidy on rice production. We used a logit and two algorithms of the propensity score matching method to know: (i) the nearest neighbor and (ii) the kernel. The effect of fertilizer subsidy on rice production was measured by the difference between the average effect of the treated group (beneficiaries of the subsidy) and that of the control group (not beneficiaries of the subsidy).

The data used is primary data. They are based on a survey in the Tillabery region nearby rice producers. This survey provided the characteristics information of the different households in 2017-2018 crop years. The sample size is 200 households whose, 51 beneficiaries of the fertilizer subsidy and 149 non-beneficiaries. The results obtained from study; show that the fertilizer subsidy increases the productivity of rice by 453.82 kg ha^{-1}. The variables such as: improved seed, sex, area influence the adoption of fertilizer subsidized.

Keywords: Subsidy; Fertilizer; Production; Rice; Niger

Abbreviations: PSM: Propensity Score Matching.

Introduction

Agriculture is in the heart of the economic development in the countries with low income where crushing the majority of the inhabitants draws her subsistence from the exploitation of the ground. Rice growing occupies the second place of the world production of cereals, after the corn [1]. In Niger, in the point of view of Sido, et al., [2], rice constitutes third cereal after the millet and the sorghum as well from the point of view of the surface production.

The rice consumption knew vertiginous progress. It was estimated enters 14 and 18 kg per annum and per capita including 3 and 5 kg of local rice (World Food Program, 2004). But since the results of the investigation Budget/Consumption the rice consumption was evaluated respectively to approximately 81.15 kg per annum and

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per capita for local rice and 41.27 kg per annum and per capita for imported rice, that is to say a total of consumption of almost 41.352 tons of local rice and 207.467 tons of imported rice [3, 2].

Considering the important due need for no satisfied rice consumption by the local production, it is necessary to create the conditions of intensification of the production to decrease the rice importation. For all develop the agricultural sector, there exists a broad consensus on the fact that higher rates of use of artificial fertilizers are necessary to increase the agricultural productivity [4]. On the other hand, the use of artificial fertilizers in Saharan Africa Sub was weak [5-8]. Vis-a-vis these various policies, several authors (quoted low) evaluated the impact of the subsidy of the agricultural input in particular fertilizers. The researchers, who were interested in the study, had divergent positions.

Authors like Zerbo and al., [9], showed in Burkina Faso the subsidies of artificial fertilizer have a positive impact on the production of rice. They used the General Micro-simulated Calculable Model. Holden and Lunduka, [10] in a study in Malawi showed that there was a significant positive tendency of the maize outputs from 2006 to 2009, following the program of subsidy by using the data of panel. Holden and Lunduka, [11] estimated the impact of the mineral fertilizer subsidies on the use of the organic fertilizer in Malawi. These authors showed that the households profiting from subsidized fertilizer have an output more raised than no-recipients. Chibwana, et al., [12] found positive correlations and statistically significant between the participation in the FISP and the agricultural output in Malawi by using several sets of panel data and a strategy of instrumental variable regression.

Adedeji et al., [13] undertook a study to combine the information of manure with a bio-economic model to explore the profitability of nitrogen on the production of rice in Nigeria. Adedeji et al., [14] made a study which concentrated only on rice but confirms the results of Liverpool-Tasie et al., [15] for Maize and Liverpool-Tasie et al., [16] on the sorghum raises questions suitable for affect the use of manure for other cultures. However, Liverpool-Tasie et al., [15] showed that, the modern input such as manures generally increase the average and the variance of the net yields production. Moreover, the studies made by Chirwa, [17] and Ricker-Gilbert and Jayne, [18] announced weak increases in the agricultural income of households coming from the input subsidies program.

Ricker-Gilbert, [18] made a study on the impact of the subsidy program of fertilizer on the supply agricultural work, the labour demand, and wages standards in Malawi. With through this analysis it notes that the program of subsidy has a weak negative effect on the work supply of the households, and a light positive effect on the work demand. Liverpool-Tasie, [19] used the data of the district of Kano in Nigeria and has the results on the subsidy target group. She finds that, the farmers who take part in the subsidy program will tend to being poorer than no participants.

