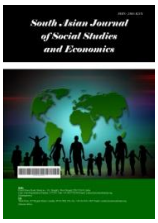

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Impact of Health Level on Agricultural Productivity in Cameroon

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Author's contribution

The sole author designed, analyzed and interpreted and prepared the manuscript.

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ABSTRACT

The objective of this study is to assess the effect of health on agricultural productivity in Cameroon. To achieve this objective, we use the techniques of Propensity Score Matching on data from the fourth Cameroonian household survey (ECAM 4). The results of the analysis show that healthy farmers produce on average than farmers in fragile health. Indeed, healthy farmers produce an average of FCFA 583,601 per hectare. This effect is statistically significant at the 5% threshold. Due to the fact that the level of health improves agricultural yields, we recommend to the public authorities, to facilitate farmers' access to health care through a reduction in health care costs, but also through a multiplication of health centers in rural areas.

Keywords: Health; agricultural productivity; propensity score matching.

1. INTRODUCTION

Health is an essential element of economic growth and future prosperity [1]. It is a powerful vector for development policies [2]. Investments in health can increase the profitability of other investments in the field of human capital such as education. In addition, it should be noted that better health increases the expectation of years of production and therefore makes it possible to benefit from more experienced workers, that is to say more productive workers [3]. Investments in health therefore have direct effects on productivity per unit of time and in turn on economic growth. In this regard, [1] WHO maintains that: "improving the health status of

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populations is a decisive input for poverty reduction, economic growth and long-term development" [4]. The direct health effects, in particular the eradication of the loss of productivity resulting from morbidity and premature mortality, also seem to favor the intensification of agricultural yields. Indeed, healthier individuals can, with additional capital and land, become more productive. They can work more intensely and more efficiently [2]. In such a context, additional spending to promote better health means rescuing the agricultural sector. The Cameroonian state has fully grasped the role that health plays in increasing agricultural productivity. Indeed, the latter increased its per capita health expenditure from 3.9% to 4.1% of GDP between 1995 and 2014, an increase of 0.2%. This increase is still insufficient, however, since it is equivalent to only 28% of the population's health expenditure. Moreover, access to health services remains low. According to data from the Ministry of Public Health (MINISANTE), access to the health service was estimated at 2.19 health facilities per 10,000 inhabitants in 2017. The density of health personnel was 1.90 per 10,000 inhabitants, i.e. less than 2 doctors per 10,000 inhabitants. It should be added that the set of health services is concentrated in city centers. As a result, rural populations are marginalized because they have to travel long distances to benefit from these services. Moreover, even when these services are allocated at the rural level, their redistribution is not equitable. This would explain the high mortality rate in rural areas (over 90%). This rural environment is characterized by a high prevalence of endemic diseases that undermine the health of farmers. In addition, a large number of health problems would be caused by a wide variety of parasitic and bacteriological infections, as well as poor hygiene conditions. Thus, the difficulties of access to the health service is not favorable to a population generally qualified as poor. However, the rural world is accepted as contributing more than 20% to the GDP, with agriculture contributing an estimated 15%[2]. In such a context, one could objectively wonder whether the substantial improvement in health capital would contribute to a substantial increase in agricultural productivity. In other words, what is the impact of health status on agricultural productivity?

The objective of this paper is to analyze the impact of health on agricultural productivity. The rest of the document is organized as follows. Section 2 presents a brief review of the literature. Section 3 presents the selected methodology. The results of the model estimation are presented and discussed in section 4. The last section concludes the document and presents some economic policy recommendations.

2. LITERATURE REVIEW

Since the work of Becker, many economists have agreed that investment in human capital is a powerful engine for improving worker productivity [5]. Indeed, Schultz and Tansel using the method of instrumental variables on data from Ghana and Côte d'Ivoire lead to the result according to which the improvement in the health level of households translates into an increase in their productivity [6]. Lee using data from the United States achieves similar results [7]. Deolalikar using panel data relating to the rural sector of the South-East Indian zone arrives at the result according to which health is an effective tool for increasing agricultural yields [8]. Weisbrod et al., use data from Saint Lucia (West Indies Island) and observe at the end of their analysis that health contributes to the improvement of worker productivity [9]. Some development actors go further in their analysis and identify two main components which influence the relationship between health and productivity. The first component highlights the immediate dimension of health. Indeed, Pitt and Rosenzweio, Deolalikar, Weisbrod et al., and Malenbaum consider that a healthy worker will be in better physical condition (more vigorous) and will then be more productive [8,9,10,11]. The second dimension has a more distant scope. In this sense Ram and Schultz argue that a better level of health can extend the life expectancy of a population [1]. As a result, workers with more experience in the economy persist longer and are more productive than young workers who replace them. These authors integrate this characteristic into their agricultural household model where they analyze the relationship between nutrition, health, productivity and farmers' profits. However, it should be noted that the expected effects of health on agricultural productivity are not unanimous in the economic literature. Indeed, some believe rather that it is the increase in agricultural productivity that improves health. Among the protagonists of this view there is Solow, Swan [12,13].

