Optimal Analysis of Factors Affecting Cotton Production in Benin

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Abstract: According to the United States Department of Agriculture, Benin is ranked among the top 5 at the continental level in the production of cotton. Over the last fifteen years, despite different policies implemented by Benin's government in agricultural sector, the cotton production has been drastically decreasing in conjunction with a rising of its production costs. Based on a triangulation approach this research aims on the one hand to determine the main factors that influence cotton production in Benin and on the other to assess if there is an optimal output that should be produced in Benin. Our findings show that, to make more profitable cotton sector, Benin needs to modernize its cotton production chains in order to produce 60 times more higher than its current level.

Keywords: Cotton production, analysis, Benin, factors, optimal, Cournot 's model, triangulation approach.

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1 INTRODUCTION

Although Africa is not the largest cotton exporter (it would account for an estimated 10-15 percent of world exports)[1], this product is a vital source of export recipe for a number of countries in the Sub-Sahara region and participate actively to the national economy, providing employment to a large majority of the labor force in that region (S. C.-G. Assogba, Tossou, & Lebailly, 2014; Bassett, 2014; Moseley & Gray, 2008). In the Republic of Benin, 45 percent of the rural population depends directly or indirectly on cotton incomes. In Benin cotton feeds 67 percent of people and represents more than 35 percent of Benin Gross Domestic Product (S. C.-G. Assogba et al., 2014).

Unfortunately, some problems occur on cotton sector in Benin over the last thirteen years. Indeed, according to World Agricultural Supply and Demand Estimates, cotton production has decreased by 40.20 percent between 2001 and 2014. This decrease has been accompanied with an increase of cotton production costs.

The purpose of this study is therefore find ways to optimize cotton production in Benin and also to determine the main factors that most influence cotton production in Benin. Regarding to the current different impediments of cotton production in West Africa, this research aims to analyze cotton production in Benin in order to assess if there is an optimal cotton output that should be produced in Benin. To answer this question, we provide in the first section an overview of cotton situation in West and Central Africa, in the world but with an emphasis in Benin cotton problems. The second part presents the methodology used to conduct this study. The third and the last part respectively focus analysis of the results, discussion and the conclusion.

2 REVIEW OF THE LITERATURE

2.1 Cotton importance in West and Central Africa

Cotton is sometimes referred to as African 'white gold' (Moseley & Gray, 2008). It represents a crucial source of income in large parts of West and Central Africa (WCA), both for rural populations and national economies (S. C.-G. Assogba et al., 2014; Rafflegeau et al., 2015). Due to widespread smallholder involvement, cotton is moreover considered to play a key role in development and poverty reduction (Baffes, 2003; Minot & Daniels, 2005; Moseley & Gray, 2008). For example, In Benin cotton feeds more than 67 percent of population and its contribution to GDP ranges from 30 to 35 percent (S. C.-G. Assogba et al., 2014).

Cotton is the dominant cash crop in most of WCA and because of that, Woodward (2009) states that a small decline in cotton prices can made an enormous difference in the ability of their farmers to pay for health care, education, and food. He assumed that a good price for cotton allows farmers to boost production of subsistence, crops, slows urbanization by keeping people in rural areas, and creates localized wealth in rural places that need it most. She (Woodward) is not the only one to state about the prominent role cotton plays in the economies of WCA. According to World

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[1] *UNCTAD, Market Information In The Commodities Area.*
http://www.ro.unctad.org./infocomm/english/cotton/chain.htm.20.09.2014

Bank, certain economies, particularly those in the CFA Franc zone, are highly dependent on cotton exports for foreign exchange earnings. In 2004, cotton accounted for almost 50 per cent of Burkina Faso's national export earnings, 56 per cent for Benin, 36 per cent for Chad and 14 per cent for Mali (Anderson & Valenzuela, 2007; Baffes, 2009; Tschirley, Poulton, & Labaste, 2009).

Cotton also plays an important economic regional role in West African Economic and Monetary Union (WAEMU). In his work, Hussein, Perret, and Hitimana (2006) demonstrated that Cotton in West and Central Africa play an important role in the regional economy by providing livelihoods and potential to add value. They affirmed that the importance and potential of processing cotton into textiles for the regional market, the artisanal textiles industry is the second employer in West Africa. This is particularly important in Nigeria and Ghana, where most of cotton produced in the countries is used by local textile industries. Yet, the seemingly importance of WCA cotton production masked a number of weakness and problems that called into question their long-term sustainability or even their survival.

