cogent food & agriculture

FOOD SCIENCE & TECHNOLOGY | RESEARCH ARTICLE

Adoption of organic agriculture: Evidence from cocoa farming in Ghana

Justice G. Djokoto[1,2]*, Victor Owusu[2] and Dadson Awunyo-Vitor[2]

Received: 02 July 2016
Accepted: 19 September 2016
First Published: 03 October 2016

*Corressponding author: Justice G. Djokoto, Agribusiness Management Department, Central University, Accra, Ghana; Department of Agricultural Economics, Agribusiness and Extension, Kwame Nkrumah University of Science and technology, Kumasi, Ghana
E-mail: dgameli2002@gmail.com

Reviewing editor:
Fatih Yildiz, Middle East Technical University, Turkey

Additional information is available at the end of the article

Abstract: Cocoa farmers in Suhum area have been cultivating conventional cocoa for several years. However, as at 2012 about 1,000 farmers had switched to the cultivation of cocoa organically. The question that arises is, what factors could have influenced this small fraction of farmers to adopt organic production practices, whilst the majority continue in conventional cocoa production? Using data on 280 organic cocoa farms and 378 conventional cocoa farms from Suhum Cocoa District in Ghana, a probit model was fitted to the data. Being male positively influenced adoption of organic cocoa production. Smaller households have a tendency of adopting organic technology. Less cocoa farming experience led to probability of adoption of organic cocoa production. Access to extension services promotes adoption of organic cocoa technology. Access to credit positively influenced adoption of organic cocoa production with a marginal effect value of 0.1295. Therefore, increased and effective extension and credit services are recommended to enhance adoption of organic cocoa production.

Subjects: Agriculture & Environmental Sciences; Economics; Economics, Finance, Business & Industry; Environment & Agriculture; Food Science & Technology

Keywords: adoption; cocoa; Ghana; organic agriculture; probit

ABOUT THE AUTHORS

Justice G. Djokoto, a Senior Lecturer at Central University, Accra. One of his recent publication is Djokoto, J.G., Afrane-Arthur, A.A., and Badu-Prah, C. (2015). Adoption of Fair-trade Practices by Cocoa Producers in Eastern Ghana. *Central Inquiry 1*(1), 11–26. The current study is a paper from his PhD thesis.

Victor Owusu, a Senior Lecturer at KNUST in Ghana. One of his recent publication is Nunoo, I., & Owusu, V. (2015). Comparative analysis on financial viability of cocoa agroforestry systems in Ghana. *Environment, Development and Sustainability*, 1–16. This paper is culled from the thesis Victor supervised.

Dadson Awunyo-Vitor, a Senior Lecturer at KNUST in Ghana. One of his recent publication is Awunyo-Vitor, D. (2016). What drives mobile money services demand by farmers in Ghana? A study of maize farmers. *International Journal of Management Practice*, *9*(2), 173–191. This paper is culled from the thesis Dadson supervised.

PUBLIC INTEREST STATEMENT

Cocoa farmers in Suhum area have been cultivating conventional cocoa for several years. However, as at 2012 about 1,000 farmers had switched to the cultivation of cocoa organically. The question that arises is, what factors could have influenced this small fraction of farmers to adopt organic production practices, whilst the majority continue in conventional cocoa production? This study is based on 280 organic and 378 conventional cocoa farms from Suhum Cocoa District in Ghana. Being male positively influenced adoption of organic cocoa production. Smaller households have a tendency of going into organic cocoa production. Less cocoa farming experience led to likelihood of adoption of organic cocoa production. Access to extension services promotes adoption of organic cocoa technology. Cocoa farmers with opportunity to take credit are more likely to go into organic cocoa production. Therefore, increased and effective extension and credit services are recommended to encourage adoption of organic cocoa production.

1. Introduction

For more than five decades now, in response to pests and disease, farmers have adopted the use of synthetic materials in cocoa cultivation (Batman, 2010). This deviated from the *hitherto* uncertified organic cultivation practices. Recently however, some farmers in the Suhum Cocoa District in the Eastern region of Ghana, adopted certified organic cocoa cultivation. As at the end of 2012, 1,000 cocoa farmers had signed on to the environmentally friendly production practice (Yayra Glover Limited (YGL), 2013). This number constitutes a small fraction of the 18,425 estimated cocoa farmers in the district. Therefore, what factors could have influenced this small fraction of farmers to adopt organic production practices, whilst the majority continue in conventional cocoa production? The objective of this chapter is to investigate the factors responsible for adoption of organic cocoa production.

Cocoa production is a major economic activity for over 700,000 households, with around 6.3 million Ghanaians (representing around 30% of the total population) depending on cocoa for their living (Afari-Sefa, Gockowski, Agyeman, & Dziwornu, 2010). The export of the beans continues to be key foreign exchange earner for the country. With declining soil fertility and diseases, the need to clear new areas particularly in the forest, which is conducive for cocoa cultivation, is high. And this poses environmental challenges. Therefore, any production practice that uses existing land in a more environmentally friendly manner is of relevance to society. Hence, factors that influence adoption of organic cocoa cultivation will be useful for policy purposes. Moreover, although published works on adoption of organic production practices exist, that on organic cocoa is rare. This study provides empirical evidence for adoption of organic cocoa production.

