

The falling production of mexican cacao analyzed through the lens of Mincerian earnings function in the context of social capital of smallholders

La caída de la producción del cacao mexicano analizada a través de la función Minceriana en el contexto del capital social de pequeños productores

Tomáš Hes ¹, Samuel Mintah ¹, Haiyan Sulaiman ¹, José Samuel Banda Arrieta ², José Ramírez Esquivel ², Tomás Martínez Saldaña ³, Juan Manuel Aguirre López ²

Originales: *Recepción: 28/07/2016 - Aceptación: 14/02/2017*

ABSTRACT

The cacao belongs to most important agricultural crops worldwide, in recent decades facing increasing demand as well as falling production capacity. The dramatically fall of production of cacao in Mexican agriculture, where it was first domesticated, is becoming a serious concern for diversity of local production, as local producers are substituting cacao plantations with more rentable crops thus giving away a rich genetic as well as agricultural legacy that could under adequate conditions provide a source of income for large region while maintaining the natural diversity. The paper tries to find the answer in studying the social capital of cacao producers of Tabasco region, coming to the conclusion that it is collective action and social capital led production set of practices that is crucial for the re-installment and prosperity of the plantations, rather than a single motive such as the recent invasion of *Moniliophthora roreri* fungus.

Keywords

social capital • cacao • Mexico • *Moniliophthora roreri* • Mincerian function

-
- 1 Czech University of Life Sciences Prague. Faculty of Tropical AgriSciences. Kamýcká 129, 165 21. Prague 6. Czech Republic. 2586rm@gmail.com
 - 2 Chapingo Autonomous University. Economics-Management Science Division. Km. 38.5 Carretera México-Texcoco. Chapingo. Texcoco. Estado de México. México. C. P. 56230.
 - 3 Colegio de Posgraduados. Estudios del Desarrollo Rural. Carretera México-Texcoco Km. 36,5. Montecillo. Texcoco 56230. Estado de México. México.

RESUMEN

El cacao pertenece a los cultivos agrícolas más importantes en todo el mundo. En las últimas décadas se enfrenta con una creciente demanda, así como con la caída de la capacidad de producción. La caída de la producción de cacao en la agricultura mexicana, donde fue el cacao domesticado por primera vez, se está convirtiendo en una seria preocupación por la diversidad de la producción local, ya que los productores locales están sustituyendo las plantaciones con cultivos más rentables, perdiendo la riqueza genética y cultural. El artículo trata de encontrar la respuesta en el análisis del capital social de los productores de cacao de la región de Tabasco, llegando a la conclusión de que la producción de cacao es una acción colectiva y relacionada con el tejido sociocultural y por lo tanto el capital social sirve como una base de conjunto de prácticas cruciales para la prosperidad de las plantaciones y lucha exitosa contra *Moniliophthora roreri*, uno de los motivos de caída de la producción.

Palabras claves

capital social • cacao • México • *Moniliophthora roreri* • función Minceriana

INTRODUCTION

The cacao (*Theobroma cacao* L.) belongs to the family Sterculiaceae, which is naturally distributed in humid tropics of the western hemisphere in higher altitudes between 18°00'N (Tabasco and Chiapas, Southern Mexico) and 15°00'S (Northern Brasil, Bolivia). Cacao was domesticated in Olmecan Central America over 5,000 years ago, and its production has spread globally to tropical areas of west Africa and south-east Asia, and belongs today to the most important crops. In these days cacao is being cultivated in 58 countries with contribution about US\$ 4.5 billion per year to the world economy. In some countries, the importance of cacao is paramount to local economy.

In Ghana for example 75% of households are involved in cacao production, while Ivory Coast supplies about 30% of the world's total cacao (48).

Cacao is considered to be the second most essential cash crop in tropics

regional (43), while almost three quarters of the world's cacao is produced by small landholders, and therefore being intrinsically involved in socio-economic processes of base populations (10, 39).

Besides social benefits for smallholders, cacao increases the biodiversity due to cultivation of cacao trees under shade conditions (13), even though cacao monocultures provide more profits for households in comparative to agro-forestry systems (6).

Three morpho-geographic groups of cacao are known: *Theobroma Cacao Cacao* (Criollo), which is the gourmet type of cacao, *Theobroma Cacao Sphaerocarpum* (Guayaquil) and *Theobroma Cacao Trinitario*, which is the result of cultivation that took place in Trinidad y Tobago in the 1960s (27).

Three types of cacao are exported: pods, wet beans and dry beans, while farmers used to sell pods which is easier for them, take the advantage of selling

dry beans that could be stored and transported for long distances (16). Despite being the first domesticator and a major cacao producer in the past, Mexico ranked in 2014/2015 only 8th post in world cacao production producing over 80,000 metric tons of cacao beans (12, 41), thus belonging along with coffee, rice, corn, wheat, soybeans, cotton to most important export commodities of the country.

Even though the surface of cacao plantations reaches only 10% of the surface of coffee plantations in Mexico, the yearly production of value of cacao comes near to 25% when compared to coffee (33) denoting importance of this crop for Mexican countryside further enhanced by the fact that the presence of cacao in federal states of Chiapas, Oaxaca, Tabasco and Guerrero also corresponds to occurrence of high levels of rural poverty, which in the abovementioned states reaches 40%.

The production of cacao, concentrated in small parcels of 1.8 hectares per producer in average (45) is dramatically falling in the past decades in Mexico. While the country produced in 1993, 51% of the international production, the current production as of 2015, only supplies 1.6%, provided by 37,000 smallholders (12).