2.2 Cotton problems in WCA

The biggest international problem that shaking WCA cotton producers that are Benin, Burkina Faso, Chad and Mali and known as "Cotton 4" is the excessive government support received by the cotton sectors in the United States and the European Union (Alston, Sumner, & Brunke, 2007; Bassett, 2010; Delpeuch & Vandeplas, 2013). Since cotton is a critical crop for some of the world's poorest countries including the "Cotton 4", cotton subsidies have taken a high profile in part. Confirming that Baffes (2007), noticed that regarding the cotton subsidies, Brazil had brought a case to the World Trade Organization (WTO), claiming that the U.S. subsidies cause a reduction in the world prices of cotton, reducing the income of Brazilian cotton growers. According to John Baffes, there are several problems that occur in WCA cotton sectors. First, the post-1980 production increases reflect solely expansion of the area under cultivation. In contrast, the pre-1980 production increases reflected yield increases per hectare, mainly in response to fertilizer use (Agbohessi et al., 2015). A growth decomposition analysis for the 1980–2005 period shows that cotton yields in WCA countries remained stagnant. That compares unfavorably with the 1.7 percent annual growth rate of global cotton output, which a reflection of yield increases is only. Second, in periods of price declines most cotton companies experienced financial difficulties, which in turn led to demands for fiscal transfers from state budgets, thus putting into jeopardy the fiscal position of those countries. For example, during the late 1990s the state-owned cotton company of Mali was in no position to manage the downturn in cotton prices, because the stabilization fund, created to set aside apportion of profits from earlier periods of high prices, turned out to be empty, resulting in financial losses of CFAf56 billion ($100 million) to the cotton company. Eventually, the cotton company was bailed out by the government through budgetary support. Similar bailouts took place in most WCA countries following the two cotton price collapses-in the mid-1980s, and in the late 1990s and early 2000s. Third, John Baffes believes that the non adoption of new technologies by WCA cotton producers is unfortunate because recent research had shown that the benefits of fully utilizing biotechnology may be even higher than the benefits from the elimination of all cotton trade distortions. He concludes by making a statement on WCA currency known as CFA Franc. The CFA Franc is fixed against the euro (or the French franc, FF, prior to 1999). The CFA Franc exchange rate has been subjected to only one adjustment since 1948—from CFA Franc 50 to CFA Franc 100 per FF in 1994. That fixed exchange rate has often led to unintended consequences, which is not surprising, given the different structure of the euro zone economies compared to those of the WCA countries. He demonstrated his statement by this example where between 2002 and 2005, the world price of cotton increased by 20 percent in US$ terms (from US$1.02/kg toUS$1.22/kg) while it declined by 9 percent in CFA Franc terms (from CFA Franc 711/kg to CFA Franc 644/kg). Within the current political and macroeconomic setting, it is beyond the control of individual WCA governments to choose the exchange rate regime that is consistent with the structure of their economies.

Some others most important problems that faced West and Central African cotton producing

countries could be such as the lack of regional and national strategy for the development of the cotton sector, the weak cotton quality management systems, the weak capacity of institutional infrastructure and lack of marketing system, the lack of necessary productive capabilities, the weak capacity for mobilization of domestic investment and insufficient attraction of Foreign Direct Investment (FDI), and the weak physical infrastructure (energy, water, communication) (Bassett, 2014; Coulibaly, Sanders, Preckel, & Baker, 2014; Iqbal et al., 2012; Sumner, 2006).

2.3 Cotton problems in Benin

Despite its importance, the cotton sector in Benin is facing enormous problems related essentially to its operation both internally and externally.

2.3.1   At the internal level

These difficulties are noted at all levels of the sector and involve cotton growers, cotton transporters, ginners and cotton growers organization. Regarding the cotton growers we can mention: a delay in the payment of decades, an improper use of agricultural inputs such as fertilizer and pesticides, a high inputs costs and labor, some difficulties in forecasting of real needs in inputs, decrease in soil fertility and irregular rainfall, a late implementation, an insufficiency and poor quality of inputs, a lack of technical support and low level of credit for the production. Regarding the cotton transporters, the defective condition of tracks makes them not to be engaged on non-charged tracks which greatly slow the evacuation of cotton (Agbohessi et al., 2015; S. Assogba, Tossou, Lebailly, & Magnon, 2014). Regarding the ginners, the problems occur on working conditions and on situations of fiber in the international market causing excessive debts for ginners and prevent some of them less efficient to participate in campaigns.

2.3.2   At the external level

These problems are mainly related to the continued decline in world prices of the fiber which cause financially, difficult manageable gap. Benin cotton problems have been the subject of several writings (Togbé et al., 2014). Some others scholars remarked that the cotton problems in Benin could be divided into two types of problems: biotechnical problem and financial problem (Agbohessi et al., 2015; Martin et al., 2005). The firsts summarize the continuing decrease of yield, consequence of the improper use of inputs, the decline in soil fertility, the poor quality of inputs and seeds, the climate changes, the delay in the delivery of inputs (Mishra, Tewari, Singh, & Arora, 2015). This lower yield influences negatively the income from the sale of seed cotton and pushes producers to develop new strategies of production such as reduce cotton areas and increase other crops like maize and rice. The seconds emphasize on an underestimation of costs which is a common phenomenon in agriculture due to either naïve optimism or a particularly poor estimate of the cost of certain factors involved in the production process; same for the high cost of inputs particularly the fertilizers and pesticides. The various systems of direct and indirect subsidies of some rich countries for the benefit to their farmers and exporters make some developing countries cotton growers such as Benin not to be capable of facing this unfair competition from rich countries without a high level of productivity in terms of agriculture, which is a big challenge for Benin. Knowing that cotton is the main export crop and that cotton represents 64 percent of export earnings, 90 percent of farm receipts and 40 percent of State revenue, the Benin Government has used several ways to solve these problems.

The main solution brought by Benin government to fix some problems that occur on cotton sector can be summarized by what it convenient to name "The reorganization of cotton sector in Benin''. In April 2006, a new government has been installed with the aim to straighten this vital sector. Its first reaction has been to pay off all back due to cotton growers over the last six years. Then the government has found a new idea to galvanize the cotton growers by fixing the seed cotton purchase prices prior to the 2006 cotton campaign. One year later the government hired hundreds of agricultural agents whose mission is to better assist and guide cotton growers. Unfortunately, few years later, cotton production has been decreasing despite all these measures taken by Benin government. Indeed, since it has been implemented in the year 2008, the cotton production has dropped by 21.60 percent , falling from 268630 tons of seed cotton in,2007-2008 to 210604 tons in 2008-2009.All that prove the cotton real problems must

be elsewhere and maybe the Benin government should seriously examine the cotton growers' opinions. For the cotton growers, to better boost the cotton production two things need to be done: make available to them and in time, inputs of high quality.