[2] *According to data from the Ministry of Agriculture and Rural Development (MINADER).*

3. METHODOLOGY

The objectives were achieved using the "Propensity score matching (PSM)" method. This approach makes it possible to produce, using non-experimental data, a control group (non-beneficiary) similar as much as possible to the group treated (the beneficiaries of the program). The next step is to estimate the impact of the program given that the samples of recipients and non-recipients have the same characteristics. Under this basis, the difference in outcome variables is attributed to the impact of the program. In our case, it is a question of comparing the differential in agricultural productivity induced by being in good health or not. In other words, the question is whether access to health improves agricultural productivity or not. Our methodology consists in presenting the principle of the PSM and the method of analysis.

3.1 Principle of Propensity Score Matching

The general idea underlying this analysis method is to determine or construct a statistical comparison group based on the probability of participating in the program [14]: $P(X) = pr\ (D = 1/\mathrm{x})$. Consider a situation where the impact of a particular treatment on the health of individuals must be assessed. "D" represents a binary variable which takes the value 1 if the individual receives the treatment and 0 if not. “Y“represents the variable on which the treatment is supposed to act. "Y0" captures the condition of individuals before the administration of treatment and "Y1" translates their condition after they have been treated. The average treatment effect is expressed as follows:

$$\Delta\overline{Y} = \mathrm{E}(Y_1 - Y_0 / D = 1).$$

Decomposition gives: $\Delta\overline{\mathrm{Y}} = \mathrm{E}(\mathrm{Y}_1 / \mathrm{D} = 1) - \mathrm{E}(\mathrm{Y}_0 / \mathrm{D} = 1)$

The second term in the right side represents the counterfactual or comparison group and describes the condition of the individuals treated before they receive treatment. In the medical sciences, it is sometimes possible to observe the situation of patients before the application of treatment, so we have a pure comparison group. On the other hand, it is more complex to have a control group when one is interested in the effect of a transfer or a social program on the well-being of individuals. In fact, most of the time, household surveys give a picture of the situation of households at a point in time (cross section) and therefore do not allow the situation of households receiving aid to be observed before they receive it. In other words, the component $\mathrm{E}\ (\mathrm{Y}_0\ /\ \mathrm{D} = 1)$ is unobserved.

3.2 Method of Analysis

The purpose of this paragraph is to present the steps for estimating the PSM, the variables and data used in the analysis.

3.2.1 The stages of PSM estimation

The estimation of the PSM is done in three stages: the estimation of the propensity scores, the determination of the common support and the estimation of the standard deviation.

3.2.1.1 Estimation of propensity scores

This estimate is made using a logit or probit type model which calculates the probability of participating in the program (access to health or not). Once the propensity scores have been determined, the treated cases should be associated with the closest untreated cases in terms of propensity scores (and therefore observable characteristics). Once the propensity scores have been estimated for each individual in the sample, we determine the common support to ensure that for each healthy individual, we can find at least one individual who does not have access to the service, but who has the same propensity scores as the latter.

3.2.1.2 Determination of the common support

The construction of the common support can be achieved by two main techniques. The Kernel technique and the closest neighbor matching technique. In the first technique, each farmer participating in the program is matched with the entire sample from the comparison group. However, for each observation in the treatment group, we observe what is the average weight of generalized observation in the control group. These weights are inversely proportional to the distance between each observation group concerning the control group, on the basis of distribution on “the propensity score”. In the second technique, each observation treated is paired with the average of five closest neighbors to the comparison sample, always based on the "propensity score" distribution. To ensure comparability between the treatment group and the comparison group, the sample is restricted to the region of the common support defined by the standard deviation values of the "scores on the propensity" in which observations between the treatment group and control group.

.**Table 1. Table showing the details of the variable used in the study**

Variables	Nature of the variables	Description of variables
Health level	Dummy	1 if the farmer is in good or fairly good health and 0 if his condition is fair or bad
Kind	Dummy	1 if the farmer is a man and o if it is a woman
Age	Digital and continuous	Age of sex of head of household
Study level	Dummy	1 if the farmer is educated and o if not
Marital status	Category variable	1 if the farmer is single, 2 if he is married monogamous, 3 polygamous, 4 widowed, 5 divorced, 6 common-law
Number of people in the household	Digital and continuous	
Value of production	Digital and continuous	Variable obtained by adding the value of each product grown by a farmer
Area exploited	continuous variable	Expressed in hectare
Agricultural productivity	Digital and continuous	Ratio between the total production in thousands of FCFA and the total area exploited.

