

THE EFFECT OF PRIMARY EDUCATION ON MAIZE PRODUCTIVITY IN IVORY COAST

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Abstract

This paper investigates whether primary education has any effect on maize production in Ivory Coast. The effect is analyzed by looking at production efficiency among farmers with primary school education benchmarked against farmers without any education. Using a Cobb- Douglas production function and maximum likelihood estimation method, the study shows that primary education has a positive effect on maize productivity.

Keywords: Maize farms, Productivity, Stochastic frontier production, Education

Introduction

As a rule, production level depends on the quantity and production factors' productivity, such as work and capital. In this respect, production can only grow either from the increase of factors' volume or from an efficient management of these two factors. Human capital develops by means of education or training that result in a productivity rise. Thus, improvement in human capital productivity through workers' education will permit an increase in production level. The economic welfare, arising from further formation, in the form of agricultural productivity growth and a greater productivity of manpower are largely obtained from European, North American, and some Asian countries. Therefore, it is usually admitted in these areas that education has a positive and significant effect on agricultural production. But in developing countries, in general and those located in Africa in particular, the link between education and agricultural productivity is not clearly established. In other words, it gave rise to intense controversies. For some people, education has a positive effect on agricultural output; for the others however, it has a negative or even no effect at all on it. Education rated in terms of the number of primary, secondary school, or higher education years, is a variable that should really impact

production in the sense that an educated farmer can easily master the new production methods.

This section highlights the importance of maize in Ivory Coast, and essentially deals with the problem statement and literature overview study. Following in the wake of Schultz (1963) pioneer works dealing with the effect of education on agricultural productivity, several additional research has shown keen interest in the issue as these decades literature indicates (Tchale and Sauer, 2007). In Ivory Coast, the importance of this crop in feeding is very uneven depending on the areas. It is consumed as a fresh corncob and as flour for bridging the gap in forest and savannah areas. It is used in daily diet in the form of maize flour, and it is also used to make local beer.

In urban area, the consumption of fritters made with maize flour, tends to grow substantially. Those industrial outlets exist in the form of flour suitable for bread-making for feeding children and animals. Thus maize can be one of the substitutes similar to rice, and its demand will grow in the forthcoming years with the price rise per kilogram, and the increase in the Ivorian population. In the production areas, it contributes to reach the self-feeding sufficiency and fight against poverty. The Ivorian corn production that is estimated to 576,910 tons in 2000 has increased by 1.1% from 2000 - 2004, whereas the exploited areas have increased by 0.4% during the same period (cf table 1). In the same period, the annual average demand per corncob is 33kilograms. Therefore, future³⁵ projections indicate a global maize demand of 990,000 tons. This overall future demand would neatly be superior to the global supply, creating an excessive demand that will be bridged by the import of maize grains. In the objective of a term stimulation of maize production, will producers' education be part of the public policies? In other words, in this public action, would initial training and teaching producers how to read and write play an important part?

Table 1: production and consumption development of maize

year nature ³⁶	2000	2001	2002	2003	2004	Annual growth average (%)
Production	576910	584536	592267	600098	608032	1,1
area	284372	278680	273101	267635	278679	0,4
Consumption	35,11	34,43	33,77	33,13	32,49	

Source: agricultural statistics, October 2005

³⁵ The projection on the bases of the Ivorian population estimated at 30 million inhabitants.

³⁶ The production is stated in tons; the area in hectares; and the consumption in kilogram per inhabitant and per year.

The issue under investigation has interested researchers from Schultz (op.cit) and the findings are that in static agricultural settings, with limited changes, farmer education has no effect on farm yields. Moock (1981) uses African microeconomic data to analyze the education impact on the technical efficiency of African farmers. His finding is that schooling has no or a substantially negative effect on those farmers' productivity. On the other hand, Lockheed, Jamison and Lau (1980) synthesize the findings of 18 papers leaning on 37 investigations in 13 Asian countries. In their work, they set up a synthesis coefficient that is agricultural production rise (anything being equal otherwise) which may be attributed to the fact that each farmer has been trained for four years at least. As a matter of fact, the average gain from an educated farmer is 7.4%. This study has triggered several literacy projects and programs for the rural world. Authorities and development institutions have immediately believed that teaching farmers how to read and write was enough to make their productivity grow.