2.4 Will cotton trade distortions be settled?

In most of the case, the round of trade negotiations is the only ways using by WCA cotton producers to express their concerns about cotton trade distortions. In response to these distortions, four cotton-producing countries in West and Central Africa-Benin, Burkina Faso, Mali, and Chad have requested that the Doha round of negotiations on trade liberalization contain financial compensation for WCA countries for as long as those Western subsidies remain in place. They have been supported by some people who think that something needs to be done toward "Cotton 4" requests. Indeed, Woodward (2009) was writing, the Doha Round of trade negotiations, which aimed to redress the inequities of the Uruguay Round, called itself a development round and sought to place agriculture at the heart of the agenda. The negotiations collapsed in 2006 owing to intransigence on the part of the European Union (EU) and the United States regarding subsidies and tariffs. Even though cotton subsidies account for just 1 percent of agricultural subsidies in countries of the Organization for Economic Cooperation and Development (OECD), cotton is the commodity most often credited for unraveling negotiations, and its subsidies have served as a poster child for unfair trade practices worldwide (Dowd-Uribe & Bingen, 2011; Heinisch, 2006; Williams Iii, Price, & Manrique, 2003). The inequities of trade policy in the cotton sector are most vividly illustrated in the plight of West African producers. In the "Cotton 4" countries of Benin, Burkina Faso, Chad, and Mali, gains from aid are overshadowed by losses in cotton trade due to current trade policies. The shares of people living on less than US$1 a day in Benin, Burkina Faso, and Mali are 41 percent, 27 percent, and 72 percent, respectively (World Bank 2006). The figure for Chad is not available, but this country ranked 173rd out of 177 countries on the 2003 United Nations Human Development Index (UNDP 2005). Given that these are four of the poorest countries in the world, their ability to compete in a global market with a commodity for which they have a significant comparative advantage is crucial for their development. In parallel to "Cotton 4" Doha Round Requests, WAEMU has adopted a new strategy which consists on increasing up to 25% the use of WCA cotton output by the regional textile industries inside its union, thus increasing processing capacity in the region significantly by 2010 that should eventually guarantee higher prices than those observed on international market. This objective may still be pertinent in the long term subject to market conditions and sufficient investment, even though it is still not achieved in 2014 as hoped since 2010. Then, we can affirm that the settlement of cotton trade distortions has to wait again unless each country of the "Cotton 4" reinvents its own remedy. According to the previous literature on cotton production in WCA and specifically in Benin, we have identified two hypotheses:

Hypothesis 1: There is an optimal level of cotton outputs that can be produced in Benin;

Hypothesis 2: The poor quality of cotton inputs and their late implementation decrease drastically each year cotton production.

3 RESEARCH METHODS

The main problem we are attempting to solve by conducting this study is that the cotton production in Benin has been decreasing drastically over the last fifteen years and this, despite the Benin government's new cotton policy. This drastic decrease in cotton production over the last fifteen years in conjunction with a rising of cotton production cost has raised the research question: Is there an optimal cotton output that should be produced in Benin?

Since the best reply learning process in the contest of quantity competition was originally suggested by Cournot, so then, we will use Cournot's model (Daughety, 2005) to verify the first hypothesis. As Benin is part of the "Cotton 4" countries which most produce cotton in West and Central Africa, we will use Benin as player 1 and the others World cotton producing countries (Burkina Faso, Mali, and Chad) as player 2. In Cournot's model player 1 solves the following problem:

$$\max_{q_1} \pi_1 = p(q_1 + q_2)q_1 - C(q_1) \qquad , \qquad (1)$$

Where $p(q_1 + q_2)$ is the demand curve, and $C(q_1)$ is cotton's cost function.

To verify the second hypothesis, an econometric analysis will be made using some data such as rainfall, area planted, cotton purchase prices, inputs quality, and the late implementation of inputs. But as some data such as the input quality and the late implementation are obviously dummy variables, so we are going to make an Analysis of Covariance (ANCOVA) that should conduct to the estimation of that following model:

$$y_i = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \beta_5 x_5$$
$$(2)$$

Where y_i is Cotton outputs Level, x_1 is Rainfall, x_2 is Area planted, x_3 is Cotton purchase Price; x_4 is Quality of inputs; x_5 is time in inputs distribution.

The scope of this study is from the campaign 1999-2000 to the campaign 2013-2014 and takes into account Benin's cotton production during these years.

The collection of x_1, x_2 and x_3 variables and some of the variables involved in this study is based on documentary research in Benin's institutions particularly those in relation with cotton production. Here are they: Ministry of Agriculture, Livestock and Fisheries (MALF) and the National Office of Food Safety (NOFS) for the data on cotton production outputs, on areas planted, on cotton purchase prices and on cotton inputs prices; National Institute of Statistic and Economic Analysis (NISEA) for the data on rainfall; Department of Forecasting and Economic Analysis (DFEA) to be inspired by their method used to estimate agricultural production in Benin; Public library in Benin to view the works done in cotton sector; National Bureau of Statistic of China for the data on world's cotton production; Some books that help us to make consistent review of the literature. x_4 and x_5 data collection has been made through a questionnaire addressed to some cotton producers.

We went to Benin and took an equal number of surveys from producers in three most important municipalities which produce cotton, surveying a total number of 150 big growers from these three different municipalities. Each respondent indicated his/her concerns about x_4 et x_5. The results of this survey combined with those coming from x_1, x_2

and x_3 (which also has been collected in Benin but in different ways) has been used to estimate the previous model and then to determine the main factors on which depends directly or indirectly cotton production. By eliminating even more variables, Benin leaders should be able to focus on the main factors and then to increase efficiency. The following table 1 gives a summary of the first information on the raw data.

