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Full length Research paper

Organic farming makes cotton production the most cost effective: Case study from Benin

Tovignan DS[1*] and Vodouhe S[2]

[1]Faculty of Agronomy, University of Parakou (UP), Benin.
[2] Faculty of Agronomic Sciences, University of Abomey-Calavi (UAC), Benin
Corresponding author: Dr. Silvere TOVIGNAN, research fields: Agricultural economics

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This article analyses the relative production cost of different cotton options in Benin. In fact, challenges faced by the conventional cotton sector lead to the introduction of two alternatives of cotton farming in Benin: cotton made in Africa (CmiA) and organic cotton. Data for this study were collected in three production zones (Banikoara, Wassa Péhunco and Kandi) in northern Benin on farmers' socio-economic characteristics and inputs used for cotton production. A detailed questionnaire was used with 180 cotton farmers (60 per alternative of cotton farming) selected by a stratified sampling method. The results show that the average relative production cost (in fcfa per hectare) is 193,725; 227,479; and 169,242 for conventional, CmiA, and organic cotton, respectively. The ANOVA test reveals a highly significant relative cost differences among production alternatives. Accordingly, organic cotton in comparison with the conventional and CmiA, is the most cost efficient alternative of cotton farming in northern Benin. A linear regression model reveals that the major socio economic determinants of the relative production cost level are: farmers' experience in cotton production, the size of cotton field, the size of maize field, and the adoption organic farming practices.

Key words: Relative cost, Sustainable cotton production, organic farming, cotton made in Africa, Benin.

INTRODUCTION

In many countries in West Africa, cotton represents the engine of economic development [1]. In Benin, the third largest cotton exporter in West Africa, after Mali and Burkina Faso, the crop is the main source of growth of national economy, representing 13% of GDP and 80% of export revenue [2]. It represents the best organized agricultural supply chain and is a direct source of cash income for 325,000 farmer households and more than 3,000,000 people [3].In spite of this importance, cotton production faces economic, environmental, and social challenges. From economic perspective, the West African cotton sector in general is subject to changes on the global market distortions, including subsidies of western countries to their cotton producers. On the environmental side, the excessive usage of fertilizers and pesticides has resulted in soil degradation, pollution of groundwater, imbalance of ecosystems, destruction of living organisms, pest resistance to pesticides and lower yields [4,5,6,7] From a social point of view, the misuse of pesticides leads to cases of food poisoning, disease and death in extreme cases[4,7].

In this context of challenges which compromises the viability of cotton sector in Benin, the policy-makers have shown increasing interest in various production alternatives towards sustainable cotton farming. As a result, for over a decade, different cotton options have been promoted. Currently, three main alternatives for cotton farming are being observed in Benin: conventional cotton, cotton made in Africa (CmiA), and organic cotton. Considering economic viability as first condition, a sustainable alternative of cotton farming should minimize the inputs (i.e. fertilizers, labour, insecticides, etc.) quantities, implying minimum production costs. Later on, it should maximize the yield, so to ensure a positive balance between production and inputs. Focusing on the

*Correspondingauthor. E-mail tsilvere@yahoo.fr

Table 1: Comparing the farming practices applied on the three alternatives of cotton

Criteria	Conventional	CmiA	Organic
Soil fertility management practices and ingredients	Mineral fertilizers	- Mineral fertilizers - Compost and green manure - Crops rotation	- Compost and green manure - crops rotation
Pest management practices and ingredients	Synthetic pesticides	Synthetic pesticides with exclusion ones on the 1a and 1b list of WHO	- Agro ecosystem balance - Natural pesticides based on plant extracts
Control system	No traceability No verification No certification	Traceability Verification	Traceability Certification
Advantage at market place	No Premium price	- No Premium price - Investment in education infrastructures	Premium price directly paid to farmers can reach 20% above conventional price

production costs, this study aimed to compare the cost efficiency of the three alternatives of cotton production and analyze the major driving forces underlying the cost level under different alternatives.

MATERIALS AND METHODS

Clarification of the Concepts

The difference between the three alternatives of cotton farming is not related to genetics but to the farming practices and some advantages at market place (Table 1).