One of the major motives for dramatic decrease of cacao production is the impact of *Moniliophthora roreri*, a pathogenous fungus invading active cacao pods that appeared for the first time in 1956 in Panama and now is being found in 11 countries of tropical America, representing a serious threat for cultivation of cacao on global level (34).

In Mexico, 90% of the 61,000 hectares seem to be infected by moniliasis (45).

Resilient and rapidly dispersing spores are apparently susceptible for most cacao crops.

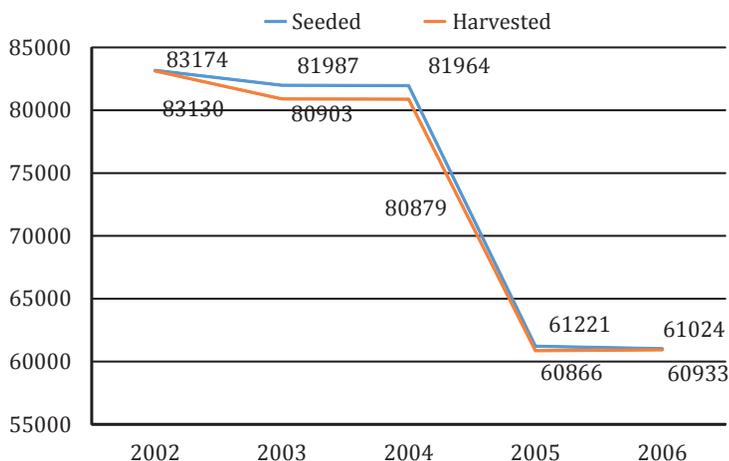


Figure 1. The falling production of cacao between 2002-2006 (19).

Figura 1. La caída de la producción de cacao entre 2002-2006 (19).

The fungus is best controlled through avoidance, due to human-mediated dispersal of the pathogen into new plantations, however strategies based on chemical as well as biological basis seem to far less efficient than adoption of cultural practices such as removal of attacked pods as well as pruning of the shade and cacao trees (23).

Especially, it is the weekly removal of attacked pods seems to be a crucial tool for prevention of the dispersion of spores, but at the same time a reason for discouragement of production of cacao, due to increased requirements for manual work, also combined with the age of the plantations being in average 70 years old and therefore providing low rentability (44).

One of the reasons for the efficiency of such practice is a possible reduction of dispersion potential of the spores of moniliasis fungus that thrive on old, not pruned plantations and high cacao trees.

The removals of infected pods as well as cutting the cacao trees in height and heavy pruning does bring results, as showed and experiment in Tabasco in 2013, where 5,000 hectares were subjected to intense practices of removal and pruning and led to increase of productivity per hectare from 350 to 800 kilograms (44).

The problem of Mexican cacao production however could be more complex than just a challenge related to chemical or biological elimination of the fungus. It is a problem of a social and demographic nature, related to cultural practices, age of producers, abandonment of the traditional production manners, which could be understood as a function of dynamics of social capital in the Mexican countryside (8). The study hence attempts to find a link between social capital and productivity of the producers in a cacao producing region in Central Tabasco, with

the goal to illuminate possible strategies for revival of declining traditional sector of production.

More than 50 years old mincer's earning function was identified as a potentially analogue theoretical construct usable for the solution of the abovementioned problem as the rentability of the cacao producers could be viewed through the lens of a function of social capital comprising of their social connectivity as well as of adopted practices and hence being correlative with the schooling and experience related models. The model was first described by J. Mincer, who modelled the logarithm of earnings as a sum of education in years, combined with a quadratic function of a period of potential experience, which become one of the cornerstones of empirical economics (18). While Becker (1964) considered the internal rate of return to schooling as the key concept of the theory of human capital, Hermann (2008) employed the mincer model on analysis of the effects on social on wages in European countries. Besides these applications there was rather a scarce application of the Mincerian wage on social capital.

Social capital and cacao production

Before applying the concept of social capital on cacao production in order to derive possible connection between the success of cacao production and social capital present in the countryside, the social capital concept is to be inducted and related with the problematics of cacao production. Interest of many scholars in the social capital concept has grown over the past years due to the fact that, there exists a relationship between the social capital stock and economic development, besides others. However, the notion of social capital is not a new

phenomenon (24), although it became subject of too many different meanings.

The concept of social capital as identified by Bourdieu (1986) was given a clear theoretical framework by Coleman (1990) who states that, social capital can be referred to as a collection of different bodies consisting of aspects of social structure that facilitate presence of personal or corporate actors, within the structure (8). Putnam (1995) describes social capital as connections among individual social networks and the trustworthiness and reciprocity of norms.

Woolcock (2001) on the other hand states that social capital is the network facilitating a collective action, leading to a group formation and formation of other forms of civic or collective actions. Narayan and Pritchett (1997) define social capital as the accumulation of resources contributing to higher generation of income and explaining how it enhances cooperation, community cooperative action and leads to solution of common property conflicts at the local level, as shown by Heller (1996) on the case of horizontal solidarity contribution to economic development of Kerala state in India.