TABLE 1

SUMMARY PRESENTATION OF DATA

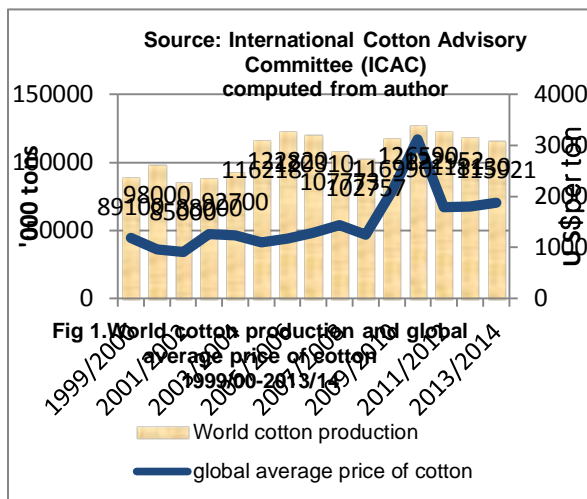| Variables	Unit of measurement of raw data	Sources
Area planted	Hectare(ha)	MALF
Cotton inputs prices	CFA Franc	NOFS
Cotton purchase prices	CFA Franc	NOFS
International market prices	CFA Franc	NOFS
Cotton production	Tons(t)	MALF
rainfall	Millimeter(mm)	NISEA
Quality of inputs	1 or 0	Author's survey
Time in inputs distribution	1 or 0	Author's survey

Source: by authors.

4 MAIN FACTS AND FIGURES

From these different data from specialized institutions, we have identifies some important facts. Firstly, international cotton prices have never been permanent. However, they spiked in 2010/11 to double their average price of the last fifteen years. Despite the soaring price of cotton in 2010/2011 and a slight decline in world cotton production a year later, global average price of cotton down 75 percent from a year earlier. This is due in part to the reserve stocks held by world cotton big consumers like China.
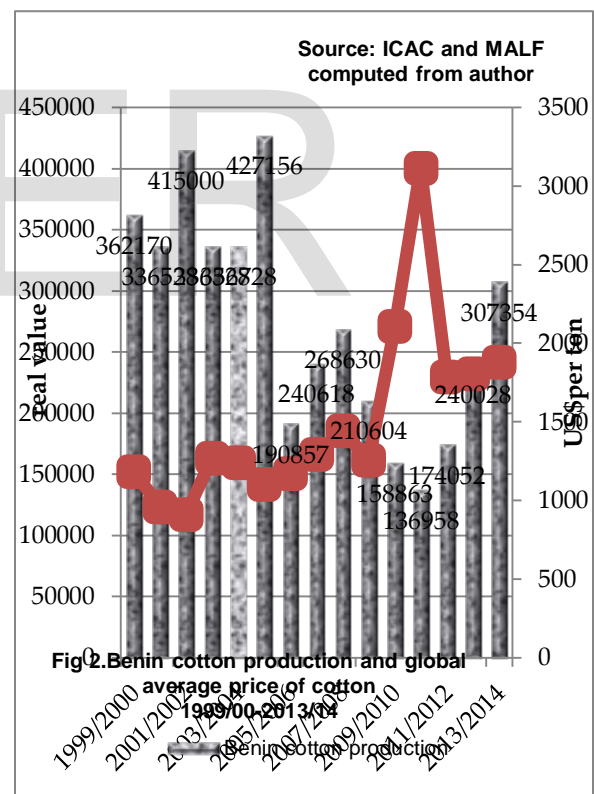
Secondly, after reaching its high level in 2004/2005, Benin cotton production dropped by 124 percent a

year later, yet during the campaign 2005/2006, World cotton production got one of its high levels. So this fall in Benin cotton production is not due to some poor weather conditions and proves that the problems only occurred in Benin. The 2006 presidential elections have in one way or another contributed to this fall in cotton production. Indeed, the cotton growers decreased their production because they are not sure of getting paid by the new authorities. This is the same situation that also occurred during the campaign 2000/2001, a year where a presidential election has been held and where the cotton production slightly dropped. The slight increase in production during the campaign 2006/2007 and 2007/2008 is due to the Benin government's new cotton policy. Numbers of measures (e.g. Pay off all back due to the cotton growers over the last six years, fix cotton purchase prices prior to the campaign; reduce some inputs prices) have been implemented after the 2006 presidential elections to boost cotton production. Unfortunately, all these measures did not keep cotton production from decreasing because two years after being implemented cotton production start decreasing drastically and reaches during the campaign 2010/2011 its worst level over the last fifteen years ; the same campaign where and for the first time, the cotton international price exceeded 3000$ per ton.

Thirdly, according to USDA, world 2014/2015 cotton production will exceed consumption for the fifth consecutive seasons, with the potential for record global stocks to exceed 100 million bales. World stocks more than doubled between 2009/2010 and 2013/2014, due mainly to cotton policies in China, which has supported world prices above market-clearing levels. China's government now intends to reduce support levels; however, world stocks are unlikely to fall in 2014/2015 as the adoption of new policies will be gradual and world production and consumption responses will lag changes in policies and prices. China's stock level is expected to stabilize, and stocks held outside of China are likely to grow. USDA projects that lower China domestic support levels, higher stocks outside of China, and falling grain and oilseed prices could reduce the world cotton price to a 5-years low.

Fig 2.Benin cotton production and global average price of cotton 1999/00-2013/14

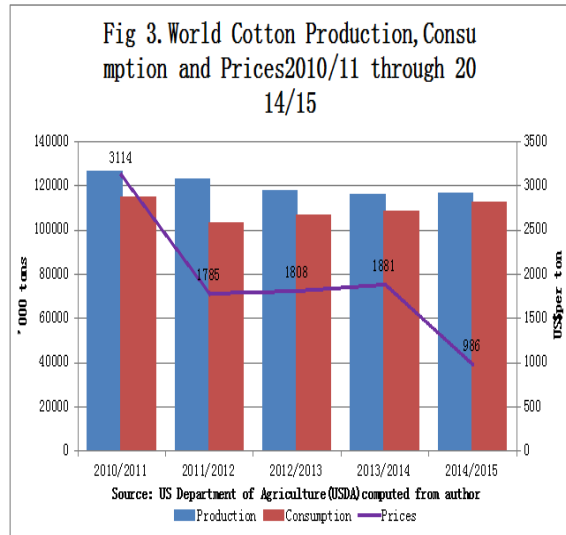Fig 1.World cotton production and global average price of cotton 1999/00-2013/14

Numbers of measures have been yet implemented during this campaign such as increase cotton purchase price and maintain some inputs prices at the same level as the years before. All this proves that Benin cotton problems might be explored elsewhere.