Vis-a-vis the controversies results of the several studies on the impact of fertilizer subsidy on the agricultural output and poor yield of rice, it is significant to know the effect of the fertilizer subsidy on the rice production in Niger what shows that, the choice of our study topic is in actuality today.

The principal objective of this study is to measure the impact of fertilizer subsidies policies on the rice production in Niger. In a specific way, to analyze:

a) The effect of the area's production on the adoption of fertilizer subsidy
b) The effect of fertilizer subsidy on the local rice production
c) These specific objectives make it possible to postulate two following assumptions
d) The area's production influences positively the adoption of fertilizer subsidy
e) The fertilizer subsidy has a positive effect on the rice production in Niger.

Methodology

We expose in this part the impact evaluation method and the raisons of their choices.

Impact evaluation method

This part is devoted to the development of the canonical principle of Rubin framework and the specification of the pairing method.

Principe of the canonical framework of Rubin: The canonical model of the evaluation was introduced by Rubin [20]. The principal assumption of this method indicates the only difference between the treated households and untreated is resulting from their individual characteristics and the treatment. If one neutralizes the differences according to characteristics', then there remains only the effect of the treatment. This treatment is represented by a random variable T which takes value 1 if household profited the fertilizer subsidy

and 0 so not. The effectiveness of the program is measured by two latent variables of result Y1i and Y0i respectively the value of the variable of result if T=1 and if T=0. These two values correspond to the potential impacts of the fertilizer subsidy. They are not simultaneously observed for the same household. For a treated household (profited household), Y1i is observed while Y0i is unknown. In this case the Y0i variable corresponds to the result which would have been carried out if the household were not profited from the subsidy (the counterfactual). For a household untreated (household not profited from the subsidy), one observes on the contrary Y0i, while Y1i is unknown.

The variable of result observed, for each household, can thus result from the potential variables and the variable of treatment by the following relation, established by Rosenbaum and Rubin, [21].

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

Only the couple (Y_i, T_i) is observed for each household. The causal effect of the subsidy is defined for each household by:

$$\Delta_i = Y_{1i} - Y_{0i} \quad (2)$$

Thanks to assumptions on the law joined off, (Y_0, Y_1, T), one can identify certain parameters of the distribution of the causal effect starting from the density of the observable variables (Y, T). Consequently, the fact of estimating the effect of the subsidy for each profited household will not be possible and one must focus oneself on the average effects of this reform. Two parameters are the subject generally of a specific examination:

a.the average effect of the treatment in the population

$$\Delta^{ATE} = IE(Y_1 - Y_0) \quad (3)$$

the average effect of the treatment in the population of the recipients

$$\Delta^{ATT} = IE(Y_1 - Y_0 \mid T = 1) \quad (4)$$

Under assumptions of identification, these two parameters are equal. In particular, if the variables of result are independent of the variables of access to the treatment. Indeed, if this sufficient condition is satisfied, then:

$$\Delta^{ATE} = \Delta^{ATT} = IE(Y \mid T = 1) - IE(Y \mid T = 0) \quad (5)$$

But, if the property of preceding independence is not satisfied, it is more probable only the elements which determine the decision of treatment determine also the variable result. Thus the results of the households of the group of treatment and control will differ even in the absence from the reform. What leads to a bias of selection? This bias of selection is such as:

$$IE(Y \mid T = 1) - IE(Y \mid T = 0) = IE(Y_1 \mid T = 1) - IE(Y_0 \mid T = 0) \quad (6)$$

$$IE(Y \mid T = 1) - IE(Y \mid T = 0) = IE(Y_1 \mid T = 1) - IE(Y_0 \mid T = 1) + IE(Y_0 \mid T = 1) - IE(Y_0 \mid T = 0) \quad (7)$$

$$IE(Y \mid T = 1) - IE(Y \mid T = 0) = \Delta^{ATT} + B^{ATT} \quad (8)$$

Where B^{ATT} is the bias of selection? The origin of this bias comes owing to the fact that the average situation of the treated households would not have been the same one in the absence of the reform as that of the households not having received the treatment because these two populations are not identical.