Also, in industry, Weiss (1988)³⁷ examines a number of data describing how farmers assembled machines, and found a measure of their production during the first month work. He notices that teaching had a very little effect on production: each additional secondary education increased the worker's production by 1.3% only. Besides, workers holding a secondary school diploma produced the same quantity as those without this diploma. He then comes to the conclusion that apparently education contributed very slightly to farmers' initial output. According to Coelli and Fleming (2004), the teaching level has a positive impact on workers' technical efficiency in Papua New Guinea. Likewise, Battese and Coelli (1995) in India find a negative coefficient, but significant for the literacy level. This means that Indian producers of rice with a high literacy level are technically more performing. Nyemeck and al. (2004) in Cameroun find that literacy level has an important effect on technical efficiency in the single-crop system of maize, but it has no impact on groundnuts production, and in the associate production of maize and groundnuts. These results show that a farmer, whose literacy number exceeds or is equal to four years, is technically more effective. These findings are similar to those of Weir (1999). As a matter of fact, Weir (op.cit) finds in Ethiopia that literacy level has a positive effect on cereals and maize producers but it is only noticeable after a minimum of four years training. Appleton and Balihuta (1998) study the impact of literacy on a sample of rural households in Uganda. They demonstrated that literacy improves it. But its effect is unimportant at the level of farming choices.

In Ethiopia, Knight, Weir and Woldehanna (2003) show by means of farming households that literacy for the person in charge of the household

³⁷ see Hal Varian (2003)

brings down aversion to risk. In addition, they have assessed the effects of education and the attitude to risk through the adoption of technology. Thus, they find that literacy encourages farmers to adopt innovative methods and take more risks. Literate farmers appear in the eyes of the illiterate ones as models.

Tian and Wan (2000) analyze the impact of literacy level over technical efficiency of cereal producers in China, and found that literacy level increases any variety of rice producers' technical inefficiency; instead, it reduces the productivity of wheat and maize.

In Ivory Coast, Gurgand (1993) studies the effect of education on agricultural production (food and cash crops). He demonstrates that literacy level has no positive effect on agricultural productivity, for rural households' education in Ivory Coast, doesn't result in an increase in agricultural productivity. In his study, the impact of education has not been revealed because the sample of his study consisted of 80% of illiterates, 20% of individuals with an education level of more than four years. The most educated households reduce the part of agriculture in their activity, to focus on more lucrative prestigious jobs. The variable (education taken in isolation has no or a negative effect on agricultural production. Nevertheless, when he analyses the instruction and vulgarization effect, he observes that education effect on family farming sometimes depends on the household access to agricultural vulgarization service. Depending on cultures, its effect is significantly positive or negative in the presence of training variable. The crossed variable "age, education" is significant. Thus, the effect of education on total agricultural production depends on both family chief age, and training.

A few years after, Audibert and al. (1999) analyze the technical efficiency of a cotton producers' sample in the North of Ivory Coast, with a stochastic production frontier with in-built inefficiency effects. The human capital, that is viewed as a quantitative variable can be defined as the percentage of the literate actives per household. It is one of the technical determiners of cotton producers. The impact of education on the technical efficiency is weak. Families where the proportion of literate persons of active age is important are those where technical efficiency is limited, or the most efficient technical exploitations, are those in which one counts in proportion less literate actives. Audibert et al. (op.cit) acknowledge that their indicator is relatively rough, as it does not measure the degree or literacy quality. Educated people in the case of cotton farming are less receptive to the counseling of training agents, for they are more individualist and more self-assured. Another possible explanation suggested by the authors of this study is that the farmers with a comparatively educational level tend to earmark time and work to activities which utility is much more maximized from the

viewpoint of their criteria. These activities exercised by educated people are for example cash crops farming activities (mangoes, cashew nuts, etc.), as well as formal or inform nonagricultural activities. So, the study shows that literacy induces an allocation effect diverting the most educated farmers toward less constraining activities; but also lucrative regarding their utility. Apart from those two studies, using Ivorian microeconomic farming data, no other study to our knowledge has tried to assess the impact of education on farming productivity. If in the 1990s the proportion of literate actives per household was weak, nowadays, with the employment crisis in urban areas, and failures at school, causing dropouts at different levels, the argument of the weak rate of persons having a primary, secondary level or higher education level is no more valid. The structure of agricultural assets has been neatly modified. One can notice a more important proportion of persons having an education level of more than six years devoting themselves to farm work. These people are much attracted by annual crops of short cycles such as tomatoes, groundnuts, maize, rice, etc. These crops bring in a swift return, and as a rule, all the production can be sold (c.f. Nuama 2010). After two decades, following former works about Ivorian farming, this study aims to find out if education in Ivory Coast, continues to exercise no or a negligible impact on agricultural production. In the framework of this study, we have chosen a short cycle annual crop (maize).