According to this view, social capital speeds up the assimilation of innovation by strengthening the linkages among individuals and amounts to improved quality and quantity of information asymmetry helping to reduce transaction costs, but also pooling risks allowing households to engage in higher risk activities with higher return on such activities (19), thus being an important contribution to economic development. Baland and Platteau (1996) described how through social capital and community based group formation helped villagers in Madras to form a community-managed forests through gaining access to state-

controlled forests, enabling villagers to control the forest from illegal logging, fires and cultivation while ensuring all year grazing forest area, contributing enormously to the development of the forest and the village at large.

Durlauf and Fafchamps (2005), suggest that, through social capital, involvement in community organisations can help in the facilitation of information channels. Interactions between individual often comes with the sharing of information which bring about knowledge transfer and sharing.

According to Coleman (1990) and Putman (1993), there is a positive influence of social capital on economic growth, as the promotion of trust and cooperation among agents results in social capital increases due to more efficient collective action (9, 17, 25).

The value of social capital lies in its ability to relinquish an efficient cycle of production through the investment into relationships encouraging the reduction of transaction costs as well as the friction of productive activities (40). Davies (2001) suggests two theoretical models which underpins the concept of social capital by embracing a neo-Marxist and a neo-Liberalist perspective.

The former according to Davies (2001) is an approach proposed by Bourdieu while the later typifies that of Putnam (1995), who is considered as the pioneer of the concept into the wider media from the academic arena. The neo-Marxist approach of social capital places more emphasis on resource accessibility and the issues of power in societies. As suggested by Baum (2000), Bourdieu highlights the different roles played by the various forms of capital in the reproduction of unequal power relations. Coleman (1990) from the view point of rational action views

social capital as not a single entity but as a variety of many entities having different characteristics in common as inscribed in its function.

Many empirical studies have tried to find the link that exists between social capital and production. Wolz *et al.* (2005) in their work on the impact of social capital on farm and household income on individual farmers in Poland found out that, social capital is significant in determining the level of agricultural income, however also concluding that, the impact of social capital on the level of agriculture is not as clear cut as expected.

Their findings point out the fact that, if individual farmers are able to increase the level of their agricultural income if they are able to actively participate in formal organizations. Adding to this, also working on the effect of Social Capital on the choice to use sustainable agricultural practices concluded that, the participation of farmers in community based organisations has a positive influence on their choice of practicing sustainable agriculture, while the extent to which a farmer adopts the practice of sustainable agriculture is influenced by social capital.

The study of Lawal *et al.* (2009) suggests that, though the status of social capital was found to be low, its influence suggests the involvement of farmers in associations at the local level that will increase their social capital level which in turn will enable them have access to more credit and therefore improve their production capacity.

Evidently, Grootaert and Bastelaer, (2002) on their work in Madagascar and Bangladesh opined that, economic heterogeneity among groups, especially, groups with varied income sources improves the rate of repayment due to the ability of group members to pool risks and as

such, social capital is identified as a major contributor to improving the income of the poor through improving the outcome of activities of the poor that might affect them. Social capital improves rural household's access to credit, education and enhances efficiency in rural programs towards agricultural productivity.

Social capital as evidently presented by these studies above suggests that higher participation levels, implementation of social networks and local organizations increases an individual's ability to access credit and this perhaps is the view in which social capital is identified as truly social in a way that, building of trust and networking among individuals on the background of a social setting spills over into the material benefits. Such meaning of social capital has been described in previous studies by Putnam *et al.* (1993). As suggested by Sharma and Zeller (1997), there is a positive spillover effect on the number of self-help groups on the credit performance of groups.

Other studies such as Kahkonen (1999) on the spillover effects found out that, community efforts to build water delivery channels is enhanced by the presence of non-water related associations and networks in the community.

As far as social capital and cacao production is concerned, several researches were done with varied focus that however could have an expressive value on the social capital related matters.

The Abia State research in south-eastern Nigeria interviewed 80 respondents showed that women have significant contribution to farm decision making among cacao farming households, where age, level of education, marital status and farm size have negatively affected women's contribution to farm decision making however, farmer organization and

extension institutions have a positively impact (32).

Effendy *et al.* (2013) found that education and farming experience could help to increase cacao production by adoption a modern technology, another study, while a study Ondo State Nigeria showed that gender and level of education have a positively associated with adoption of the disseminated cacao technologies (31).

The study of Yahaya *et al.* in 2015 found out that farmer demographic characteristics have significant effect on cacao production, and concluded that government should support producers with technology adoption as the most efficient way of support.

Another important factor should take in consideration that cacao farmer's access to rehabilitation techniques information which also could help them to get more knowledge about modern cacao production (2), by the study of Abbeam *et al.* (2014), with trying to determine the ability of cacao farmers to use agrochemicals through interviews of 156 cacao farmers in Ghana, the results showed that gender, age, size of household and farm, educational level and the average age of cacao farms have an important effect in agrochemical usage but in general the purchasing power of these inputs are very low and these agrochemicals play a crucial role in increasing the productivity of cacao farms in south-eastern Asian countries.

Objectives and hypothesis

The aim of this work is to show that there is a relationship between the behavior of cacao producers expressed as a function of social capital and production output related variables. If such aim is proven, it would provide a hint on the explanation what may lie behind the

falling production of Mexican cacao, not reduced only to impact of fungi nor market related impacts. In more detailed focus, the objectives of the work are to find a potential relationship between characteristics of chosen variables related to a cacao production such as annual production per hectare, rentability of each producer, a combination of production processes such as pruning or shortening of cacao trees and characteristics of social capital fragmented into concrete chapters such as trust, norms and rules, interaction and network related effects.