Section two of this article presents the principles of organic production, the theoretical review as well as the empirical literature, pertinent to technology adoption. The model specification and method of analysis are outlined in section three. The results obtained from the previous section are presented and discussed in section four. The article concludes with conclusions and recommendations section.

2. Literature review

2.1. Principles of organic farming

Organic farming is governed by rules, the generality of which has been established by the International Federation of Organic Agriculture Movements (IFOAM). The most important internationally accepted standards, consisting of a multitude of rules on cultivation, pest and weed control, and animal husbandry have been set out in International Federation of Organic Agriculture Movements (IFOAM, n.d.). Organic farming is an especially environmentally friendly farming style that aims to run the farm as an integrated system (Best, 2010; Mader et al., 2002). This is based on four principles, namely; health, ecology, fairness and care.

The principle of health posits that, organic agriculture should sustain and enhance the health of soil, plant, animal, human and planet as one and indivisible. The key characteristics of health are immunity, resilience and regeneration. Health in this context is not simply the absence of illness, but the maintenance of physical, mental, social (World Health Organization (WHO), 1946) and ecological well-being.

Production is to be based on ecological processes, and recycling. This is the principle of ecology. Organic operators must therefore work with the living systems, emulate them and help sustain them. Nourishment and well-being are achieved through the ecology of the specific production environment. Apart from organic farming, pastoral and wild harvest systems should fit the cycles and ecological balances in nature. Recycling (through reuse), efficient management of materials and energy in order to maintain and improve environmental quality and conserve resources are encouraged.

Fairness is characterised by equity, respect, justice and stewardship of the shared world, both among people and in their relations to other living beings. The goals of fairness are: (1) Produce sufficient supply of good quality food and other products. (2) Build on relationships that ensure fairness with regard to the common environment and life opportunities. (3) Animals should be provided with the conditions and opportunities of life that accord with their physiology, natural behaviour and well-being. (4) Natural and environmental resources that are used for production and consumption should be managed in a way that is socially and ecologically just and should be held in trust for future generations.

In organic agriculture, precaution and responsibility are the key concerns in management, development and technology choices. This principle of care emphasises that whilst science is a necessary condition to ensure that organic agriculture is healthy, safe and ecologically sound; practical experience, accumulated wisdom and traditional and indigenous knowledge, which offer time tested valid solutions are sufficient conditions for organic production. Organic agriculture should prevent significant risks by adopting appropriate technologies and rejecting unpredictable ones. Decisions should reflect the values and needs of all who might be affected, through transparent and participatory processes. The principle of care enjoins practitioners to manage resources in a precautionary and responsible manner to protect the health and well-being of current and future generations and the environment[1].

The employment of these principles has led to some key practices in organic cocoa production (Table 1). These contrasts with conventional production practices that differ based on planting, weed, pest and disease control (Table 1).

2.2. Organic production technology and organic certification

Uncertified organic production is a common practice in many areas of the developing world. However, the certification of organic agriculture is relatively recent (Bouagnimbeck, 2013; Paull, 2013). In some countries, the commercial use of the term *organic* is legally restricted.

Table 1. Conventional and organic cocoa cultivation practices

Practice	Conventional practices	Organic practices
Planting	Spacing: 3 × 3 m. Seedlings from clean nurseries or planting at stake	Spacing: 3 × 3 m. seedlings from only organic nurseries
Weed control	Manual weed control, use of cover crops and recommended chemicals	Weed regularly manually. Use cover crops No chemical weed control
Pests and diseases control	Remove mistletoes, dead branches and black pods	Remove mistletoes, dead branches and black pods.
	Collect and burn away from the farm diseased pods once a week to prevent spread of black pod disease. When necessary to bury on the field, bury 60 cm deep. Remove pods with even small sign of black pod attack. Apply recommended chemicals. Dosage 85–500 ml/ha depending on pesticide	Collect and burn away from the farm diseased pods once a week to prevent spread of black pod disease. When necessary to bury on the field, bury 60 cm deep. Remove pods with even small sign of black pod attack
		Spray with neem tree extract when sanitation practices are inadequate
		Apply 40 ltrs/ac = 3 mistblowers/acre
		Wear protective clothing
	Wear protective clothing	Other permitted products can be used
Fertility management	Apply NPK fertilisers such as *Asaase Wura* and *Cocofeed*. Others are triple super phosphate and ammonium sulphate	Improve fertility with use of cover crops, leguminous plants, compost making, farm yard manure and planting shade trees. Other permitted products can be used

Notes: From Opoku-Ameyaw et al. (2010); AGROECO (n.d.). Fieldbook: Organic and fairtrade cocoa AgroEco: www.agroeco.net.