Then, like the counterfactual average of the result of the treated households $IE(Y_0 \mid T = 1)$ is not observed, it is significant to choose a substitute in order to consider the effect average of the treatment on the treaties. With this intention, two assumptions are made: Assumption of conditional independence and the assumption of the common support.

The following part presents some methods evaluation of impact. Being given, that no method is perfect, it is always desirable to proceed by triangulation, design of the Experimental or Random Checking.

Propensity Score matching method: The score of propensity is the probability for an individual I of receiving a T=1 treatment knowing these characteristics [21]. Statistically, this method aims at balancing the distribution of the observable characteristics between the recipients and no recipients of kind to neutralize skew due to the difference in these characteristics and to preserve the effect suitable for the treatment (program).

This method is based on two assumptions: the assumption of conditional independence and the assumption of common support.

The assumption of conditional independence: This assumption stipulates that there are certain conditioned variables to which the results of the recipients Y_1 and no

recipients Y_0 are independent of the assignment of the treatment (program). Mathematically that is expressed: $(Y_1 Y_0) \perp T \mid X$. This assumption was introduced by Rosenbaum and Rubin [21].

The assumption of the common support : This assumption makes it possible to make sure that for each profit individual of the subsidy of manure, there are individuals in the group of no recipients having the same characteristics observed: 0 < p (T=1|X) < 1.

Approach control of the observables characteristics variables

There are several methods of control of the observable characters. We present in the continuation most current.

Estimator by pairing on the observable characteristics: Let us consider the average effect of the treatment on the treaties:

$$\Delta^{ATT} = IE(Y_1 - Y_0 \mid T = 1) = IE(Y - Y_0 \mid T = 1) \quad (9)$$

$$\Delta^{ATT} = IE(Y - IE(Y \mid X, T = 0) \mid \mathrm{T} = 1) \quad (10)$$

$$\Delta^{ATT} = IE_{x|T=1}(IE(Y_1 \mid T = 1, X = x) - IE(Y_0 \mid T = 0, X = x) \quad (11)$$

The final estimator of Δ^{ATT} is then obtained like the average of the variations of the treated households and the built counterfactual. The problem is thus to estimate for each household which profited from subsidy of the characteristics X_i, the quantity $IE(Y_0 \mid X = x_i, T = 0) = g(x_i)$. With this intention, it is enough to pair each household profited with households which have the same characteristics X_i (matching on the variables) or to make pairing while being based on the scores of propensity of the households of the two groups then to estimate $g(x_i)$.

Estimator by pairing on the scores of propensities

Rosenbaum and Rubin [21], solved the problem of dimension of the vector of characteristics by modifying the assumption of conditional independence. They suppose that: If the variable of result Y0 is independent of the access to the treatment T conditionally with observable X, then it is also independent of T conditionally to the score of propensity (X), which is the probability for an individual of being in the group of treatment conditionally a vector of variables observed: $Y_0 \perp T \mid X \Rightarrow Y_0 \perp T \mid P(X)$ where $P(X) = P(T = 1 \mid X)$

Because of this property, it is not necessary to pair the individuals on the individual variables of conditioning. It is enough to pair them on their score of propensity, which constitutes a unidimensional summary of the whole of these variables. The individual untreated noted i' which is paired with the individual treated i is then defined by $P(xi) = P(xi')$

Correction of the skews allotted to the observable variables: The procedure of ASP is done by using a logit or a probit to calculate the predicted probabilities of the treatment while being based on variables (co-variables) observable. The use of pairing by score of propensity requires some considerations with regard to the choice of the variables to be included and the algorithm of pairing. Moreover, certain tests must be carried out in order to make sure of quality of the pairing and Choice of variables.

Choice of the algorithm of matching : After the estimate of the score of propensity, the following stage in the implementation of Score Propensity Score Matching (PSM) is the choice of the algorithm. They exist several algorithms of matching to knowing: nearest close, the ray, the core and the stratification to quote only these.