In order to test the results of the questionnaire, the following hypothesis were formulated, to proof the whether there is a potential link between the social capital of smallholders as understood through the lens of Social Capital Theory and the impact on production due to information access, information transfer, collaboration as well as access to networks and infrastructures, the following hypothesis were formulated.

H₁: There is a significant relationship between social capital associated with a producer and rentability of annual production of cacao per hectare.

H₂: Social capital of type D has higher impact than social capital of dimension A, B and C on the rentability of the producers.

H₃: There is a significant relationship between social capital associated with a producer and a combination of pruning, reduction of height of cacao trees and age of the producers.

METHODOLOGY

Data

Data collection took place in February 2016 in municipality C-16 Gral. Emiliano Zapata, Cardenas, in Central Tabasco in south-eastern Mexico, where 101

semi-structured questionnaires with a combination of 50 principal questions entailing 230 subquestions which however include aksi monthly calendars. The questions are closed as well as open ended of a dichotomous and contingency type, as well as based on level of measurement related to agricultural and socio-economic standing of smallholders, were distributed among the rural population of cacao producers landowners.

The collection was done by an interdisciplinary team composed of both agronomists as well as economists and cacao producers and was possible due to a collaboration between Czech University of Life Sciences Prague, Autonomous University Chapingo and the department of Economic Development of Municipality of Cardenas as well as of an Association of Cacao Producers of Tabasco.

No collection of this type was done in the past in the locality, which was chosen for its importance for the cacao production on national level, as the production of cacao in Tabasco State ranks 3rd in its economic importance in the state and 1st in terms of cacao plantation surface on national level, distributed between four municipalities of Comacalco, Cardenas, Cunducan and Huimanguillo (38), while C-16 belongs to most important cacao plantation in Cardenas being positioned in a coastal plateau at altitude of 10 meters. In terms of socio-economic standing, the C-16 municipality was according to the 2010 census inhabited by 3684 inhabitants, with 7.6% occurrence of analfabetism, low presence of indigenous groups (0.11%) and cocoa being a predominant cash crop being produced in 818 farms, out which 0.71% were equipped with computer.

The descriptive statistics of selected variables such as age, years of experience, family character, size of cacao plantations in terms of surface as well as number of

trees, age of plantation, height of trees, cost of chemical care as well as cost of pruning, quantity produced and total production are described in table 1 (page 193) and table 2 (page 194) below.

Theoretical framework and definition of dimensions of social capital

The poor definition and inconsistencies in defining on what social capital stands for have resulted in definition of several dimensions of social capital, conceiving different forms, levels and characteristics that divide the concept on different dimensional levels.

On the aspect of characteristics of social capital, the concept can be grouped as relational dimension, resource dimension and structural dimension.

However there exist other forms of dimensions of social capital and as opined by Molina-Morales (2010) these include expressive ties and instrumental ties, relational dimension, cognitive dimension and structural dimension (45).

Social capital can also be divided into individual level which consists of benefits or potential benefits that an actor enjoys as a result of social networking, while the next dimension is communal level which includes civic spirit, community trust, and adherence to beneficial norms.

As one of the main dimension is considered the trust (8, 25, 45), followed by rules and norms governing social action accompanied by sanctions and information flow capacity (9, 11), types of social interaction (11) and network resources. The theoretical framework summarizations upon which is based the outcome of this analysis, could be described in the illustrative hypothesis (a,b,c) as mentioned below.

The social capital increases according to the level of participation in voluntary associations (20).

Table 1. Descriptive statistics of chosen quantitative data variables collected.
Tabla 1.1 Estadística descriptiva de variables colectadas elegidas.

Descriptive statistics variables	Age	Years of experience	Family members			Surface of cacao plantation	Number of trees	Age of trees	Height of trees
			Men	Women	Children				
Mean	58.41	26.37	1.85	1.87	1.44	2.21	1266.24	29.07	4.43
Standard error	1.41	1.12	0.1	0.1	0.14	0.18	94.36	1.3	0.13
Median	58	25	2	2	1	2	1200	30	4
Mode	50	30	1	1	1	1	600	30	5
Standard deviation	14.1	10.85	0.96	0.97	0.8	1.84	948.35	13.06	1.26
Sample Variance	198.73	117.7	0.92	0.94	0.64	3.37	899371.7	170.69	1.58
Kurtosis	-0.54	-0.45	1.61	1.3	-0.23	11.1	13.55	28.49	4.82
Skewness	0.13	0.02	1.3	1.22	0.22	3.19	3.26	3.82	1.39
Range	70	50	4	4	3	9	5720	120	8
Minimum	26	5	1	1	0	1	480	5	2
Maximum	96	55	5	5	3	10	6200	125	10
Count	100	94	92	93	32	100	101	101	100

Tabla 2. Descriptive statistics of chosen quantitative data variables collected.
Tabla 2. Estadística descriptiva de variables colectadas elegidas.