Table 2. Descriptive statistics of the variables used

Variables	Observation	Average	Standard deviation	Minimum	Maximum
Health level	2226	0, 7749326	0, 4177205	0	1
Kind	2226	0, 5220126	0, 4996274	0	1
Age	2226	26.1442	20,1148	1	95
Educational level	2226	0, 714735	0, 451642	0	1
Marital status					
Singles	2226	0, 3027853	0, 4595663	0	1
Monogamous married	2226	0, 2587601	0, 438052	0	1
Polygamous married	2226	0, 0840072	0, 2774609	0	1
Widows / widowers	2226	0, 0507637	0, 2195641	0	1
Divorced	2226	0, 0193172	0, 1376682	0	1
Free Union	226	0, 2843666	0, 4512136		
Household size	2226	6,412848	4,171578	1	27
Agricultural productivity	2226	466,3238	11216,54	2,00e-06	303030.3

3.2.1.3 Estimation of the standard deviation

The standard deviation estimate is obtained by applying the bootstrap method, which consists in replicating the entire estimate on a random sample with the return to the initial sample and determining the standard deviation of the entire distribution of the estimators obtained. This standard deviation estimate considers the fact that "propensity scores" have been estimated. Consequently, each bootstrap must take into account not only the association of the random sample, but also the estimation of the scores.

3.3 Description of Data and Variables to be used

3.3.1 Variables used

The three measures are generally used in econometric studies to assess the impact of health on agricultural productivity. These include: graded self-assessment of health obtained through surveys, height-to-weight measurement and the frequency of the disease [1,7,8]. In this study, we opt for the graded self-assessment of the level of health as approached by Lee [7]. The variables used in this study are summarized in the following Table 1.

3.3.2 Data descriptions

To achieve the objectives of this research, we use the data from the fourth Cameroonian household survey ECAM 4. The collection of this data was carried out in 2014 by the government through the National Institute of Statistics (INS) in the concern to measure the progress made in achieving the Millennium Development Goals. The main objective of this survey is to update the poverty profile, but also to take stock of the evolution of indicators measuring household living conditions established in 2007. The level of annual agricultural production, the cultivated areas, the state of health of the household as well as other variables are indicated in this database. This basis therefore seems appropriate to assess the impact of health on agricultural productivity. Furthermore, this database has the advantage of providing information on the different strata of Cameroon (urban, semi-urban and rural strata). Agriculture is mainly practiced in the rural world (more than 63.7% of housewives practice agriculture). Therefore, we will only be interested in this study in rural farmers. Thus, our sample consists of 2226 farmers. Table 2 provides descriptive statistics for the variables used in the analysis.

As presented, Table 2 does not provide enough information on the characteristics of households according to whether or not they are healthy. It is for this reason that we present in Annex 1, the descriptive statistics of households according to whether or not they are healthy.

By exploring these two tables we note that for the same variables, healthy farmers and those in fragile health have different characteristics. To assess the impact of health on agricultural productivity, it is necessary to neutralize these differences so that the effect obtained from the estimate is the only consequence of the level of health and not of the specific characteristics of the farmers present. This is why we use Matching techniques in the next subsection. These techniques will reduce the differences between individuals so that the observed result is

only the consequence of good health and not the characteristics of farmers. The challenge here is therefore to reduce as much as possible the biases linked to the observable characteristics of the two subgroups.

4. RESULTS AND DISCUSSION

4.1 Estimation of Propensity Scores by Probit Regression

The results of the probit regression are presented in Table 3. These results show that land title, sex, age, level of education, the number of people in the household, the type of equipment used for agriculture, the value of land, the total area of the land, the labor costs, the purchase of fertilizers, as well as proximity to regions like the Center or the Coastline significantly influence the level of health of the farmer.

The probit was run on the sample of the variables defined above (Table 3). The results of this model show that only the size of the household does not influence the health of farmers.

4.2 Matching Quality Tests

Before presenting the results, it is important to ensure that the quality of the propensity scores is good. To appreciate this, it is necessary to check the balancing property. The basic idea here is to compare the difference between the treatment group and the control group after and before pairing, and check if this difference remains. If there are several differences between the characteristics of the two groups, this implies that the pairing was not completely successful, and should therefore be improved.

Before pairing we saw that there were differences between the characteristics of healthy farmers and those in fragile health (see Annex 1). After matching, we find that there are only two significant differences in terms of average between the two groups. This difference in mean concerns the variable level of education and polygamous status (Table 4). Our two groups are now comparable to the limit of two variables, namely: the level of education and the polygamous status. We can validate the hypothesis of a good matching because two variables among the 9 are significantly different from zero.