Certification is based on a pledge by certificated farmers (operators) to comply by some standards. These standards are produced and enforced by both private institutions and governments (Latruffe & Nauges, 2014). Some countries in Europe such as France and Germany had national standards. The UK Soil Association (UKSA) also has standards. The European Union standards are however in force in Europe, although UKSA still operates independently of the EU standards. Australia, Canada, Japan and the United States of America (US) have their national standards (Mayen, Balagtas, & Alexander, 2010). Although for commercial purposes, there are varying levels of recognition of certification (standards), organic practices may be recognised so long as they are certified by a national or international organic certifying body (Djokoto, 2015).

The process of certification starts with an application for certification. The applicant completes a questionnaire. Where the land has ever been cultivated, applicants are granted *in-conversion* status. When this period (usually two years) elapses, full organic status is granted. After the first inspection, annually, there is inspection to ensure compliance. Prior to application, the farmer must study the appropriate organic standards. Farmers are expected to ensure farm facilities and production methods conform to the standards. Extensive documentation is required. This details farm history and current set-up, and usually includes results of soil and water tests. To enhance subsequent documentation, record-keeping forms an integral part of organic agriculture. The record-keeping involves written, day-to-day farming and marketing records and covers all activities which must be available for inspection at any time. A written annual production plan would usually be submitted. This contains everything from seed to sale: seed sources, field and crop locations, fertiliser application and pest control activities, harvest methods, storage locations among others.[2]

2.3. Theoretical review
The theory of planned behaviour and diffusion of innovation theory are relevant in the investigation of adoption behaviour (Ajzen, 1985; Rogers, 1995, 2003). In the view of Rogers (1995), the adoption of innovation is related to innovation decision process made up of four stages. These are knowledge acquisition, persuasion, decision and confirmation.

Traversing the four stages is influenced by the information receivers' socio-economic characteristics, social systems and characteristics of the innovation. Kaiser, Wölfing, and Fuhrer (1999) noted that, environmental attitude alone is often a poor predictor of behaviour; a wide range of other factors that are beyond the control of the decision-maker exists. The theory of planned behaviour (Ajzen, 1985) which incorporates the role of social pressures and the perceived difficulty in carrying out the behaviour is advocated.

2.4. Empirical review
Following from the theory of diffusion of innovation by Rogers (1995), socio-economic characteristics of the sample could have significant effect on the decision-making process towards adoption. These may well be farm and farmer characteristics; age of farmer, gender of farmer, education of farmer and size of farmer's household. Others are participation in agricultural extension activities, experience in farming and membership of farmer-based organisation.

Tiffin and Balcombe (2011) studied 237 (151 conventional, 86 organic) horticultural producers in UK. Based on cross-sectional data collected in 1996 and using Bayesian averaging model, they found that age of farmer did not significantly influence adoption of organic technology. Earlier, Burton, Rigby, and Young (2003) found a negative and statistically significant coefficient for the age variable using the same data-set but with duration analysis.

For fruit and vegetable farmers in France, Mzoughi (2011) concluded that there was no effect of age of farmers on adoption of organic technology. This result was based on a logit model using data collected in 2008/2009 on 134 conventional farmers and 38 organic farmers. Jayawardana and Sherief (2012) also reported similar results for coconut farmers in India based on correlation analysis. Hattam and Holloway (2005), Best (2010) and Thapa and Rattanasuteerakul (2011) have also reported similar results for Mexico, Nigeria, Germany and Thailand respectively. The findings of Anderson, Jolly, and Green (2005) about fresh-market produce sector in California, USA were not different.

Despite these neutral effects of age of farmer on organic technology adoption for diverse crops and geography, Genius, Pantzios, and Tzouvelekas (2006), Kassie, Zikhali, Manjur, and Edwards (2009), Kallas, Serra, and Gil (2010), Läpple and Rensburg (2011), Läpple (2013) and Rana, Parvathi, and Waibel (2012) reported statistically significant effect of age of farmer on organic technology adoption. The study of Genius et al. (2006) was based on 118 conventional farmers and 44 organic farmers of diverse crops in Crete, Greece. Employing a probit model, it was observed that younger farmers adopted organic farming more than older farmers. Kassie et al. (2009) studied farmers of diverse crops in Ethiopia using logit estimations and showed similar negative effect of age on organic technology adoption. The evidence of Kallas et al. (2010) was for grapes in Spain, based on 26 organic and 94 conventional farmers. Younger farmers had a higher probability to adopt organic technology as in the findings of Läpple (2013) and Rana et al. (2012). Wollni and Andersson (2014) provided a contrary conclusion for agricultural producers in Honduras. Fitting data from 47 organic and 192 conventional households to a probit model, they found that age of head of household was positively related to adoption of organic technology. These evidences provide mixed effects of age of farmers on adoption of organic farming.