Choice of the method

The great literature on the choice of the method evaluation of impact enables us to say that the method of matching per score of proportion is used by many researchers in the evaluation of impact. Indeed, this method is an option less doubtful than we can use to make this study taking into account nature of our data available and in the objective to have the most consistent estimators.

The following part will announce empirical analysis to us of the subsidy of manure on the production of rice.

Empirical Analysis of the Fertilizer Subsidy on the Rice Production

The part analyzes empirical is devoted to the presentation of the zone of study, the presentation of the sample, the prediction of the variables of the model and finally the specification of the model log it which will enable us to make pairing by score of propensity and to determine the observable characteristics of the households influencing the adoption of subsidized manure.

Presentation of the zone of study (Tillabery-Niger)

The area of Tillabery (or Tillaberi) is located at the south-west of the Republic of Niger. It covers a surface of 97,506 km2, that is to say 7.7 % of the country. Its climate is heat and relatively wet. According to the territorial cutting of 2002, the area of Tillabery is subdivided in 6 departments

themselves subdivided in urban and rural communes. This area is populated of 553,127 inhabitants [3].

The area of Tillabery is crossed by the river Niger, which gave him its characteristic of the area of rice growing. To this end, it is the locality in Niger, where rice growing is practiced, from where our choice of the area for the investigation.

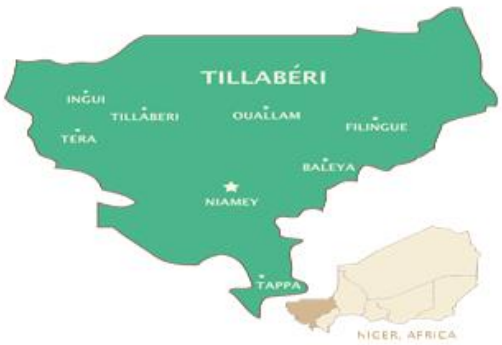


Figure 1: Tillabery region map.

Presentation of the sample

The sample that we use is from Agricultural Ministry with a size of 200 households. These households will constitute our data base. These data are of 2017/2018 agricultural season. They result from a survey which we carried out on banks of the Niger River, because it is in this locality where rice growing is developed in Niger. The data base comprises 51 recipients of the fertilizer subsidy and 149 not recipients, contains sociodemographic, economic and technological characteristics of the households. The sample is distributed between the four (4) communes as Table 1 shows it.

Commune	Téra	Tillabéry	Kollo	Say	Total
Sample	35	50	90	25	200

Source: authors from survey of agricultural ministry
Table 1: distribution of the households surveyed by commune in the area of Tillabery

Prediction of variables of the model

The variables of interest in this model are as follows: the productivity of rice, the fertilizer subsidy and rice area production.

While basing itself on the review of the literature we can specify our model. Indeed, this review will suggest us the relevant explanatory variables. The taking into account of the relevant variables is essential to eliminate skew in the regression. The omission of relevant variable can cause a situation of bias.

The variable of Model	Variables single	Awaited sign
Educational level of the household head (1 = informed, 0 = if not)	ninstru	+
Gender of the household head (1 = male, 0 = female)	sexmenag	+
Age of the household head (in years)	agemenag	-
The marital status (1 = married, 0 = if not)	etatmatri	+
Quantity of rice produced (in kg)	quatriz	+
type of the seeds (1 = selected, 0 = local)	typsem	+/-
Quantity of manure used (in kg)	quaeng	+
Emblavée surface (in hectare)	supemb	+
Income of households except rice growing (in FCFA)	revmenag	+
Subsidy of manure (1 = to profit, 0 = if not)	subveng	+
Experiment of head of household (in year)	expmag	+
Size of household	npcharg	+

Source: authors from the review of literature.
Table 2: summary of the awaited results.