Study area and database

Based on the three alternatives of cotton farming, the three municipal areas were selected with the support of agricultural extension officers. As a result, Banikoara, Wassa Péhunco and Kandi were selected. Banikoara is the first municipality in terms of cotton production in Benin, where the cotton farming systems mainly followed the conventional alternative. CmiA producers were located in Wassa Péhunco where the most experienced farmers of this production alternative are found. Concerning organic cotton, it was promoted by OBEPAB and the municipal area of Kandi was selected.

The research units were farmers producing cotton in general. A total of 180 cotton farmers (60 per municipality, implying per alternative of cotton farming) were randomly sampled at each municipality. Data collected were about the farmers' socio-economic characteristics and the quantities and prices of inputs involved in cotton production. The study was conducted by survey methods on respondents using structured interviews based on a questionnaire. The questionnaire is structured in three parts: farmer' demographic data, farm management activities and farming operations costs. Statistical analysis was performed using the software STATA 11. ANOVA tests were used to compare cost differences among production alternatives while a linear regression model based on Ordinary Least Square (OLS) estimation was used to highlight the determinants of the cost level.

RESULTS

Farmers' socio-economic characteristics

The main socio-economic characteristics of the respondents (Table 2) show that men (about 90%) are the major actors in cotton farming. There was no woman found in conventional cotton. The highest proportion of women (23%) was found in the group of organic cotton. On average, farmers applying conventional alternative of cotton farming are the oldest, more experienced in cotton production, and educated. Furthermore, they have the biggest households, and the biggest cotton farms and maize farms. Considering the land acreage, conventional alternative is the most important form of cotton farming in the study zone. However, the CmiA alternative provides the highest yield.

Relative production cost under cotton production alternatives

Considering the different production alternatives, the average production cost of one hectare of cotton were found to be 193,725 (± 24016.72) fcfa/ha, 227,479 (± 26381.16) fcfa/ha, and 169,242 (±48787.64) fcfa/ha for

Table 2: Socio-economic and demographic characteristics

Variables	Conventional	CmiA	Organic	Total
Qualitative Variables a				
Female	0 (0)	03 (5)	14 (23.3)	17 (09.44)
Male	60 (100)	57 (95)	46 (76.7)	163 (90.56)
Quantitative Variables b				
Age (Number of years)	43.5 (9.94)	39.31 (9.28)	41.98 10.56)	41.6 (10.03)
Experience in cotton production(Number of years)	18.76 (8.03)	3.73 (1.31)	5.75 (5.62)	9.41 (8.76)
Level of education(Number of years)	1.68 (3.38)	1.13 (1.85)	0.42 (1.64)	1.07 (2.46)
Household size (Number of persons)	14.13 (7.18)	10.88 (4.73)	9.98 (5.93)	11.66 (6.25)
Size of land under cotton (Ha)	8.20 (6.53)	2.10 (1.38)	1.27 (0.97)	3.85 (4.96)
Size of land under maize (Ha)	3.9 (2.88)	1.95 (0.96)	2.29 (2.01)	2.71 (2.26)
Cotton yield (Kg/ha)	728.3 (215.7)	751.2 (318.8)	702.3 (281.8)	727.3 (274.6)

a: Values in brackets are relative frequencies; b: Values in brackets are standard deviations

Table 3: Relative production costs per production alternative

Costs	Conventional	CmiA	Organic	ANOVA tests
Variables	69827.64a (16049.55)	91491.65b (30035.05)	53830.83a (49325.22)	F = 17.90 df = (2, 177) P = 0.0000
Fixed	5039.09a (3822.69)	9912.27a (12078.61)	31094.44b (29262.15)	F = 33.97 df = (2, 178) P = 0.0000
Household labour	118858.42a (26571.64)	126075.7a (35763.44)	84316.944 b (48691.04)	F = 20.59 df = (2, 178) P = 0.0000
Total	193725.16a (24016.72)	227479.63b (26381.16)	169242.22c (48787.64)	F = 42.13 df = (2, 178) P = 0.0000

Note: fcfa 1 = Euro 655; for each type of costs, values with the same letters (a, b or c) are statistically equal whereas values with different letters (a, b or c) are statistically different at 1% level (P < 0.01).

conventional, CmiA, and organic cotton, respectively .ANOVA tests reveal highly significant differences (P < 0.01) between types of costs and production alternatives (Table 3). Variable costs were significantly lower (P < 0.01) in organic and conventional farming alternatives. Fixed costs were significantly lower (P < 0.01) in conventional and CmiA alternatives. Household labour-related costs were significantly lower (P < 0.01) in organic alternative. Considering the overall production cost, organic cotton was found to be the most cost efficient alternative, followed by the conventional cotton. Indeed, the production cost for 1 ha of organic cotton was significantly lower compared to conventional and CmiA alternatives.