The analysis of the effect of education on maize farming productivity is done via the estimate of a production stochastic frontier of Cobb - Douglas type, in which education is one of the determiners of productive efficiency. Contrary to former works conducted in Ivory Coast, which view education as a quantitative variable in this work, it is considered as a dichotomist or mute variable. The productive efficiency notion is intimately linked to the concept of production frontier which is the reference in connection with the observed situation of a producer can be compared and it is equivalent to productivity notion. In fact, productivity can be defined as the ratio between output and production resources. Thus, an increase in productivity means that the sector can produce more with the same resource level, otherwise, a greater managerial and technical skill. According to Lesueur and Plane (1995), the notion of frontier permits to draw a single productivity measure, that takes simultaneously into account the whole pertinent factors. As a result, we eliminate the risk of having to make a synthesis evaluation from non-converging individual productivity factors. The measure of technical efficiency implies the involvement of production frontier, based on production factors arguments. The rest of the document is structured as follows:

- the second part deals with the methodology;
- the third part presents the findings;

- lastly, the document ends with a conclusion.

Methodology

This section describes how the microeconomic data relating to maize exploitation have been collected; it also presents the analysis model as well as the variables used in this work. The analysis of impact of education over productivity can be done in three different ways. The first approach divides the farmers' sample into two under samples which discrimination element is the literacy level. The first under sample consists essentially of literate producers, and the other under sample will only be composed of illiterate producers. In this case, the work consists with each under sample, to estimate the productive performance score, and make an average equality test at a certain threshold. This student average equality test will enable us to say whether on average the producers who have been taught how to read and write are technically more productive than the others. The second approach is the one used by Gurgand (op .cit), it consists in estimating a production function that comprises apart from the classical production factors, an education variable. The significance of education coefficient of the estimated production function will permit to say if the education variable "education" has and or no effect upon the related crop production. The last approach is the one used by Audibert et al. (op. cit). One estimates a frontier production within-built inefficient effect as suggested by Battese and Coelli (op.cit). Literacy is part of the arguments determining technical inefficiency. This last method is the one used in the current survey. Contrary to the work of Audibert et al. (op .cit) which considers education as a quantitative variable, in this work, we have considered this variable as a silent one. The use of an indicator or silent variable permits to segment the sample of maize producers into two sub samples, determine if the segmentation criterion is really discriminating. In these three estimation methods, of education impact on productivity, one may suppose that the variable must be unevenly distributed. Moreover some variables such as the health state of maize producers, the aptitudes or capacities transmitted at birth, the quality of the exploited soils, are factors that might have an impact upon our sample maize producers' productivity. It's always difficult to analyse the effect of primary education and the effect of other factors such as health condition; inborn skills and the lands' quality, etc., thus, we have adopted the reasoning referred to as "all things equal as well", whereby we assumed that one single factor varies while keeping the others constant

The variables used

Two types of variables have been used: the variables related to the production frontier, and the determinants. The first type comprises, the

production of grain maize, all variety included, evaluated in kilograms (dependent variable), the cultivated area in acres, the manpower, equivalent days, and the capital estimated in CFA Francs (variables independent from the model). The last one represent the equipments value (matchets, hoes, etc.) used in the production activity instead of writing off values cost, for the lifetime of these tools is less than one year (cf table 2 and 3).

Table 2: characteristics of quantitative variables used

variables	Characteristics			
	Minimum	Maximum	Average	Standard deviation
Production in kilograms)	400	1300	900	60
Area (in acres)	50	150	80	10
labour (in manpower days)	580	4800	2500	140
Capital (in CFA Francs)	4000	20000	12000	1500
Years of experience (in past years)	2	40	10	7

Source: Survey data (2005-2006) and (2006-2007).