Adoption of organic technology may be influenced by gender. Ragasa (2012) in a review of technology adoption in agriculture concluded from 35 case studies that, women have much slower observed rates of adoption of a wide range of technologies than men. This was attributed to differentiated access to complementary inputs and services. Specifically for organic technology, Tovignan and Nuppenau (2004) collected data on 200 cotton farmers equally split between conventional and organic producers in the year 2003/2004 in Benin. Using a logit model they showed that, gender distinguished organic technology adopters from non-adopters. Burton et al. (2003), Kassie et al. (2009) and Tiffin and Balcombe (2011) provided similar evidence. However, Mzoughi (2011) observed that for diverse crop farmers in Nigeria and horticultural farmers in France respectively, gender does not distinguish adopters of organic technology from non-adopters. Thus although technology adoption is often distinguished based on gender, there rare cases in which this is not the case.

In Benin, Tovignan and Nuppenau (2004) showed that households with large family sizes were more amenable to adopting organic technology in cultivating cotton. Wollni and Andersson (2014), Sarker, Itohara, and Hoque (2009) and Kisaka-Lwayo (2008) provided similar findings for Honduras and South Africa respectively. The Sarker et al. (2009) study was conducted with 195 Bangladeshi farmers. In the South African case, the data was collected between October and November 2004 from 151 organic farmers and 49 conventional farmers and analysed using discriminant analysis. Burton et al. (2003) also provided evidence from UK for horticultural producers. These conclusions were based on the fact that farm households rely on household members for non-mechanised farm operations in many developing countries. However, Tiffin and Balcombe (2011) applied Bayesian averaging method to the data of Burton et al. (2003) and showed that, the positive coefficient of household size did not impact adoption of organic technology significantly. The review on household size also point to mixed conclusions although the influence of large households on technology adoption preponderates.

Whether formal or skill-based, education should be influential in the decision to adopt technology, more so, organic technology. Since information is the centre piece of education, the ability and or access to information would contribute to making informed decisions more so as certified organic technology is an innovation. Also, in organic farming, record keeping is a necessary requirement (Djokoto, 2015). Tovignan and Nuppenau (2004), Genius et al. (2006), Kassie et al. (2009), Mzoughi (2011) and Latruffe and Nauges (2014) have confirmed this in the specific case of organic technology adoption. They all showed that higher level of formal education was strongly associated with adoption of organic farming. The conclusions of Takagi (2010) was based a logit model estimation with a sample of 200 vegetable farmers in Indonesia. These plausible evidence notwithstanding, a neutral effect of education on organic farming technology adoption was found by Hattam and Holloway (2005), Best (2010) and Thapa and Rattanasuteerakul (2011). Thus evidence of the positive influence of education on organic technology adoption is emphatic.

Farmers who have engaged in agriculture over a long time are likely to acquire more experience about the successes and failures of the technology employed to turn out products. Over time, experience would support overcoming challenges hence; the farmer would stick to the technology already being practiced. On the contrary, experience of failures from the past would also motivate them to seek new technologies for the purposes of trying them out. Therefore, the effect of experience of farmers would be a mixed. Hattam and Holloway (2005) concluded that experience in farming was negative and statistically significantly related to adoption of organic technology. Rana et al. (2012) on the other hand showed that, experience in farming positively and statistically significantly influenced technology adoption. Thapa and Rattanasuteerakul (2011) also reported a positive but statistically insignificant coefficient.

The empirical review shows that logit and probit models have been applied in the modelling adoption although Bayesian averaging and duration analysis was found. The data have largely been cross-sectional data dating back to the mid-1990s from developed and developing countries. The products covered were mostly crops; fruits, vegetables, cotton, coconut, grapes among others. However, none of the studies was on cocoa. Therefore, we report the investigation of adoption of organic cocoa in this article.

3. Methodology

3.1. Research area

At the time of data collection in 2014, organic cocoa production in Ghana was only located in the Suhum-Craboa-Coalter district of the Eastern Region of Ghana. The total land area is about 850 km^2 with 20% of this area under cocoa cultivation contributing more than 500 metric tonnes of beans (YGL, 2008). According to Ayenor et al. (2004) about 600 ha of land was under organic cocoa by 2003. Since then, significant progress has been made. More than 10,000 ha are under organic cocoa cultivation made up of more than 1,000 organic certified farms (YGL, 2013).

3.2. Data collection

As the article seeks to assess the organic cocoa farmers, the defined populations are thus growers of conventional cocoa and growers of organic cocoa. Thus, the population of organic cocoa farmers are those who grow organic cocoa in the Suhum area. In order to obtain farmers with similar operating environment, the population of conventional cocoa growers is defined to be in the Suhum Cocoa district as well. According to the Yayra Glover Limited, the firm that facilitates organic cocoa production in the study area, there are 1,000 organic cocoa farmers operating in the Suhum-Craboa-Coalter District. Whilst the cocoa health and extension division (CHED), responsible also for extension services to cocoa farmers, put the number of conventional cocoa farmers in the district at 18,425. From these sub-populations, the sample size of 278 and 378 organic and conventional farms were determined respectively.