Fourthly, The U.S. cotton crop is projected to rise sharply to 16.3 million bales in 2014/2015, due to both higher planted area and an expectation of lower abandonment. At the same time, lower demand for imports by China is likely to limit U.S. export potential, resulting in increased stocks and lower prices.

Fig 3. World Cotton Production, Consumption and Prices2010/11 through 2014/15

Source: US Department of Agriculture (USDA) computed from author

5 RESULTS

The aim of this part is to confirm or invalidate the global hypothesis (HG) which consists of determining an optimal level of cotton outputs that can be produced in Benin and this, will be made by resolving the following equation known as Cournot competition model.

$$\max \pi_1 = P(q_1 + q_2)q_1 - C(q_1) ; \quad (1)$$

p ($q_1 + q_2$): demand function;

c (q_1): Benin cotton cost function;

$q_1 + q_2 = Q$ where Q is the sum of the outputs of Benin and its competitor, the others world cotton producing countries. All we have to do now is to determine the expression of p and the expression of c (q_1). Now let's look at the table below:

TABLE 2

DETERMINATION OF OPTIMAL LEVEL OF COTTON PRODUCTION IN BENIN (1)

Year	Global average price of cotton p	World cotton production Q	$\dfrac{Q}{(1000 * p)}$	$p - \dfrac{Q}{(1000 * p)}$
1999/ 2000	1182	89100000	75,4	1106,6
2000/ 2001	960	98000000	102,1	857,9
2001/ 2002	909	85000000	93,5	815,5
2002/ 2003	1268	88000000	64,4	1203,6
2003/ 2004	1240	92700000	74,8	1165,2
2004/ 2005	1104	116218000	105,3	998,7
2005/ 2006	1171	122820000	104,9	1066,1
2006/ 2007	1293	120310000	93,1	1200,0
2007/ 2008	1444	107773000	74,6	1369,4
2008/ 2009	1255	102757000	81,9	1173,1
2009/ 2010	2108	116990000	55,5	2052,5
2010/ 2011	3114	126590000	40,7	3073,4
2011/ 2012	1785	122952000	68,9	1716,1
2012/ 2013	1808	118130000	65,3	1742,7
2013/ 2014	1881	115921000	61,6	1819,4
Total	22522		1161,8	21360,2
Simple average	m= 1501,5		d=77,5	q=1424,0

Source: Our results

In most cases there is a linear relationship between the price p and the quantity Q materializes by the following equation:

$p = mQ + b$ (3). To find out whether this could be applied to our case, we will be making a linear regression:
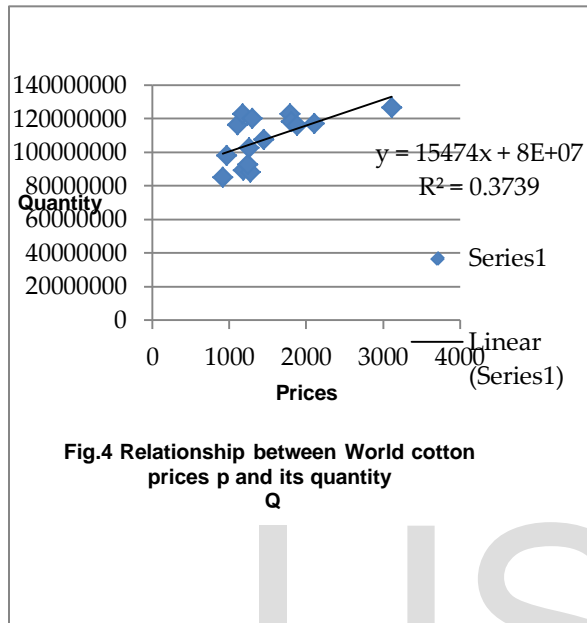

Fig.4 Relationship between World cotton prices p and its quantity Q

So the relation between p and Q is not linear, meaning that the World cotton quantity demand is affecting by more than one factor and therefore we cannot apply the linear demand function that is $p = mQ + b$ (3) to our case. Now let's make a regression analysis of the following model:

$y = \beta_0 + \beta_2 x_2 + k$ (4)   Where $x_2 = \frac{Q}{(1000*p)}$

We will be using the component of the table 3.

TABLE 3
DETERMINATION OF OPTIMAL LEVEL OF COTTON PRODUCTION IN BENIN (2)

Year	Global average price of cotton	World cotton production	$\frac{Q}{(1000*p)}$	$p - \frac{Q}{(1000*p)}$
1999/2000	1182	89100000	75,4	1106,6
2000/2001	960	98000000	102,1	857,9
2001/2002	909	85000000	93,5	815,5
2002/2003	1268	88000000	64,4	1203,6
2003/2004	1240	92700000	74,8	1165,2
2004/2005	1104	116218000	105,3	998,7
2005/2006	1171	122820000	104,9	1066,1
2006/2007	1293	120310000	93,1	1200,0
2007/2008	1444	107773000	74,6	1369,4
2008/2009	1255	102757000	81,9	1173,1
2009/2010	2108	116990000	55,5	2052,5
2010/2011	3114	126590000	40,7	3073,4
2011/2012	1785	122952000	68,9	1716,1
2012/2013	1808	118130000	65,3	1742,7
2013/2014	1881	115921000	61,6	1819,4
Total	22522		1161,8	21360,2
Simple average	m= 1501,5		d=77,5	q=1424,0

Source: Our results

Estimation with Eviews 6.0 gives these first results as shown below:

TABLE 4

ESTIMATION RESULTS FOR COTTON PRICE
MODEL, 2000/01-2014/15

Variable	Coefficient	Std.Error	t-Statistic	Prob
C	116.8972	7.454916	15.68055	0.0000
X2	0.972302	0.004866	199.8168	0.0000
R-squared	0.999675	Mean dependent var	---	1501.467
Adjusted R-squared	0.999649	S.D. dependent var	---	568.8569
S.E. of regression	10.65036	Akaike info criterion	---	7.692631
Sum squared resid	1474.593	Schwarz criterion	---	7.787038
Log Likelihood	-55.69473	Hannan-Quinn crite.	---	7.691625
F-statistic	39926.74	Durbin-Watson stat	---	1.440271
Prob(F-statistic)	0.0000	---	---	

Source: Our results
$R^2 = 0.999675$ $\bar{R}^2 = 0.999649$
This regression shows there is a strong relationship between y and x_2 and so, we can consider this model as being our demand function.

$\hat{y}$ = 116, 8972 +0, 972302 x_2, where $x_2 = \frac{Q}{(1000*p)}$.
Recall that we previously got m =1501, 5 and which represents the simple cotton average price over the last fifteen years. Let's substitute p by m. We got this:
$\hat{y}$ = 116, 8972 +0, 972302*(1501, 5 - $\frac{Q}{1501500}$). We finally realized that: $\hat{y}$ = 1576, 78 - 0, 00000647*$Q + k$

So the demand function can be expressed by: p = 1576, 78 – 0, 00000647*Q + k
Regarding the real k we got this table:

TABLE 5
COTTON PRODUCTION FROM 1999 TO 2014

Year	Value of k
1999/2000	-337
2000/2001	-550
2001/2002	-600
2002/2003	-350
2003/2004	-256
2004/2005	-400
2005/2006	-326
2006/2007	-200
2007/2008	-63
2008/2009	300
2009/2010	600
2010/2011	1619
2011/2012	300
2012/2013	300
2013/2014	300

Despite k does not have the same value, we noticed that it took four times the value of 300. So then we can generalize by writing the final expression of the demand function that is:
p = 1576, 78 – 0, 00000647*Q + 300 that give us:
p= 1876, 78– 0, 00000647*Q
Now let's determine the expression of c (q₁). Total costs are the sum of fixed costs and variables costs and as the fixed costs are supposed to be knowing for each period and because we will have to derive the total cost, the fixed costs may not be taken into account so then we can simplify the expression of the total costs by determining only the variable costs.
To determine the variables costs, we make an assumption that consists of affirming that for each period, Benin cotton production variable costs equal two third (worst case) of its cotton earnings. Let vc be the variable costs for each year, uvc the unit variable cost. So we have: vc = $\frac{2}{3}$q et $uvc = \frac{\frac{2}{3}q}{3q}p = \frac{2}{3}p$
Based on this, we get the following table:

TABLE 6

DETERMINATION OF VARIABLE COSTS

Year	p	q	vc	uvc
1999/2000	1182	362170	285389960	788
2000/2001	960	336528	215377920	640
2001/2002	909	415000	251490000	606
2002/2003	1268	336528	284478336	845,3
2003/2004	1240	336728	278361813	826,7
2004/2005	1104	427156	314386816	736
2005/2006	1171	190857	148995698	780,7
2006/2007	1293	240618	207412716	862
2007/2008	1444	268630	129300573	962,7
2008/2009	1255	210604	176205347	836,7
2009/2010	2108	158863	223255469	1405,3
2010/2011	3114	136958	284324808	2076
2011/2012	1785	174052	207121880	1190
2012/2013	1808	240028	289313749	1205,3
2013/2014	1881	307354	385421916	1254
Mean uvc				1001,0

Source: Our results

$$C(q_1) = 1000.978 * q_1$$

$$\pi = p(q_1 + q_2) * q_1 - C(q_1) \quad (1)$$

$$\pi = (1876,78 - 0,00000647 * q_1 - 0,00000647 * q_2) * q_1 - 1000,978 * q_1$$

$$\frac{\partial \pi_1}{\partial q_1} = 0,00000647 * q_1 + 1876,78 - 0,00000647 * q_1 - 0,00000647 * q_2 - 1000,978$$

$$\frac{\partial \pi_1}{\partial q_1} = 0 \text{ So then}$$
$$0,00000647 * q_1 + 1876,78 - 0,00000647 * q_1 - 0,00000647 * q_2 - 1000,978 = 0$$

This means for the campaign 2013/2014 where the world cotton production is estimated to be 115921000, to find out the level of Benin cotton outputs that maximizes its profit, we will have to solve the set of equations below:

$$2q_1 + q_1 = 135363524$$
$$q_1 + q_1 = 115921000$$

Then we got: $q_1 = 19442524$

Produce 19442524 tons of cotton means that Benin should be part of World's top five cotton producing countries. This also means Benin is 60 times far away from its current cotton production. However this allows us to drawn important information that is: the more Benin will produce cotton, the more it will be economically beneficial and the less Benin will produce cotton, the less it will be economically beneficial. The table below shows the optimal outputs that Benin should produce regarding the world cotton production.