The regression model estimation in table 4 is globally significant with 43% of production cost variation explained by the variables introduced in the model.

Results show that the main determinants of the cost level are: farmers' experience in cotton production, cotton land acreage, maize land acreage, and organic alternative of cotton farming. The more experienced is the farmer, less are his production costs, experience is

Table 4: Results of the regression model

Variables	Coefficients	P>z
Socio-economic characteristics (Z)		
Age	0.001 (0.001)	0.246
Sex (1/0)	0.010 (0.050)	0.834
Experience in cotton production	-0.006** (0.002)	0.028
Level of education	-0.004 (0.005)	0.365
Household size	-0.003 (0.002)	0.248
Cotton land acreage	-0.013*** (0.004)	0.002
Maize land acreage	0.014* (0.008)	0.098
Production alternatives (A)		
Conventional (1/0)	(omitted)	-
CmiA (1/0)	0.005 (0.048)	0.915
Organic (1/0)	-0.331*** (0.050)	0.000
Model summary		
Constant	12.305*** (0.087)	0.000
Observations (Parameters)	180 (9)	-
R-square	0.43	-
Chi2 (Probability)	138.21*** (0.0000)	-

Note: The values in bracket are the standard-errors; *, **, *** significant at 10%, 5%, and 1%, respectively.

therefore one important production input to consider in cotton farming. The increase of the cotton land acreage leads to the decrease of relative production costs, meaning that, irrespective to farming system, cotton production is responsive to economy of scale. The relative production costs of cotton vary in the same direction with maize land acreage. This can be linked to farmers' behaviour to direct cotton inputs to food crops production, basically maize. The regression results confirm also that the organic system lowers significantly the relative production cost.

DISCUSSION

The household labour seems to play a quite significant role in the cotton production as it records the highest production costs as compared to variable and fixed costs. For all the three alternatives farming of cotton, the family labour cost is above the 50 percent of the total production cost. Most studies using gross margin as efficiency indicator fail in observing such prominence of household labour in cotton production. Even farmers themselves can hardly detect the value of family labour in their cotton business; they mostly rely on the global amount of money gained from selling cotton.

Organic cotton was found to be the most cost efficient alternative. Indeed, organic farming in general is acknowledged as a beneficial system for the overall health of and environment. From a global perspective, organic farming is mainly characterised by the prohibition of a majority of synthetic chemicals in both crop and livestock production [8]. Therefore, cost related to variable inputs such as chemicals, fertilisers and pesticides widely used in other farming alternatives are saved. Nevertheless, organic system often bears higher fixed costs. According to Lampkin [8], the term holistic is widely used to describe the management approach utilized in organic farming. This refers to the set of principles/regulations enshrined in organic farming that determine standards and practices across the whole farming system, in contrast of the application of agro-environment prescriptions (for example) where the intent is to target specific elements of the farming system.

Results reveal that CmiA(the most recent cotton farming system introduced in Benin) has the highest production cost. This is due to the combination of conventional inputs and organic ones (mainly as regard to soil fertility management) applied by CmiA farmers. Following the argument that learning from experience reduces allocating errors [9] the results of the regression model reveal that most experienced farmers have lower production cost. Similar results were found by [10], who showed that most experienced farmers are the more cost efficient.

This confirms farmers' experienceas a factor reducing significantly the relative production cost per hectare. As consequence, CmiA farmers are on average the less experienced than conventional and organic farmers (see table 2). Therefore, CmiA farmers still need time to master the best combination of input to minimize production cost.

CONCLUSION

This study compares three cotton farming systems using the approach of costs valuation. The results highlight that organic cotton is the most cost efficient alternative for cotton farming in northern Benin. Accordingly, organic farming appears as a production alternative in favour to the economic theory as it helps to minimize the production cost. Nevertheless, it might not support the income maximisation expectation that is not considered

in the current study. Independently from farming alternative, the production cost reduces when farmers gain experience. It is therefore important to set up policies that support farmers during the early stage of the adoption of sustainable agricultural practices.

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