Descriptive statistics variables	Chemical protection cost per 1 ha	Pruning cost per 1 ha	Quantity produced - baba	Total monthly production					
				Jan	Feb	Mar	Oct	Nov	Dec
Mean	197.4	496.08	1044.55	214.65	218.27	211.14	232.17	237.32	235.74
Standard error	18.51	31.29	64.01	12.4	13.74	13.78	13.71	15.04	13.86
Median	166.67	425	1000	180	175	160	200	200	200
Mode	250	500	1000	300	300	300	300	300	300
Standard deviation	186.04	314.46	643.27	124.65	138.04	138.44	137.77	151.19	139.34
Sample variance	34611.32	98887.77	413795.05	15536.63	19055.22	19166.94	18979.8	22857.68	19414.69
Kurtosis	26.37	0.84	14.15	3.96	2.34	3.7	0.81	6.17	3.1
Skewness	4.33	1.01	2.95	1.48	1.41	1.48	0.99	1.84	1.43
Range	1474	1465	4900	785	685	840	680	980	780
Minimum	26	35	100	15	15	10	20	20	20
Maximum	1500	1500	5000	800	700	850	700	1000	800
Count	101	101	101	101	101	101	101	101	101

Networking leads to higher accumulation of social capital (9, 17, 26)

Interaction, mentoring and mutual support leads to higher social capital (19, 35).

Taking these definitions into account and creating and intersection of the available data and in the assumption of social capital being a sum of the following variables, we award the following criteria as social capital prone qualities in table 3.

Estimation method used

We compare the production of chosen variables products with four chosen Social Capital indicators, searching for a

relationship using mincer's regression model through cross sections of data analysis with fixed effects within Ordinary Least Square (OLS) method, as depicted in formula below.

The advantage of mincer's framework is that its capture of two different economic concepts. While the hedonic or wage function reveals rewards of the labor market for productive assets such as experience and schooling, the rate of return of education provides a comparison which could be used to determined the optimal level of investments of human capital (14).

Table 3. Dimension of social capital related to the questionnaire.
Table 3. Dimensiones de capital social relacionadas con el cuestionario.

Dimensions of social capital	Question number	Questions in the questionnaire
A. Trust	5	Years of experience
	44	Increased level of confidence
B. Rules and norms governing social action	3	Education
	6	Children studying university degree
C. Types of social interaction	16	Relative economic importance of the activity
	29.34	Assessment by professional agronomists
	29.36	Group work participation
	29.38	Experience interchange
	43	Participation in the past year
	33	Technical assistance
D. Network resources	7	Number of family members
	13	Number of families living the household
	29.35	Membership in an organization
	29.40	Institutional relationship

The original equation provided by Mincer (1974), as per Formula 1, is listed below:

$$\text{In}y = \text{In}y_0 + rS + \beta_1 X + \beta_1 X^2 \quad (1)$$

where:

y = earnings

y_0 = earnings of those without education nor experience

S = years of schooling

X = years of potential experience in labour markets

The tailored substitution of the original Mincer was done through substitution of earnings (y) by output of cacao production and analogically of y_0 , while years of schooling were substituted by Social Capital_{A,B,C,D} and Cacao Care variable.

In the first calculation of the Regression 1 (Formula 1) the statistical relationship between the annual cacao rentability per 1 ha and the Social Capital_{A+B+C+D} sets was sought, while providing an answer to the H_2 .

Formula 2 (table 4, page 197). Regression 1-the relationship between the different types of social capital and rentability.

In the second calculation of Regression 2, the Cacao Care variable and Social Capital_{A+B+C+D} was provided, employing the Formula 2 (table 4, page 197) below. The Cacao Care variable is provide in Formula 2 (table 4, page 197).

$$\text{In}y = \text{In}y_0 + \beta_1 A_i + \beta_2 B_i + \beta_3 C_i + \beta_4 D_i + \omega_i^2 + \varepsilon_i$$

Formula 3 (table 5, page 197). Regression 1: relationship between the Cacao Care variable and Social Capital_{A+B+C+D}

Statistic fit and F-test was applied for both calculations in order to confirm the robustness.

RESULTS AND DISCUSSION

The first examination in table 6 (page 198), below revealed that there cannot be found a convincing relationship between social capital and cacao production her hectar, as all p-values are above the required 5% threshold (A=0.16; B=0.62; C=0.50; D=0.22, Cacao Care=0.8).

In the second examination as per table 7 (page 198) below, in a similar tone most of the variables could not be considered as statistically significant as the p-values exceed the 5% threshold (A=0.27; B=0.48; D=0.40).

However, the social capital of type C shows signs of statistical relationship with Cacao Care dependent variable.

The result point at rather a surprising result of a negligent importance of social capital and productivity of the cacao plantation.

The hypothesis on a significant relationship between social capital associated with a producer and rentability of annual production of cacao per hectare cannot be confirmed. In other words, producers that show low level of social connectivity not necessarily have to show lower productivity per hectar, while the productivity is rather dependent on other factors.

With this particular result comes and uncertainty in relation to the second hypothesis H_2 , which therefore cannot be confirmed either.

The third hypothesis can be however confirmed as there seems to be a significant relationship between social capital associated with a producer and his/her social interaction such as group work, interchange of experience, requested technical assistance or assessment by experts. Combination of approaches including pruning, reduction of height of cacao trees and age of the producers are indeed boosted by the social capital that is created in a collective interaction.

Table 4. Variables applied in formula 1 (page 196).
Table 4. Variables aplicadas en fórmula 1 (page 196).

y_i	be a dependent variable y in market i related to cacao output, where P corresponds to annual production and S corresponds to cacao producing surface calculated as $y_i = \left[\sum \frac{P_i}{S_i} \right] / S$
y_0	average cacao output of 20% producers with low social capital according to Pareto principle
A, B, C, D	be the independent variables related to different type of social capital A as calculated in table 7 (page 198).
$\beta_{1,2,3,4}$	be the coefficient of x : social capital A,B,C,D
α	be the intercept of the regression line and the Y axis
ϵ_i	be an error term - residual value describing market i
ω_i	be a performance variable of Cacao Care $\omega_i = \ln \left(\frac{AP * HP}{C_p * C_{Ch}} \right)$ <p>where: AP = Age of Plants HP = Height of Plants C_p = Cost of Pruning C_{CH} = Cost of Chemical Care</p>

Table 5. Variables applied in formula 2 (page 196).
Tabla 5. Variables aplicadas en fórmula 2 (page 196).