Logit model

The specification of the model of probability supposes that, we condition the treatment by a latent variable (not observed Y_i^*). Let us consider β the vector of the coefficients associated with the explanatory variables and X_i the vector with the explanatory variables with i=1..., N (in our case i=1..., 200) the number of the individuals and $\in_i$ the term of error. Thus, the coefficients of the parameters are given as follows:

$$Y_i^* = X_i\beta + \in_i \quad (12)$$

Y_i^* is the decision to fertilizer subsidize

X_i a vector of the explanatory variables which can influence the decision to subsidize
β_i a vector of the coefficients associated with the explanatory variables
ε_i is the term of error
Let us suppose Y_i the probability of profiting from the subsidy with two possibilities (to be subsidized or not), Y_i takes values **0** and **1**. As Y_i is binary, the following relation is posed:

$$Y_1 = \int_{0 si Y_i^* = X_i\beta + \epsilon_i \leq 0}^{1 si Y_i^* = X_i\beta + \epsilon_i > 0} \quad (13)$$

Let us suppose what ε follows a logistic law, the function of distribution is given by:

$$F(x, \beta) = \frac{1}{1 + e^{-(x\beta + \varepsilon)}} \quad (14)$$

with the density of the logistic law:

$$f(x, \beta) = \frac{e^{-(x\beta + \varepsilon)}}{(1 + e^{-(x\beta + \varepsilon)})^2} \quad (15)$$

The estimate of the logit model is done using the maximum of likelihood ratio because it gives more robust and effective estimators.

The following part is devoted to the analyses of the estimate results of the various models; it will make it possible to check the assumptions of studies.

Results and Discussions

This part shows the descriptive analyses, the presentation of the results of estimate and the characteristics influencing the adoption of subsidized manures. The effects of the treatment of the subsidy of manure on the production of rice will be calculated with the method of pairing on score of propensity by using two algorithms to know: nearest close and the core. In end, the observable characteristics of the households influencing the adoption of subsidized manures will be determined by the marginal effects, calculated with resulting from a logit.

Descriptive analysis of the variables of the model

This part will be presented into two; the first part will present the descriptive statistics of the quantitative variables and the second of the qualitative variables of the model.

Descriptive statistics of the quantitative variables of the model: Table 3 shows that the average age of the head of household is 42 years. Smallest of these heads of the households, is 23 years old and oldest is 76 years. This result translates that inquired are adults. The household lays out on average 5.06 people. In addition the minimal size of the households is of 2 people whereas the maximum size is 32 people. These heads of the households have one year 40 years minimal and maximum experience. That gives us an average experiment by head of household a little more than 16 years. Moreover, the minimal surface devoted to rice growing is 0.1 hectares while the maximum one is 3.55 hectares; therefore we have on average 0.78 hectares per head of household. The income except rice growing of these households varies from 0 to XOF 150,000. In end, the produced quantity of rice varies from 110 kg to 3,000 kg, with on average 906.03 kg per head of household. The quantity of urea used varies from 20 to 1,300 kg, while that of NPK varies from 40 to 2,660 kg. These results show us that the quantity of NPK used is roughly the double of that of urea as indicates the INRAN (200 kg ha $^{-1}$ of NPK against 100 kg ha $^{-1}$ of urea).

	Average	Std. error	minim	max
Age household head (in year)	42.32	10.17	23	76
Size of Household	5.06	4.44	2	32
Experience of household head (in year)	16.79	11.13	1	40
Area of production (in hectare)	0.78	0.48	0.1	3.55
Not agriculture income (in FCFA)	6386.84	19,206.52	0	150,000
Quantity of rice product (in kg)	906.03	545.54	110	3,000
Urea (in kg)	99	125.38	20	1,300
NPK (in kg)	198.24	250.77	40	2,660

Source: authors, from data analysis
Table 3: Descriptive statistics of the quantitative variables of the model.

Descriptive statistics of the qualitative variables of the model: Table 4 following gives to us the report on the descriptive statistics resulting from the data of investigation.