TABLE 7

DETERMINATION OF OPTIMAL COTTON PRODUCTION

Word cotton production(estimation and assumptions)	Estimated optimal outputs for Benin (In tons)	Part of Benin production In world cotton production (%)	Estimated cotton global average prices (USD)
115921000 (2014/2015 est.)	19442524	16,8	1501,2
118204000	17159524	14,5	1500,3
120000000	15363524	12,8	1499,2
130000000 (ass.)	5363524	4,1	1492,7

Fig 5: Global average price estimation and Benin cotton optimal level
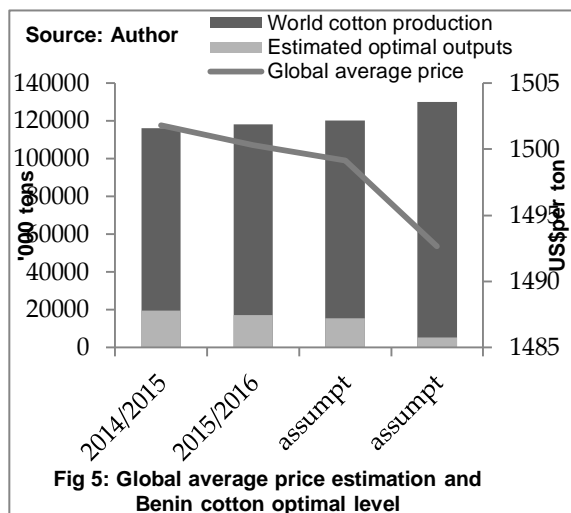
Once the HG has been confirmed, let's focus on the HS that is the poor quality of cotton inputs and their late implementation decreases drastically each year cotton production.

HG will be conducted through the following model:

$$y_i = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \beta_5 x_5 \qquad (2)$$

y_i	x_1	x_2	x_3	x_4	x_5
Cotton outputs level	Rainfall	Area planted	Cotton purchase price	Quality of inputs	Time in inputs distribution

To collect the data coming from x_4 and from x_5, a survey has been conducted and here are the results of this Sampling. We took an equal number of surveys from producers in three municipalities (Banikoara, Gogounou, and Segbana) which most produce cotton, surveying a total number of 150 big producers from these different municipalities. The results from this survey have been presented in the following tables:

TABLE 8

DISTRIBUTION OF UNITS ACCORDING TO THEIR EXPERIENCE

Municipalities and numbers of producers	Modality	Effective	Relative Frequency	Frequency
Banikoara 50	Less than 5 years			
	5-10 years			
	More than 10 years	50	100	33,3
Gogounou 50	Less than 5 years			
	5-10 years			
	More than 10 years	50	100	33,3
Segbana 50	Less than 5 years			
	5-10 years			
	More than 10 years	50	100	33,3
TOTAL		150		100

Source: Author's survey

So then all the surveys have been producing cotton since more than 10 years. This shows that they have much more experience about cotton production.

TABLE 9

DISTRIBUTION OF THE UNITS
ACCORDING TO THEIR PRODUCTION LEVEL

Municipalities and numbers of producers	Modality	Effective	Relative Frequency	Frequency
Banikoara 50	Less than 10 tons			
	10-20 tons	6	12	4
	More than 20 tons	44	88	29,3
Gogounou 50	Less than 10 tons			
	10-20 tons	13	26	8,7
	More than 20 tons	37	74	24,7
Segbana 50	Less than 10 tons			
	10-20 tons	9	18	6
	More than 20 tons	41	82	27,3
TOTAL				100

Source: Author's survey

All the surveys produce at least 10 tons, this is perfectly the requirement that cotton growers in Benin should meet in order to be called big producers and in order to get all kind of benefit that goes with.

TABLE 10

DISTRIBUTION OF THE UNITS
ACCORDING TO THE DROP IN PRODUCTION

	Modality	Effective	Relative Frequency	Frequency
Banikoara	Yes	50	100	50
	No	0	0	0
Gogounou	Yes	50	100	50
	No	0	0	0
Segbana	Yes	50	100	50
	No	0	0	0
TOTAL				100

Source: Author's survey

All the surveys have recognized that there is a drop in their cotton production over the last ten years.
TABLE 11

DISTRIBUTION OF THE UNITS
ACCORDING TO THEIR CAPACITY OF
PRODUCTION

	Modality	Effective	Relative Frequency	Frequency
Banikoara	Less than 5 tons	0	0	0
	5-10 tons	4	8	2,7
	10-20 tons	39	78	26
	More than 20 tons	7	14	4,7
Gogounou	Less than 5 tons	2	4	1,3
	5-10 tons	43	86	28,7
	10-20 tons	2	4	1,3
	More than 20 tons	3	6	2
Segbana	Less than 5 tons	0	0	0
	5-10 tons	7	14	4,7
	10-20 tons	31	62	20,7
	More than 20 tons	12	24	8
TOTAL				100

Source: Author's survey

98 percent of cotton growers have seen their production drop at least by 5 tons. However 48 percent of them have seen their production drop between 10-20 tons over the last ten years. So then, 94.67 percent of cotton big growers are unanimous

on the fact that the inputs quality and the time used in their implementation are the main factors that mostly impact their cotton production level.

TABLE 12
DISTRIBUTION OF THE UNITS ACCORDING TO THE REASON FOR THE DROP IN COTTON PRODUCTION

	Modality	Effective	Relative Frequency	Frequency
Banikoara	Rainfall			
	Area planted			
	Inputs prices	2	4	1,3
	Inputs quality	38	76	25,3
	Cotton purchase prices	2	4	1.33
	Time in inputs distribution	8	16	5,3
	Others			
Gogounou	Rainfall			
	Area planted			
	Inputs prices			
	Inputs quality	34	68	22,7
	Cotton purchase prices	4	8	2,7
	Time in inputs distribution	12	24	8
	Others			
Segbana	Rainfall			
	Area planted			
	Inputs prices			
	Inputs quality	45	90	30
	Cotton purchase prices			
	Time in inputs distribution	5	10	3,3
	Others			
TOTAL				100

Source: Author's survey

Let's set the following assumptions:

$I_1 = 1$ the inputs used are good quality,

$I_1 = 0$ the inputs used are bad quality,

$T_1 = 1$ there is a delay occurs in the inputs implementation,

$T_1 = 0$ the inputs used have been implemented on time.