ω_i	be a performance variable of Cacao Care as described in table 4 (page 197)
A, B, C, D	be the independent variables related to different type of social capital A as calculated in table 4 (page 197)
$\beta_{1,2,3,4}$	be the coefficient of x : social capital A,B,C,D
α	be the intercept of the regression line and the Y axis
ϵ_i	be an error term - residual value describing market i and time t
ω_i	average performance of 20% of producers with low performance variable of Cacao Care, according to Pareto principle

Table 6. Model 1: OLS, dependent variable Rentability.
Tabla 6. Modelo 1: OLS, variable dependiente Rentabilidad.

	Coefficient	Std. Error	t-ratio	p-value
const	0.013646	0.0450645	0.3028	0.7627
A	0.000599971	0.000428577	1.3999	0.1648
B	-0.00358642	0.00737424	-0.4863	0.6278
C	-0.00532681	0.00790991	-0.6734	0.5023
D	0.00561049	0.00463063	1.2116	0.2287
Cacao Care	-1.19122e-06	5.74432e-06	-0.2074	0.8362

Mean dependent var	6.165696	S.D. dependent var	0.869020
Sum squared resid	0.253936	S.E. of regression	0.051701
R-squared	0.996671	Adjusted R-squared	0.996461
F(6, 95)	4740.020	P-value(F)	2.4e-115
Log-likelihood	161.0461	Akaike criterion	-308.0923
Schwarz criterion	-289.7175	Hannan-Quinn	-300.6517

Table 7. Model 2: OLS, dependent variable Cacao Care variable.

Tabla 7. Modelo 2: OLS, variable dependiente Cacao Care.

	Coefficient	Std. Error	t-ratio	p-value	
const	-1.22555	1.22929	-0.9970	0.3213	
A	0.0238686	0.0216546	1.1022	0.2731	
B	0.258438	0.370624	0.6973	0.4873	
C	0.778547	0.389362	1.9995	0.0483	**
D	-0.0366215	0.043771	-0.8367	0.4048	

Mean dependent var	1.184230	S.D. dependent var	2.677351
Sum squared resid	678.0635	S.E. of regression	2.643926
R-squared	0.063434	Adjusted R-squared	0.024812
F (4, 97)	1.642456	P-value(F)	0.169788
Log-likelihood	-241.3394	Akaike criterion	492.6788
Schwarz criterion	505.8037	Hannan-Quinn	497.9935

CONCLUSION

This type of interaction may therefore be crucial in the strategy of implementation of new practices that may be vital in the fight against moniliasis outbreak and may have higher importance than network resources, trust and rules and norms implemented through external action.

The study proposes to enhance agronomic approach focused on solution of complex agroindustrial phenomena by categorical considerations related to social capital of the moving force of the agroindustry itself: the smallholders and their social ecosystems.

In the particular case of mexican cacao, if only the mean age of producers reaches 58 years is to be mentioned it is clear that the nature of the individual smallholders must have an inevitable and intrinsic impact on care and thus on the fate of cacao plantations, while it is possible to move beyond this simple indicator and look for more complicated, social capital related patterns behind the production output.

Result of the analysis using the lens of Mincerian wage function on the cacao production related data Central Tabasco, yielded a result confirming that collective action can possible be one of the most efficient ways of creating social capital that will actually translate into adoption of new practices and implementation of innovations in the countryside. This result was distilled from the statistically significant relationship between a sum of activities such as interaction between producers, sharing of local knowledge and interaction with external sources of information and impact of the abovementioned fungus on the production output.

Collective work and frequent interaction thus seem to be a most efficient vehicle not only for information dissemination, but also to synchronization

of employed used methods in smaller communities such as the community C-16 Gral. Emiliano Zapata in Central Tabasco. Less convincing results on the relationship between social capital and the general productivity point at the fact that social capital may be an overrated concept or on the other hand a too complex phenomenon that is to be studied from many deeper angles before there is a certainty of the answer to the question on what it actually is and how dependent/how impacting is this phenomenon on local collectivities.

Even if the paper can however raise a question on the extent to the claim of the Mincer model on the exogeneity of the productive efficiency, the message of this result on pointing at social interaction as the most important class of social capital is distinct and could become a signal for the focus of subsidies in the cacao producing sector. This could be essential for the perspective of the sector, especially during an era of fight against a rapidly expanding plague that is according to cacao producers also fomented by ancient practices that naturally support the dissemination of spores of moniliasis, such as insufficient pruning and excessive height of the cacao plants.