Variables	Frequency (in %)	Effective
Fertilizer subsidy		
Subsidized	26	50
Not subsidized	74	140
Education Level		
Educated	27	52
Not educated	73	138
Matrimonial status		
Married	63	119
Not married	37	71
gender of the household head		
Male	79	150
Female	21	40
Type of seeds		
Selected	33	62
Locale	67	128

Source: authors, from the data analysis
Table 4: descriptive statistics of the qualitative variables of the model.

This table shows that 26% of the surveyed heads of household had the subsidy of manures against 74% which did not profit from the latter. Moreover, 27% of the surveyed population is informed and 73% are not it. The 79% of surveyed are male against the 21% female. In Niger the women become head of household in the event of divorce or the death of the husband what explains the low number of the heads of female household in the sample. The 33% of surveyed use seeds improved against 67% using the local ones.

Analyze quality of pairing by the score of proportion

The analysis of the quality of pairing requires the construction of a common support and the test of balancing on the observable characteristics of the groups of treatment and control [22]. With this intention we use the model logit to explain the use of manure subsidized by the observable characteristics of the rice growers.

Adoption of subsidized fertilizer : The model of the logit type used not only makes it possible to determine the observable characteristics influencing the adoption of subsidized manure, but also to satisfy the condition of balancing of the characteristics of the households using subsidized manure and those which do not use.

Let us have the results of the estimate by the model logit, which makes it possible to leave the bond between the explanatory variables and the use of subsidized manures.

Independents variables	Coefficient	Z
Education level (1= educated)	0.21	0.33
Gender of the household head (1= male)	2.68**	2.49
Age of the household head (in year)	-0.03	-0.93
Matrimonial status (1= married)	-1.48**	-2.13
type of seeds (1= subsidized)	3.60***	5.19
Production ; (in hectare)	-3.30**	-2.40
Production area in square	0.80	1.51
Not rice production income (in FCFA)	1.3e-05	1
Experience of household head (in year)	0.04	0.50
Size of household	0.11	1.47
Constant	-2.99	-1.62
LR Khi-deux (10) Prob > chi2 Pseudo R square	136.87*** 0.0000 0.6027	

*** Significant at 1%; ** significant at 5%; Source: authors, from the data analysis
Table 5: Result of logit model (Variable dependent = fertilizer subsidy).

This Table 5 has the results of the estimate of the adoption of subsidized fertilizer.

The model is adequate because calculated Khi-square (136.87) is higher than theoretical Khi-square which is 23.209. Indeed, we cannot accept the null assumption which stipulates that all the coefficients are null. Thus there is at least a variable which explains the probability of adoption of subsidized manure. To ensure itself of the validity of the results of estimate we used a test of prediction. The analysis of the prediction makes it possible to see the capacity of the model to predict the probability of D taking value 1 and 0. For the D=1 event we record 45 good predictions out of the 53 is a probability of 84.91%. For the contrary event D=0 we have 141 good predictions out of 147 is a probability of 95.92%. In a general way, the model is predicted with a probability of 93%.

The test of balancing makes it possible to test the equality of the averages of each variable selected of the group of the treaties and of group controls after pairing. This test is done using program of Becker and Ichino, [23] "pstest, both ".

The individual tests of the significativities indicate the type of improved seeds is significant to 1%, the production area and the marital status are significant to 5%.

Decomposition of the marginal effects of fertilizer subsidized adoption: We present in this section the marginal effects of the adoption of subsidized manures, to see elasticities of various characteristics of the households on the action to adopt subsidized manure (Table 6).

Independent variables	dy/dx	Z
Education level (1= educated)	0.016	0.31
Gender of the household head (1= male)	0.12***	2.70
Age of the household head (in year)	-0.002	-0.92
Matrimonial status (1= married)	-0.13*	-1.78
type of seeds (1= subsidized)	0.47***	4.28
Area of production (in hectare)	-0.24**	-2.23
Area of production square	0.05	1.48
Not rice production income (in FCFA)	9.52e-07	0.84
Experience of the household head (in year)	0.003	1.38
Size of the household	0.008	1.48

*** Significant at 1%; ** significant at 5%; * significant at 10%
Source: authors, from the data analysis.
Table 6: Marginal effects of adoption of subsidized manures.