As a rule, in Ivory Coast, fertilizers are used in growing some plants such as rubber tree, cotton and cocoa farming, etc., in a nutshell; it is used for cash crops, but not in food crops. However, maize farming in the area of study, uses nether fertilizers, nor weed killers; it is all about a traditional production of maize without any chemical product.

Table 3: Characteristics of qualitative variables used

Variables	Frequency (in percentage)
Access to land	80
Access to informal loan	20
Access to training	60
Access to education	70

Source: survey data (2005-2006) and (2006-2007).

Maize is produced either in combination with rice or in pure farming. The systematic rotation of crops has been ruled out, and solely pure maize farming production system has been adopted. As a rule, producers have several farms; we have seized the working times in maize farms, and estimated the equipments value on the basis of this activity period. The determinant arguments are five, namely, the farmer's experience years, the mode of access to the land; the access to informal loan, to vulgarization and literacy. Among these variables, only the variable "farmer's experience years is a quantitative variable, the four others are qualitative variables (access to education, to training service, informal loan and to land). They are taken into account as silent variables. They are defined as follows:

- the mode of access to land can be defined as follows: **1** if the farmer owns the land he is cultivating, and **0** if he doesn't;
- access to informal loan is worded as follows: **1** if the farmer had access to the existing informal loan, and **0** if he didn't;
- the variable "access to training" is described as follows: 1 if the maize farmer has access to training and 0 if he hasn't;
- the variable "education" is defined as follow: 1 if the farmer has an education level superior or equal to six years (primary school), and 0 if he hasn't.

The underling idea to the introduction of determinants in the frontier production model is that these factors may partially explain the productivity scores observed.

In principle, the production factors and productivity determinants have to be contrasted signs. The first ones are positively linked to production, whereas the second ones vary in opposite direction with inefficiency. Indeed, the expected signs of production the elasticity in ratio with the production factors must all be positive, whereas those of the determinants must be negative. A significantly positive sign of a production factor means that it increases maize production. On the contrary, the significantly negative sign of a determinant shows that it improves productivity. For the production frontier model, the determinants are used to explain the technical productive inefficiency of producers represented by $-U_i$. A determinant negative sign indicates that it reduces the productive inefficiency, in other words, it improves the productive efficiency that is considered as the productivity score. The educated maize producer should be technically more performing than his illiterate colleague, for he has the capacity to take advantage of the training opportunities, and existing information. In other words, if an educated producer gets the same maize production as an illiterate, all things being equal in other respects, he will be considered as less productive than the other. Access to informal structures loan urges the producer to be more effective so as to honor his commitment as regards the financial backer. The maize farmer who benefits from training and supervision should be more in debt than any non-beneficiary colleague.

- the stochastic production frontier model

In this study, we will suppose that a maize production activity can be characterized by a product (grain maize), and by production input vectors the stochastic approach has been jointly suggested by Aigner, Lovell and Schmidt (1977) and by Meeusen and Van Den Broeck (1977) from the following model:

$$Y_i = f(X_i, \beta) + \varepsilon_i \dots \dots \dots \text{(equation1).}$$

with $\varepsilon_i = V_i - U_i$

Where

Y_i is the production of grain maize $f(X_i, \beta)$ represents a production function of a chosen shape in principle, that's to say a Cobb- Douglas or a Trans logarithmic function which β parameters are unknown and must be estimated and the error term ε_i with two components. The first V_i is a purely residual term, taking into account maize production variations that are not under the control (indeed, there may be extreme factors such as climate, luck, etc., that may explain that production is not exactly on the efficient frontier). This is the component that gives a stochastic interpretation to the frontier³⁸. This error term may also, as it is traditionally the case, take into account observation errors or the possibility of variables missing in the model. The second component non negative U_i , represents the technical inefficiency of farmer i. this component reflects the fact that each farmer must be below the production frontier.