REFERENCES

1. Abbeam, G. D.; Setsoafia, E. D.; Ansah, I. G. K. 2014. Modelling farmers investment in agrochemicals: the experience of smallholder cacao farmers in Ghana. *Research in Applied Economics*. 6(4): 1-16.
2. Adeogun, S. O.; Olawoye, J. E.; Akinbile, L. A. 2010. Information sources to cacao farmers on cacao rehabilitation techniques (CRTs) in selected states of Nigeria. *Journal Media and Communication Studies*. 2(1): 9-15.
3. Baland, J. M.; Platteau, J. P. 2000. *Halting Degradation of Natural Resources: Is There a Role for Rural Communities?* Oxford University Press.
4. Baum, F.; Palmer, C.; Modra, C. 2000. Families, social capital and health. In Winter, I. (Ed) -*Social capital and public policy in Australia*. Melbourne: Australian Institute of Family Studies p. 250-274.
5. Becker, G. S. 1964. *Human capital: a theoretical and empirical analysis, with special reference to education*. National Bureau of Economic Research, New York. Distributed by Columbia University Press.

6. Blare, T.; Useche, P. 2013. Competing objectives of smallholder producers in developing countries: examining cacao production in Northern Ecuador. *Environmental Economics*. 4(1): 72-80.
7. Bourdieu, P. 1986. The Forms of Capital. 1985. *Handbook of Theory of Research for the Sociology of Education*. p. 56.
8. Boza, S.; Marcos, G.; Cortés, M.; Mora, M. 2016. Perfiles basados en actitudes hacia los programas de apoyo público de microempresarios rurales de la zona central de Chile. *Revista de la Facultad de Ciencias Agrarias*. Universidad Nacional de Cuyo. Mendoza. Argentina. 48(2): 161-175.
9. Coleman, J. S. 1988. Social capital in the creation of human capital. *American Journal of Sociology* 94: 95-120.
10. Coleman, J. S. 1990. *Foundations of Social Theory*. Harvard University Press, Cambridge, M A.
11. Collier, P.; Hoeffler, A. 1998. On Economic Causes of Civil War. *Oxford Economic Papers*.
12. Dahlquist, R. M.; Whelan, M. P.; Winowiecki, L.; Polidoro, B.; Candela, S.; Harvey, C. A.; Wulfhorst, J. D.; McDaniel, P. A.; Bosque-Pérez, N. A. 2007. Incorporating livelihoods in biodiversity conservation: A case study of cacao agroforestry systems in Talamanca, Costa Rica. *Biodiversity and Conservation*. 16: 2311-2333.
13. Davies, A. 2001. But we knew that already! - A study into the relationship between social capital and volunteering. Conference paper. Anne Davies. Home Start. Sheffield.
14. Durlauf, S. N.; Fafxhamps, M. 2005. Social Capital. In: P. A. a. S. N. Durlauf, ed. *Handbook of Economic Growth*. North Holland: Elsevier B.V. 2: 1640-1666.
15. Effendi, Y.; Jones, A. M.; Scherer, G. F. E. 2013. Auxin-Binding-Protein1 (ABP1) in phytochrome-B-controlled responses. *Journal of Experimental Botany*. 64: 5065-5074.
16. Fleming, K.; Smith, V. E.; Bittenbender, H. C. S. 2009. *The Economics of Cacao Production in Kona*. Honolulu (HI). University of Hawaii. 17 p.
17. Food and Agriculture Organization of the United Nations (FAO). 2015. *Trade Reforms and Food Security*. Rome.
18. Franzen, M.; Mulder, M. B. 2007. Ecological, economic and social perspectives on cacao. *Biodiversity and Conservation*. 16(13): 3835-3849.
19. Geomexico.com. 2012. The Geography of cacao production in Mexico. Available in: <http://http://geo-mexico.com/?p=5900>. (Accessed January 2016).
20. Grootaert, C.; Bastelaer, V. 2002. Understanding and measuring social capital: A multi-disciplinary tool for practitioners. Washington: World Bank.
21. Heckman, J.; Lochner, L.; Todd, P. 2003. Fifty Year of Mincer Earnings Regressions. National Bureau of Economic Research. Working Paper 9732.
22. Heller, P. 1996. Social capital as a product of class mobilization and state intervention: industrial workers in Kerala, India, *World Development*. 24: 1055-1071.
23. Hermann, Z. 2008. The effect of social capital on wage income. Institute of Economic of the Hungarian Academy of Sciences.
24. Kahkonen, M. P.; Hopia, A. I.; Vuorela, H. J.; Rauha, J. P.; Pihlaja, K.; Kujala, T. S. 1999. Antioxidant activity of plant extracts containing phenolic compounds. *Journal of the Agricultural and Food Chemistry*. 47: 3954-3962.
25. La Porta, R.; Lopez-de-Silanes, F.; Shleifer, A.; Vishny, R. W. 1997. Trust in large organizations. *American Economic Review*. 87: 333-338.
26. Lawal, J.; B. Omonona, O.; Ajani, O. 2009. Determinants of constraints to credit access among cacao farming households in Osun State, Nigeria. *Pakistan Journal of Social Sciences*. 6(3): 1683-1691.
27. Mendoza-López A, R. A.; Gallardo-Méndez, C. H. 2011. El mundo del cacao (*Theobroma cacao* L.) kawa (Maya) cacahuatl (Náhuatl). *Agroproductividad*. 4: 20-26.
28. Mincer, J. 1974. *Schooling, Experience and Earnings*. New York: National Bureau of Economic Research.
29. Molina-Morales, X. F.; Martínez-Fernández, M. T. 2010. Social Networks: effects of social capital on firm innovation. *Journal of Small Business Management*. 48: 258-279.