The role of the socio-economic characteristics in the adoption of subsidized fertilizer

The sex of the head of household is positively significant to 1%, which wants to say the men are encouraged to adopt subsidized manure than the women of 0.12 point. That can be explained by the fact that the women are interested in the commercial activities. The marital status is negatively significant to 10%, therefore the married men are incited with the adoption of subsidized manure than the no married ones of 0.13 point. This result can be explained by the fact why the grooms exert other cultures of subsistence to satisfy the requirement in consumption for their families.

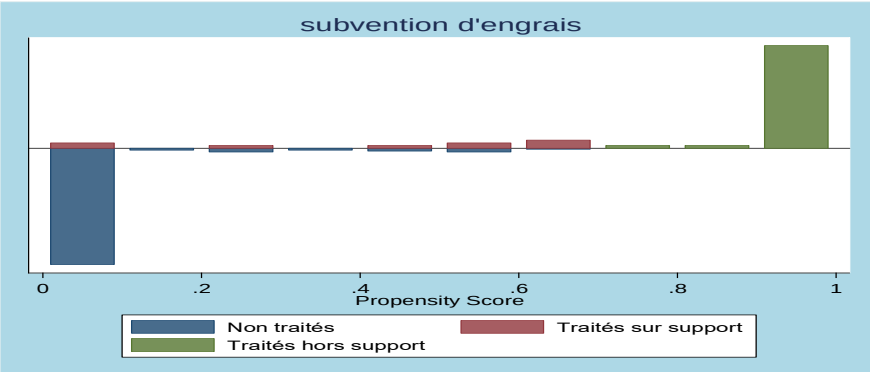
The role of the technological variables in the adoption of subsidized fertilizer

The type of seeds is positively significant to 1%, which implies the use of a unit of improved seeds increases the probability of adopting the subsidized manure of 0.48 point.

However, the production area is negatively significant to 5% implying the use of a unit of more than production area decreases the probability of adopting the subsidized manure of 24%. Moreover, the production area with square is positively nonsignificant that explains why there is not an effect threshold (the threshold from which this variable will have a positive effect). Consequently, more this variable increases more the adoption decreases. This

result is still explained owing to the fact that in Niger the subsidy is made by targeting population. Therefore, only the small producers profit from it. The estimate of the model logit will make it possible to estimate well the scores of propensity of the subsidy of manure in the following stage.

Distribution of propensity score for the fertilizer subsidy: Let us present the various scores of propensities on the common support to see the distribution in the optimal blocks (Figure 2).



Source: authors with the program "psgraph" for Leuven and Sianesi, [24].
Figure 2: Score of propensity for fertilizer subsidy.

This figure, presents the distribution of the scores of propensities in the common support for the treaties (on support and except support) and groups it untreated (the group controls). Indeed, the two distributions are on both sides determining line. The histograms have the same forms but with different sizes, that translated a good distribution of the scores of propensity on the common support. However, the common support is understood between 0 and 0.8 on the graph and that pairing starts from 0.0495589 (Table 7).

Table 7, shows us that on the whole 118 observations were retained, distributed as follows: 67 of the group controls and 51 of the treated group. In this study we take the average of the five (5) closer neighbors in matching as indicates us Ravallion, [25] to have the more robust estimates.

	Fertilizer subsidy		
Inferior Landmark of blocs	**Control group**	**Traited group**	**Total**
0.0495589	16	10	26
0.2	17	11	28
0.4	8	10	18
0.6	11	8	19
0.8	15	12	27
Total	67	51	118

Source: authors, from the results of the application of the "pscore" program.
Table 7: Distribution of the observations in the optimal blocks according to the group (treatment and control).

The test of balancing of the observable characteristics, using the order pstest both, makes it possible to test the observations before and after pairing finally to see the difference in their averages. The property of balancing is satisfied bus after pairing the test with equality is nonsignificant.