For the organic population, a list was obtained from Yayra Glover Limited, whilst CHED office in Suhum provided a list for the conventional sub-population. For each list, the sample size was proportioned based on communities of the sample frame. From these proportions, simple random sampling was used to select the sample of farmers.

For purposes of controlling for environmental differences, for each organic cocoa community sampled, a nearby community growing conventional cocoa was sampled. This neighbouring criterion allows for two subsamples with an analogous composition (Guesmi, Serra, Kallas, & Gil Roig, 2012; Madau, 2007; Tzouvelekas, Pantzios, & Fotopoulus, 2002). A cocoa farm is operationalised as a crop farm that has more cocoa plants than any other cultivated plant in the farm and that organic practises will be applied to the other plants.

3.3. Model

Unlike Bayesian averaging model and duration analysis, logit and probit models are the most popular choice as models in economics, as demonstrated in the review of literature. The two popular models differ essentially in the distribution of the error terms. Whilst logit assumes a logistic distribution, probit assumes a normal distribution. The dependent variable in both cases may be binary or multinomial. For the purposes of estimation, the dependent variable undergoes a natural logarithmic transformation. The independent variables or covariates are usually policy variables. In practice and from the empirical review, the common covariates in the study of organic technology adoption are farm and farmer characteristics as noted earlier.

Duration analysis, which is also less popular than logit and probit, has a long history in biometrics and statistical engineering (Burton et al., 2003). This seeks to capture the time between the availability of the technology to the time of adoption. This method is capable of handling diffusion and adoption together. Duration analysis can also be used to model entry and exit decisions as a process of choice of when to adopt and when to abandon. Unlike logit and probit models that rely on one equation for estimation, duration analysis relies on two important concepts (equations), the hazard function and the survivor function that are related in a one-to-one relationship. Since the current study seeks to study adoption rather than diffusion, the probit procedure was employed.

Let the utility of a cocoa farmer be represented by U. Then, the utility gained by adopting organic technology T will be $U_i(T)$. Let $T = 1$ for farmer adopting organic technology and $T = 0$, otherwise. Then, in order to maximise utility, a farmer adopts organic technology if:

$$U_i(1) < U_i(0) \tag{1}$$

On the contrary, no adoption takes place when

$$U_i(1) \leq U_i(0) \tag{2}$$

Therefore, the utility gained by adopting organic technology is:

$$U_i^*(T) = U_i(1) - U_i(0) \tag{3}$$

Considering that the decision to adopt depends on some factors such as farm and farmer characteristics represented by X_i,

Then,

$$U_i^*(T) = X_i\beta + \varepsilon_i \tag{4}$$

where $T = 1$ if $U_i^*(T) > 0$ and $T = 0$ otherwise. ε_i is assumed to be continually distributed and has symmetry around zero.

Thus the probability of adopting technology:

$$\Pr(T_i = 1) = \Pr(U_i^* > 0) = \Pr(\varepsilon_i > X_i\beta) = 1 - F(-X_i\beta) = F(X_i\beta) \tag{5}$$

If the probability of adoption is P_i, then probability of non-adoption is $1{-}P_i$. Thus, the log odd is:

$$L_i = \ln\left(\frac{P_i}{1 - P_i}\right) \tag{6}$$

Table 2. Definition of variables

Variables	Definition	A priori expectation
Adoption of organic production	Organic = 1 and zero otherwise	Not applicable
Gender (GENDER)	Male = 1 and female = 0	–
Extension participation (EXTNACCESS)	Yes = 1, no = 0	–
Cocoa farming experience (FARMEXP)	How long farmer cultivated cocoa in years	+,–
Age of farmer (AGEFARMER)	Age of farmer measured in years	–
Education (EDUC)	Years spent in formal education system	+
Age of cocoa farm (FARMAGE)	Years since cocoa farm was planted till 2014	+,–
Household size (HHS)	Number of persons living in household	+
Farmer-Based organisation membership (FBO)	Member of farm association = 1	
0 = otherwise	–	
Access to credit (ACCESSCRED)	Yes = 1, No = 0	+
Size of farm (FARMSIZE)	Area cultivated with cocoa	+,–
Incidence of CSSVD (CSSVDATTACK)	Incidence of CSSVD of farm = 1 and 0 otherwise	+,–

Replacing the left hand side of Equation 5 with Equation 7 results in

$$L_i = \ln\left(\frac{P_i}{1 - P_i}\right) = X_i\beta + \varepsilon_i \tag{7}$$

X_i are as defined in Table 2.

4. Results and discussion

4.1. Summary statistics

The mean farmer age of 48.7 years (combined sample) is indicative of somewhat aging in cocoa production (Table 3). The respective means for conventional and organic 48 and 49 are statistically significantly different at 5% level of probability. Since gender was defined as male = 1, the mean is the percentage of males. Thus, whilst males constitute 82% of the conventional farmers, males make up 88% of organic farmers. Together, males make up 85% of the combined sample. Based on the *t* test statistic, clearly, there are more males in organic cocoa farming than males in conventional cocoa farming. Although, this combined sample relates to cocoa, the heavy involvement of males does not depart from the male dominance in agriculture (FAOSTAT, 2015). Cultural norms that give men greater opportunity to own land as against females may have accounted for this result. Conventional cocoa farm households have a mean size of 6.4, not different from that for organic households. However, these are not statistically significantly different from zero.