4.3 Average Effect of Health on Agricultural Productivity

The indicator of the impact of health on agricultural productivity is the yield per hectare. The impact of health on yield per hectare allows us to know if the production of households in good health is greater than the production of households who are in poor health. The following table presents the result of the estimation of the average effects of access to the health service on agricultural productivity. To ensure the robustness of the estimation of the average effects, we first calculated the differences in the outcome variable between the treatment group and the comparison group. Then, to get the standard deviation, we made 100 replications by the Boostrap command in Stata 16.

Table 3. Probit modeling of the factors that explain health

Variables	Coefficient	P-value
Kind	0, 2396789	0.001
Age	-0. 014852	0.000
Educational level	0. 1632587	0.051
Marital status		
Monogamous married	-0, 1675314	0.151
Polygamous married	0, 242939	0.133
Widows / widowers	0, 0622549	0.744
Divorced	-0, 5756174	0.015
Free union	-0, 3741236	0.000
Household size	-0, 0078074	0.384
constancy	1.161793	0.000
Observation		2.226
Pseudo-R2		0.0459

**** Significance at 1%, ** significance at 5%, * significance at 10%*

Table 4. Sample matching test

Variables	Unpaired sample			Kernel matched sample			Sample matched by the 5 closest neighbors		
	Average		P-value	Average		P-value	Average		P-value
	Treatment	Control		Treatment	Control		Treatment	Control	
Kind	0. 54377	0. 44711	0.000	0. 54355	0. 52366	0.242	0. 54355	0. 52366	0.242
Age	23.948	33.705	0.000	23.932	24.772	0.194	23.932	24.772	0.194
Educational level	0. 73275	0. 65269	0.000	0. 73287	0. 70219	0.046	0. 73287	0. 70219	0.046
Marital status									
Monogamous married	0. 23942	0. 32535	0.000	0. 23984	0. 22847	0.431	0. 23984	0. 22847	0.431
Polygamous married	0. 0829	0. 08782	0.727	0. 08188	0. 10807	0.009	0. 08188	0. 10807	0.009
Widows / widowers	0. 03884	0. 09182	0.000	0. 03891	0. 04811	0.186	0. 03891	0. 04811	0.186
Divorced	0. 01159	0. 04591	0.000	0. 01103	0. 01447	0.369	0. 01103	0. 01447	0.369
Free Union	0. 29913	0. 23353	0.004	0. 29965	0. 28903	0.494	0. 29965	0. 28903	0.494
Household size	6.5055	6.0938	0.052	6.5052	6.4992	0.967	6.5052	6.4992	0.967

Table 5. Average effect of the effect of access to credit on agricultural productivity

	Kernel			5 closest neighbors		
	ATT	Standard deviation	P>|z|	ATT	Standard deviation	P>|z|
Agricultural productivity	583.1601	273.5474	0.033	589.4297	273.5687	0.031
Number of sightings	2226					

**** Significant at 1%, significant at 5%, significant at 10%, with z student statistics*

The results of the estimation of the average effects for the two methods (pairing by Kernel and pairing by five closest neighbors) show that producers who are healthy increase their agricultural yield by about FCFA 583,601 per hectare. Here we find the effect that we could expect, and which is widely shared in the literature, namely: good health increases agricultural productivity [6]. This effect is statistically significant at the 5% threshold. The assumption that healthy farmers are more productive is therefore true in the case of Cameroon. Thus, by improving the health capital of agricultural households we are contributing to an increase in agricultural production.

5. CONCLUSION

The objective of this paper was to assess the effect of the level of health on agricultural productivity in Cameroon. Econometric results have shown that a healthy farmer is more productive than a farmer with poor health. Therefore, we recommend the public authorities to improve the health of farmers, by facilitating their access to health care (reduction of costs of access to medical care, multiplication of health services in rural areas to allow farmers to go to the health services in time in an emergency). We also recommend that the public authorities organize health campaigns to make farmers aware of the need to be constantly consulted since farmers handle toxic products in their production activity.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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ANNEX-1

Variables	Healthy farmers		Farmers with fragile health	
	Observation	Average	Observation	Average
Kind	1725	0, 5437681	501	0.4471058
Age	1725	23.94841	501	33.70459
Educational level	1725	0, 7327536	501	0.6526946
Marital status				
Singles	1725	0, 3281159	501	0.2155689
Monogamous married	1725	0, 2394203	501	0.3253493
Polygamous married	1725	0, 0828986	501	0 0878244
Widows / widowers	1725	0, 0388406	501	0.0918164
Divorced	1725	0, 0115942	501	0.0459082
Free Union	1725	0, 2991304	501	0.2335329
Household size	1725	6.505507	501	6.093812
Agricultural productivity	1725	597.3332	501	15.24341

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