Result of the estimates of the average effect of the subsidy of manure on the production of rice: This part presents the estimates of the average effect of the subsidy of manure on the production of rice. However, we chose the following methods of pairings: pairing by the core and pairing by nearest close.

Table 8, comprises the results of the estimates of the pairings taken into account. In all the methods applied, the number of group of control is higher than the number of the households in the group of the treaties that will enable us to make a good pairing.

Rice production	n.treat	n.contr.	ATT	t.stat.
Propensity score matching by nearest neighbor	51	25	453.82***	2.67
propensity score Matching by kernel	51	115	434.40***	2.85

*** Significant at 1%
Source: Results of estimate starting from the data analysis,
Table 8: Result of the estimate of the effect of the subsidy of manure on the production of rice.
Where,
n.treat. =a number of the treaties;
n.contr. =numbers of control;
ATT = Average Traitment for Treated;
std.err = standard error;
t.stat = statistical test.

In this table, all the average effects of treatment are positive and significant to 1%. These results show that the subsidy has a positive effect on the production of rice. The subsidy of manure significantly increases the production of almost 453.82 kg ha $^{-1}$ with the threshold of 1% by the method of pairing by nearest close, also with the same threshold by the method of pairing by the core, increases the production of 434.40 kg ha $^{-1}$. Therefore, the subsidy of manure has a positive and significant impact on the production of rice. These results confirm those of Chirwa [17] Indeed, those which use subsidized manure have an output more raised than those which do not use it.

The last part presents the conclusion, the recommendations and the limits with resulting from the results obtained above.

Conclusion, Recommendations and Limits

Niger, a country in the process of development where crushing the majority of the population draws her substance from the exploitation of the ground. But, agriculture in this zone meets many the difficulties. We record the low agricultural productivity amongst other things that one can connect to not use in an intensive way the agricultural inputs in accordance with the treaty of Abuja.

The resolution of this topic by the model logit and two algorithms (nearer close and core) of the method of pairing by the score of propensity, lead us to the following results:

The use of a unit more of the improved seeds increases the adoption of subsidized manures of 0.48 point. That wants to say those which use the improved seeds adopt more subsidized manure than those which use the local seeds of 48%. The sex of the head of household is positively significant to 1%, which wants to say the men are encouraged with the adoption of subsidized manures than the women of 0.12 point. This result can be refined by the fact that the women are interested in the commercial activities. The marital status is negatively significant to 10%, therefore the married men are incited with the adoption of subsidized manure than the no married ones of 0.13 point. Indeed, the grooms practice other cultures of subsistence apart from that of rice. On the other hand, these results show that the increase in a unit of the surface decreases the adoption of subsidized manure of 0.24 point. This reduction can be explained by the fact that the granting of subsidy of manure in Niger is made by targeting population. Only the small producers are authorized to profit from the subsidy of manure and that the quantity sold is very limited. Consequently, the result cancels our H1 assumption which stipulates that the production area influence positively the adoption of subsidized manures.

The results after pairing show that, the subsidy of manure significantly increases the production of almost 453.82 kg ha^{-1}. These results can be due to the fact that the subsidies are regarded as a fall of price, then as stipulates it the theory of demand, when the price of a good drops, its request increases. Indeed, the effects of the subsidy of manure on the rice productivity, confirm our second assumption which stipulates that the subsidy of manure acts positively on the production of rice. Moreover, they confirmed also the results of the authors like: Gerber, [4], Zerbo, et al., [9] and Holden and Lunduka, [10,11].

Have regard these results, we can encourage the government to continue the program of the subsidy of manure in the objective to promote the intensification while agricultural input. Moreover, the government must widen its budget devoted to the subsidy to satisfy the requirement in manure for the small producers who cannot supply themselves on the market.

While setting up the policies of subsidy, the State must follow closely the policies so that they can arrive to the appropriate authority.

The limits raised in work are as follows:

a) Data out of instantaneous cuts;
b) The absence of certain socio-economic and technological variables such as the contact with the services of popularization, the access to the credit…;
c) Not taken into account of the unobservable ones.
d) A possible study on this topic can be made by holding in account these limits.

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