The mean cocoa farming experience of 16.26 years for conventional cocoa farmers is significantly lower than that of organic cocoa farming for which the mean years of experience is 19.83 years. Regarding years of formal education, the means fall slightly below 9 years. This suggests that on average, the members of the sub-samples and combined sample have barely completed basic school. Organic cocoa farmers tended to have more years of formal education than conventional farmers although the difference is not significantly different from zero statistically.

As in the case of gender, access to agricultural extension was defined as a dummy variable. The 84% of conventional cocoa farmers who have access to extension service is below the 93% recorded by the organic sub-sample. This is not surprising because, aside of CHED providing extension services to both

Table 3. Summary statistics

	Conventional mean (Standard error)	Organic mean (Standard error)	Combined mean (Standard error)	*t* test
AGEFARMER	48.28	49.29	48. 71	−1.0632**
	(0.582)	(0.751)	(0.463)	
GENDER	0.82	0.88	0.85	−2.0461**
	(0.020)	(0.019)	(0.014)	
HHS	6.40	6.42	6.41	−0.1006
	(0.181)	(0.174)	(0.127)	
FARMEXP	16.26	19.83	17.79	−4.1153***
	(0.47)	(0.897)	(0.418)	
EDU	8.58	8.62	8.60	−0.1565
	(0.176)	(0.187)	(0.128)	
EXTNACCESS	0.84	0.93	0.884	3.5116***
	(0.018)	(0.015)	(0.012)	
FARMAGE	18.09	29.34	22.90	−10.4414***
	(0.506)	(0.951)	(0.544)	
FARMSIZE	2.03	2.32	2.16	−2.1802**
	(0.096)	(0.100)	(0.070)	
CSSVDATTACK	0.19	0.32	0.25	−3.7508***
	(0.020)	(0.027)	(0.017)	
ACCESSCRED	0.19	0.49	0.32	−8.4107***
	(0.020)	(0.029)	(0.018)	
FBO	0.86	0.92	0.89	2.8405**
	(0.017)	(0.015)	(0.012)	
N	378	280	658	

Notes: Provision for invalid questionnaires resulted in 280 questionnaires, 2 more than the 278 sample size estimated.
**5% level of statistical significance
***1% level of statistical significance

organic and conventional cocoa farmers, organic farmers have additional extension support from organisations such as YGL. Just as other tree crops, age has an important influence on yield of cocoa. It would be observed that, organic cocoa farms are almost twice as old as conventional cocoa farms.

The mean farm size of conventional cocoa farmers is 2.03 ha whilst that of organic farmers is 2.32 ha. These two means are statistically significant different at 5% level of probability given the *t* statistic of 2.1802. There is significant disparity between the two sub-samples regarding cocoa swollen shoot disease (CSSVD) attack. Whilst more than 30% of organic farmers experienced CSSVD, less 20% of conventional farmers experienced the disease. Although 32% of the combined sample had access to credit facilities, there is significant disparity between the two sub-samples. Conventional farmers recorded 19% whilst the organic sub-sample recorded 49%. This disparity is not surprising as the credit is often important in technology adoption. As much as 89% of the farmers in the combined sample belonged to farmer-based organisations. However, the organic sub-sample registered 92% FBO membership with the convention al sub-sample posting 86%. Indeed, these proportions are statistically significantly different. These differences may be due to the fact that FBO are tools for mobilisation for technology adoption. Due to the many variables showing statistically significant differences between organic and conventional sub-sample, there is the likelihood of realising many statistically significant parameter estimates in the adoption model estimation.

4.2. Determinants of adoption of organic cocoa production

The low linear correlation coefficients (Appendix 1) shows that there are no multicollinearity problems associated with the explanatory variables. Access to extension and credit may not be truly exogenous. Therefore, each of these were modelled as the endogenous variable together with other variables as exogenous variables. The predicted values of these were included in the adoption model. It was expected that, had these not been truly exogenous, their parameter estimates should be statistically significant. However, none of these were statistically significant. Therefore, access to extension and access credit in this study are exogenous.