The technical inefficiency production measures (Farrell indicator) are given by the following formula:

$$Te_i = \frac{Y_i}{f(X_i, \beta) + V_i} \dots\dots\dots \text{(equation2)}$$

With Te_i : the technical efficiency score of farmer i; Y_i : the effective production of maize; $f(X_i, \beta) + V_i$ the maximum production on the production frontier. As a matter of fact, according to Greene (2008), even though the parameters are supposed to be known, one cannot observe in ε_i share of V_i and that of U_i . Under usual regularity measures, the defined model at the equation (1) level can be statistically identified, in the sense that the model parameters can be identified from the observation, but for each observation we will only get at start one estimate of ε_i . Residues permit to determine an average efficiency of the analyses sector. This average efficiency will be provided by the average of ε_i , since $E(V_i) = 0$. To get an estimate of the efficiency measure, for each maize farm, we need to estimate U_i from V_i . Jondrow and al. (1982) have suggested a method to go round this difficulty: it is based on the conditional distribution of U_i , given \mathcal{E}_i . An estimate of U_i will then be provided by a central tendency characteristic (the average, the mode) of this distribution where \mathcal{E}_i is replaced by its estimate (Deprins and Simar, op.cit). We can then deduct an estimate of the technical efficiency of each farm as the complement to one of the productive efficiency score. Hypotheses related to V_i and U_i are : V_i follow a normal life

³⁸ see Deprins and Simar (1989)

of parameters θ and σ_v^2 ; U_i also follows a truncated normal law on the right of parameters μ and σ_u^2 ; V_i and U_i are independent among themselves and independent from the factors explaining the model. Under these hypotheses, the model (1) parameters, that is to say β_i , δ_i , μ , $\sigma^2 = \sigma_v^2 + \sigma_u^2$ et $\gamma = \sigma_u^2 / (\sigma_v^2 + \sigma_u^2)$ are estimated by the likelihood maximum method with the software « Frontier 4.1 » of Coelli (1996) , σ^2 and γ measure respectively the total variance and the part of technical inefficiency in the total variance.

Data may be estimated in two methods: the method of widespread least squares or through maximum likelihood. If we use the first method, no hypothesis is required on the error terms, contrary to the maximum likelihood method. I used the Coelli (1996) frontier software. The method used in that software is the maximum likelihood with hypotheses on the terms representing inefficiency and the random effect.

The statistic unit is the maize farming observed in a period of two consecutive agricultural campaigns (2005-2006) and (2006-2007). During the agricultural campaign, 2005-2006, the sample of ninety was drawn by chance with a 10% Poll. During the campaign (2005-2006), we chose to follow the same maize Producers. These maize producing households, that make the sample of our study, have also been chosen in a risky way with the farmers producing the same cash crop file, Anader agricultural counselors have available. As a matter of fact, this file that was designed by agricultural counselors, serves as a contact file between the agricultural counselor and the peasants, and it is his main working tool, for it enables him to have succinct information on each single farmer, and his farm. All in all, we have temporary individual data on two consecutive agricultural campaigns.

The questionnaire consists of two sections: one dealing with household and another one about production unit. The household section identifies the maize producer, deals with access to financing aids source and the land. The second section relating to production unit, analyses production activities, production factors' cost, supervision and marketing. Concerning the questionnaire administration mode, it covers several pages, addressing the persons in charge of the production unit, id, the one who calls the shot regarding the farm. Some data, such as the area, working periods and the number of farm laborers, etc., have been collected in the farms. Production evaluated in kilograms has been appraised by laying output squares. Identifying the person in charge of the production unit takes into account the following socioeconomic features: literacy level, years of experience, and possible or no access to informal credit. The variable « mode of access to land » permits to highlight the different modes of access to the land existing

in the study area. These data have been collected early from the household chiefs. This survey has taken place outside the different crops fields.

The functional forms of the model

To value the parameters vectors and the determinants β and δ of equation (3), one may use several functional forms (Cobb-Douglas, trans-logarithmic, etc.). In this paper, we have chosen the functional form of Cobb-Douglas type. The interest of this functional form is that it is practical; in addition, the parameters of this production are the production flexibility with regard to the factors, and this is not the case for the trans-logarithmic form. Practically speaking, the maize production frontier model is as follows:

$$\text{Ln } (Y_{it}) = \beta_0 + \beta_1 \text{Ln } (X_{1t}) + \beta_2 \text{Ln } (X_{2t}) + \beta_3 \text{Ln } (X_{3t}) + V_{it} - U_{it}$$

..... (equation 3)

with

$$U_{it} = \delta_0 + \delta_1 (d_{1t}) + \delta_2 (d_{2t}) + \delta_3 (d_{3t}) + \delta_4 (d_{4t}) + \delta_5 (d_{5t}) + W_{it}$$