30. Narayan, D.; Pritchett, L. 1997. Cents and sociability: household income and social capital in rural Tanzania. World Bank Research Working Paper No. 1796, Washington: The World Bank.
31. Nmadu, J. N.; Sallawu, H.; Omojeso, B. V. 2015. Socio-economic factors affecting adoption of innovations by cacao farmers in Ondo State, Nigeria. *European Journal of Business, Economics and Accountancy*. 3 (2): 58-66.
32. Obinna, A. P.; Ifenkwe, G. E. 2013. Farm decision making among cacao farming households in Ikwuano L. G. A. Of Abia State Nigeria. *International Journal of Academic Research in Progressive Education and Development*. 2(1): 275-286.
33. Ocampo, B.; Rios, B.; Soria, B. 2012. Production of Cacao in Mexico. FCA UNAM.
34. Philips-Mora, W.; Wilkinson, M. 2007. Frosty pod of cacao: a disease with a limited geographic range but unlimited potential for damage. *The American Phytopathological Society*, 97(12): 1643-1648.
35. Porters, A, 1998. Social capital: its origins and application in modern sociology. *Ann. Rev. Soc.*, No. 24: 1-25.
36. Putnam, R. D. 1993. Making democracy work: civic traditions in modern Italy. Princeton University Press, Princeton, New Jersey.
37. Putnam, R. D. 1995. Tuning in, tuning out: the strange disappearance of social capital in America. *PS: Political Science & Politics*. 28: 664-683.
38. Ramirez-Meneses, A.; Garcia-Lopez, E.; Obrador-Olan, J.; Ruiz-Rosado, O.; Camacho-Chiu, W. 2011. Plant diversity in cocoa agroforestry systems in Cardenas, Tabasco, Mexico. *Universidad y Ciencia, Trópico Húmedo*. Cardenas, Tabasco. Retrieved 2016, Available at: http://www.dof.gob.mx/SEDESOL/Tabasco_002.pdf
39. Ramos, G.; Gonzalez, N.; Zambrano, A.; Gomez, A. 2013. Olores y sabores de cacao venezolanos obtenidos usando un panel de catación entrenado. *Revista Científica UDO Agrícola*. (1): 114-127.
40. Rupasingha, A.; Goetz, S. J. 2007. Social and political forces as determinants of poverty: A spatial analysis. *The Journal of Socio-Economics*. 36: 650-671.
41. Sanchez, P.; Jaffe, K. 1992. Rutas de migraciones humanas precolombinas a la Amazonia sugeridas por la distribución del cacao. *Interciencia*. 17(1): 28-61.
42. Sharma, M.; Zeller, M. 1997. Repayment performance in group based credit programmes in Bangladesh. *World Development*. 25(10): 1731-1742.
43. Steffan-Dewentera, I.; Kessler, M.; Barkmann, J.; Bosa, M.; Buchorig, D.; Erasmih, S.; Fausth, H.; Geroldh, G.; Glenke, K.; Gradsteind, S.; Guhardjai, E.; Harteveldd, M.; Herteld, D.; Höhna, P.; Kappash, M.; Köhlerh, S.; Leuschnerd, C.; Maertensj, M.; Marggrafe, R.; Migge-Kleiank, S.; Mogeai, J.; Pitopangl, R.; Schaeferk, M.; Schwarzem, S.; Spornnd, S.; Steingrebek, A.; Tjitrosoedirdjoi, S.; Tweleh, A.; Weberh, R.; Woltmannk, L.; Zeller, M.; Tscharrantkea, T. 2007. Tradeoffs between income, biodiversity and ecosystem functioning during tropical rainforest conversion and agroforestry intensification, *Proceedings of the National Academy of Sciences*, 104. Available at: <http://www.pnas.org/cgi/doi/10.1073/pnas.0608409104>.
44. Teorema Ambiental. 2015. La producción de cacao en México desciende al octavo sitio. Disponible en: <http://www.teorema.com.mx/biodiversidad/ecosistemas/la-produccion-de-cacao-en-mexico-desciende-al-octavo-sitio>. (Accessed January 2016).
45. Wei-ping Wu. 2008. Migrant Settlement and Spatial Distribution in Metropolitan Shanghai. *Professional Geographer*. 60(1): 101-120.
46. Wolz, A.; Fritzschn, J.; Reinsberg, K. 2005. The impact of social capital on agricultural income among corporate farms in the Czech Republic. Paper presented at the XIth Congress of the European Association of Agricultural Economists (EAAE). "The Future of Rural Europe in the Global Agri-food System", Copenhagen, Denmark. 24-27 August. Available in: http://www.eaae2005.dk/CONTRIBUTED_PAPERS/S46_285_Wolz_etal.pdf (Accessed: 21 November 2005).

47. Wollcock, M. 2001. The place of social capital in understanding social and economic outcomes. *Canadian Journal of Public Policy*. 2: 11-17.
48. Worldatlas. 2015. Top 10 Cacao Producing Countries. Available at: <http://www.worldatlas.com/articles/top-10-cacao-producing-countries.html> [Accessed in 15 March 2016].
49. Yahaya, A. M.; Karli, B.; Gül, M. 2015. Economic analysis of cacao production in Ghana: the case of eastern region. *Custos e @gronegocio on line*. 11(1): 336-352.

ACKNOWLEDGMENT

This research was enabled due to financing provided by CULS IGA project reg. nr. 20165006 and further enhanced thanks the participation of the first author in Eulalinks Sense Erasmus Mundus Partnership EM A2-Strand 1 Lot 8 project.