The estimated probit model (Table 4) shows statistically significant coefficients and marginal effects for seven out of the eleven variables. The coefficient and marginal effect of age of farmer are negative and statistically insignificant. Thus age of farmer does not influence adoption of organic cocoa production. Although, there is the likelihood of younger farmers interested in experimenting with new technology than older farmers for which reason age of farmer may influence technology

Table 4. Probit estimation of adoption of organic cocoa production in Suhum district

Adoption	Coefficient (Robust std. err.)	Marginal effects (Delta-method std. err.)
AGEFARMER	−0.0073	−0.0022
	(0.0067)	(0.0020)
GENDER	0.3035*	0.0917**
	(0.1562)	(0.0469)
HHS	−0.0360**	−0.0109**
	(0.0175)	(0.0053)
FARMEXP	−0.0161**	−0.0049**
	(0.0081)	(0.0024)
EDU	−0.0016	−0.0005
	(0.0171)	(0.0052)
EXTNACCESS	0.4283**	0.1295**
	(0.1891)	(0.0565)
FARMAGE	0.0589***	0.0178***
	(0.0065)	(0.0017)
FARMSIZE	−0.0484	−0.0146
	(0.0340)	(0.0102)
CSSVDATTACK	0.1107	0.03346
	(0.1311)	(0.0395)
ACCESSCRED	0.6393***	0.1933***
	(0.1150)	(0.0324)
FBO	0.3221*	0.0974*
	(0.1795)	(0.0543)
Constant	−1.6813***	–
	(0.3936)	
	Model specifications	
R^2-type measure	0.27	
Number of observations	658	
Log pseudolikelihood	−351.51	

*Significance at 1% level.
**Significance at 5% level.
***Significance at 10% level.

adoption, the findings of this study does not confirm this (Genius et al., 2006; Kassie et al., 2009; Kallas et al., 2010; Läpple & Rensburg, 2011; Lapple, 2013; Rana et al., 2012). However, the conclusions of Tiffin and Balcombe (2011), Mzoughi (2011), Jayawardana and Sherief (2012), Hattam and Holloway (2005), Best (2010), Thapa and Rattanasuteerakul (2011) and Anderson et al. (2005) are consistent with the findings of this study.

The sign of the parameters of gender are positive and the magnitudes are statistically significant. This implies, being male positively influences adoption of organic cocoa production. In fact, there is a 9% probability that a male will adopt organic cocoa production. This gender difference in technology adoption have been underscored by Tovignan and Nuppenau (2004), Burton et al. (2003), Kassie et al. (2009), Tiffin and Balcombe (2011) and Ragasa (2012). Indeed, Ragasa (2012) explained that lack of complementary access to inputs by females account for the gender difference in technology adoption. The findings of this study are however inconsistent with that of Mzoughi (2011).

The literature review is almost unanimous that larger households have a tendency of adopting organic production than smaller households. The results of this study provide contrary evidence. That is, smaller households have a tendency of adopting organic technology. Specifically, an increase in household size by 1 will result in 1% probability of adoption of organic cocoa production. This finding departs from those Tovignan and Nuppenau (2004), Wollni and Andersson (2014), Sarker et al. (2009) and Kisaka-Lwayo (2008) and Burton et al. (2003).

As noted in the review, farmers who have engaged in agriculture over a long time are likely to acquire more experience about the successes and failures of the technology employed to turn out produce. Over time, experience would support overcoming challenges hence; the farmer would stick to the technology already being practiced. On the contrary, experience of failures from the past would also motivate them to seek new technologies for the purposes of trying them out. The negative and statistically significant parameters imply that less cocoa farming experience lead to probability of adoption of organic cocoa production. Less experienced farmers may be more predisposed to taking risks in line with the learning curve. Also, the stronger effect of experience may be responsible for the negative effect. Specifically, the negative sign specifically establishes that, farmers with fewer years of experience in cocoa farming tend to adopt organic cocoa production. Recalling that the first certification was as recent as 2010, farmers with more experience in cocoa farming would have been used to the old way of farming and not particularly interested in learning new methods. The finding of this study is consistent with the conclusions of Hattam and Holloway (2005), Thapa and Rattanasuteerakul (2011) and Rana et al. (2012).

Long years in formal educational system afford beneficiaries the opportunity to acquire knowledge in general and ability to read and write. The knowledge may include that on the environment. This knowledge among others could push them to adopt organic cocoa farming. The ability to read and write will also enable the beneficiary to read instructions on packages of agricultural inputs, as well as agricultural extension material and have the capacity to keep records. The result of this study shows that, the sign of the education coefficient and marginal effect are negative and the magnitudes are statistically insignificant. This may have arisen from the indifference between years of education for conventional and organic farmers. This implies formal education does not distinguish conventional and organic cocoa farmers. This finding is consistent with those by Hattam and Holloway (2005), Best (2010) and Thapa and Rattanasuteerakul (2011). However, there is evidence of neutral effect of formal education on adoption (Genius et al., 2006; Kassie et al., 2009; Latruffe and Nauges, 2014; Mzoughi, 2011; Takagi, 2010; Tovignan & Nuppenau, 2004). Combining this finding with the literature reviewed, formal education does not appear to be a disincentive to adoption of organic farming.

Unlike formal education, the parameters of access to extension services are positively signed and the magnitude of the marginal effect is statistically indistinguishable from zero. This result implies that, access to extension services may promote adoption of organic cocoa technology adoption. As noted earlier, aside of CHED, other organisations do provide extension services to cocoa farmers[3].