So we can rewrite our previous model as the following:

$$y_i = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 I_i + \beta_5 T_i \qquad (2)$$

Then, based on the results of table 4 we got the following table:

TABLE 13

TOWARDS ESTIMATION OF COTTON

Years	y_i	x_1	x_2	x_3	I_i	T_i
1999/2000	362170	1018,5	369784	187	1	0
2000/2001	336528	839,9	369784	239	1	1
2001/2002	415000	1045,5	383425	186	1	1
2002/2003	336528	1043,5	303090	155	1	1
2003/2004	336728	1031,8	314096	249	1	1
2004/2005	427156	1176,6	313083	178	0	1
2005/2006	190857	943,1	191216	158	1	1
2006/2007	240618	996	227303	158	1	1
2007/2008	268630	1185,1	253842	166	1	1
2008/2009	210604	887,1	209803	178	1	1
2009/2010	158863	1042,9	145704	159	1	1
2010/2011	136958	963,7	181765	264	1	1
2011/2012	174052	1210,4	208057	364	1	1
2012/2013	240028	1301,6	351189	244	1	1
2013/2014	307354	1075,9	350000	259	1	1

PRODUCTION IN BENIN

The use of value 0 is distributive and could have been put anywhere. With EViews 6, we got the results that follow:

TABLE 14

ESTIMATION RESULTS FOR BENIN COTTON
PRODUCTION MODEL

Source: Our results

Variable	Coefficient	Std.Error	t-Statistic	Prob
II	26407.80	58247.28	0.453374	0.6600
X2	1.007720	0.182970	5.507565	0.0003
X3	-417.7304	249.3826	-1675059	0.1249
X1	33.55687	88.26732	0.380173	0.7118
TI	24670.51	50705.78	0.486542	0.6371
R-squared	0.793512	Mean dependent var		276138.3
Adjusted R-squared	0.710917	S.D. dependent	---	922559.60
S.E. of regression	49604.71	Akaike info crite	---	24.72276
Sum squared	2.46E+10	Schwarz crite.	---	24.95878
Log likelihood	-180.4207	Hannan-Quinn crite.	---	24.72025
Durbin-Watson stat	1.775582	---	---	---

These results show that only the area planted could
explain Benin cotton production level and therefore
we reject the second hypothesis**.**

6 DISCUSSIONS AND CONCLUSIONS

Benin cotton production has been facing one of its
most difficult time where the production has been
drastically dropping. This situation is not due to
bad weather condition or due to the poor quality of
inputs or even due to the lack of management.
What matters is to introduce some news and
moderns agricultural tools and inputs such as the
use of tractors and the use of GMC. Cotton
represents 75 percent of Benin's export earnings
and therefore needs a particular attention to make
this sector more competitive and more profitable.

First of all, we found that given a world cotton
production level, there is an optimal level of
output that Benin can produce in order to
economically take advantage of its cotton
production. What we most learnt about this is that,
Benin current cotton production is 60 times less
high than its optimal level. Much more works
needs to be done to significantly increase cotton
production and get the desired level. The first
thing that urges to do is to modernize cotton
production in Benin (Moumouni & Idrissou, 2013).
Benin is known as one of the African top five
cotton producers and has been producing cotton
since early 1960 and all this time, we have been
using hands to produce cotton. To produce more,
we better have to change this way by introducing
news and moderns production tools such as the
use of tractors. What now makes Burkina Faso
better than Benin in term of cotton production is
the use of the Genetically Modified Cotton (GMC).
A few years ago, Benin had been producing more
cotton than Burkina Faso but since this country has
adopted the GMC, it surpassed Benin in term of
cotton production. The use of the GMC could also
contribute to fix some problems regarding the use
of pesticides, known as being dangerous for all
kind of living being. In the document entitled "A
report for PAN UK's Pesticides Poverty and Live
hoods project" which has been released in Benin in
August 2010, 73 intoxication cases have been
recorded in 2009 with 37 death cases. According to
the same document there are also some
environmental problems due to the use of
pesticides since several animal species are
threatened in the cotton growing areas during the
period of "phytosanitary" treatments. The most
affected species are earth-worm, bees, snakes and
rodents. But the mentioned problems could be

reduced when using the GMC since they require little use of pesticides.

Second of all, we have got different world cotton prices given world cotton production. Because of rapid ongoing structural changes in the cotton market, it very hard to forecast cotton price and even it does, some models such as those used by the USDA, tended to overestimate cotton prices in recent years. Our findings are therefore important since it can improve the existing models.

Thirdly, our survey shows that 95 percent of cotton growers are unanimous on the fact that the input quality especially the pesticides supplied to them are the only reason that explains the drop in their cotton production over the last fifteen years.

The same survey shows that they are 98 percent strongly supportive to pay a higher price to solve fix this problem. Unlikely we found that the area planted is the only variable that explains cotton production in Benin. This finding is extremely important since we also have found that to be more profitable, cotton production in Benin should be 60 times more higher that its current level. And based on our finding, to increase significantly cotton production Benin should widely increase its cotton area planted. This can be done since only 30 percent of Benin topsoil have been using. But we strongly think that is time not to let only farmers produce cotton, Benin's government should now implicate itself in cotton production by starting producing cotton with news and moderns agricultural tools. The suggestion we are making is that Benin government instead of being only responsible for cotton production could hire some hand workers every cotton season, supply them with moderns tools, and make them produce cotton. We think that is the only way to increase significantly cotton production in Benin.

The fact we conducted our study over the last fifteen years could have an impact on our findings since some estimations have been made and this could have been improved by taking into account a wide and diversified data but our intention was to identify some problems that have been occurring on cotton sector over the last fifteen years in order to fix them.

Our survey has not been conducted by ourselves but has been made by friends whose time and resources are limited and could have been wide if

conducted by ourselves. The simplicity of the survey could also have a real impact on our result but has to be done that way since most of the surveys are growers and cannot fill out the questionnaire by themselves so they have to be directly question (most of time in the work time) and report their opinion. The component of the demand function that we used has been found sometimes by using their repetitive values and sometimes by using their average. This could also have an impact in our results.

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