..... (equation 4)

Ln is the Naperian logarithm,

i represents the farmer, it ranges from 1 to N;

t represents time, it takes a value of either 1 or 2 ; since the survey took place in two agricultural campaigns;

Y : farmer i production valued in kilograms;

X₁: the surface valued in ares;

X₂: manpower expressed in men, equivalent hours according to FAO; it comprises men and women working hours;

X₃: capital valued in CFA francs, it represents the expenses in seeds and equipments (matchets, hoes, files, etc.) ;

Determinants

d₁: the farm owner’s years of experience;

d₂: mode of access to land (silent variable);

d₃: access to existing informal credit in the study zone (silent variable);

d₄: household chief’s education level (silent variable);

d₅: access to training and supervision (silent variable).

Results

This section analyses the effect of primary education on the Ivorian maize farmers’ productivity. The agricultural counselors’ role consists in keeping track of 900 farmers’ work in the study area. There are four main sampling methods:

- random sampling;
- cluster sampling;
- systematic sampling;

- stratified sampling.

We used the first method. As a result, each producer has the same likelihood of seeing their name come up just as any other population individual. The agricultural counselors have a list of peasants, and the list that served as a base for the random drawing. In the final analysis, the sample consisting of producers was drawn by chance with a survey rate of 10%, and we selected those 90 farmers. The sample size should be equal to 180 farmers equally distributed into the two agricultural campaigns. This section presents the result of the estimation production frontier, as well as that of the determinants with a particular accent on the relationship between education and productivity. All the production factors have a real impact on the maize production, because they are all significant and have the expected sign (cf table 4). Whereas at the determinants' level, two over five are not significant. It is about vulgarization and the mode of access to land.

Table 4 : Production frontier and maize production determinants

Variables	Coefficients	Standard deviation	T stat ³⁹
Constant	0.7182	0.0756	9.4179***
Acreage	0.3197	0.0878	3.6412***
Work	0.0886	0.0416	2.0817**
Capital	0.0768	0.04557	1.7000*
Determinants			
Constant	0.1053	0.1984	0.5207
Years of experience	0.3152	0.1876	1.688*
Mode of access to land	0.1360	0.0764	1.78*
Access to informal credit	-0.2470	0.1178	-2.0967**
Access to vulgarization	0.2750	0.6136	0.4482
Access to education	-0.1630	0.028	-5.82**
μ	0.2885	0.0831	3.24*
η	0.1320	0.0795	2.04**
σ^2	0.1373	0.0149	9.2147***
γ	0.6864	0.0209	3.2842***
Likelihood		logarithm	= - 69,88

Author's estimate on the basis of the survey data (2005-2006) and (2006-2007).

The education impact is significantly different from zero; this means that education has an effect on maize production. This result invalidates those of Gurgand (op.cit), Audibert and al, (op.cit) as well as the findings of Tchale and Sauer (op.cit). In fact, Tchale and Sauer (op. cit) have valued the level and determinants of maize producers' productive efficiency in Malawi. The findings show that the highest productivity levels are achieved by farmers using an integrated fertilization, instead of mineral fertilizers solely. Regarding policy variables used in their analysis, access to input and

³⁹ *** significant at 1% , **Significant at 5% , * significant at 10%

production markets, credit and additional services have a significant impact on maize farmers' productivity. On the other hand, our result complies with those of (Neymeck and al. (op. cit) and Knight, Weir and Woldehana (op. cit). Why is education impact so significant for maize farming? The number of persons knowing how to read and write per household has substantially increased. It is valued at 70% against 30% illiterates (cf table 3). Furthermore, maize farming is of short cycle, in three months, brings in an income. Lastly, maize production is mostly sold.

Conclusion

This object of this study was to find out, with regard to earlier surveys, whether education keeps having no impact on Ivorian farmers. Among the three assessment methods used to value literacy effect over productivity, the production frontier method with incorporated inefficiency effect was used. The empirical analysis from temporary microeconomic data stemming from maize farms shows that from now on, education has an effect on these farmers productivity in the Moronou. Therefore, the public policies aiming to improve peasants' productivity, should integrate projects and programs, dealing with teaching rural households how to read and write.

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