The positive and statistically significant parameters of age of cocoa farm variable imply that farmers with older trees have a higher probability of adopting organic cocoa production than farmers with younger trees. Aged cocoa trees tend to produce less than younger cocoa trees. This would decrease yield and consequently, income. However, with organic cocoa, the farmer would earn a premium on this low yield. This may motivate farmers with aged cocoa trees to adopt organic cocoa production practices.

Associations provide opportunities of networking. In the case of cocoa farming, farmers share knowledge and experiences among themselves. The marginal effect of membership of farm association is positive and statistically significant. This implies members of farm associations have a tendency to adopt organic cocoa farming. This is not surprising. Given that organic cocoa farming is new compared to conventional cocoa farming; using associations with its attendant network opportunities explains this result. It would be observed that the magnitudes of both the coefficient and marginal effect of membership of farm association are as high as that for gender, implying the influence of *FBO* on organic technology adoption are equally important. This finding reinforces importance of *FBO* in enhancing technology adoption. Organic cocoa farmers without *FBO* membership should be identified and encouraged to join.

The sign of the parameters of access to credit are positive and the magnitudes are statistically significant. The marginal effect of 19% implies that access to credit will increase probability of adoption of organic technology by 19%. Since, this is the highest magnitude among the statistically significant coefficients, credit access is the most important policy variable in organic technology adoption. This is not surprising as certification is at a cost for which reason some credit may be required. Also, credit will be useful for purchasing other production materials. This finding calls for increased access and strengthening of credit services to cocoa farmers especially organic cocoa producers. This may be facilitated by the extension organisations servicing organic cocoa farmers.

5. Conclusion and recommendations

This study investigated the factors responsible for adoption of organic cocoa production in Suhum Cocoa District in Ghana. Data on 280 organic cocoa farms and 378 conventional farms was fitted to a probit model. Conventional producers represented majority of the sample reflecting the high population of conventional producers in the study area relative organic producers. Cocoa cultivation remains popular with males. Close to 90% of the sample participated in cocoa extension programmes. The age of farmer did not influence adoption of organic cocoa production. Being male positively influences adoption of organic cocoa production. Smaller households have a tendency of adopting organic technology. Less cocoa farming experience led to probability of adoption of organic cocoa production. Access to extension services may promote adoption of organic cocoa technology adoption. Farmers with older trees have a higher probability of adopting organic cocoa production than farmers with younger trees. Access to credit positively influenced adoption of organic cocoa production. Members of farm associations have a tendency to adopt organic cocoa farming. Therefore, increased and effective extension and credit services are recommended to enhance adoption of organic cocoa adoption.

Funding
The authors received no direct funding for this research.

Competing Interest
The authors declare no competing interest.

Author details
Justice G. Djokoto[1,2]
E-mail: dgameli2002@gmail.com
Victor Owusu[2]
E-mail: victowusu@yahoo.com
Dadson Awunyo-Vitor[2]
E-mail: awunyovitor@gmail.com
[1] Agribusiness Management Department, Central University, Accra, Ghana.
[2] Department of Agricultural Economics, Agribusiness and Extension, Kwame Nkrumah University of Science and technology, Kumasi, Ghana.

Citation information
Cite this article as: Adoption of organic agriculture: Evidence from cocoa farming in Ghana, Justice G. Djokoto, Victor Owusu & Dadson Awunyo-Vitor, *Cogent Food & Agriculture* (2016), 2: 1242181.

Notes
1. See IFOAM website: http://www.ifoam.org/en/organic-landmarks/principles-organic-agriculture for further details on these principles.
2. This paragraph draws on an earlier work by Djokoto (2015).
3. The discussion of Extension education, age of cocoa farm and FBO did not include reference to previous literature because the authors are unaware of any.

References
Afari-Sefa, V., Gockowski, J., Agyeman, N. F., & Dziwornu, A. K. (2010, September 19–23). Economic cost-benefit analysis of certified sustainable cocoa production in Ghana. *Poster presented at the Joint 3rd African Association of Agricultural Economists (AAAE) and 48th Agricultural Economists Association of South Africa (AEASA) Conference*, Cape Town. Retrieved November 03, 2012, from http://ageconsearch.umn.edu/bitstream/97085/2/33.%20Cost%20benefit%20of%20cocoa%20in%20Ghana.pdf

AGROECO. (n.d.). *Field book: Organic and fairtrade cocoa agroeco*. Retrieved from www.agroeco.net

Ajzen, I. (1985). *Attitudes, personality, and behaviour*. Milton Keynes: Open University.

Anderson, J. B., Jolly, D. A., & Green, R. D. (2005). Determinants of farmer adoption of organic production methods in the fresh-market produce sector in California: A logistic regression analysis. In *2005 Annual Meeting, July 6–8, 2005, San Francisco, California (No. 36319)*. Western Agricultural Economics Association.

Ayenor, G. K., Röling, N. G., Padi, B., Van Huis, A., Obeng-Ofori, D., & Atengdem, P. B. (2004). Converging farmers' and scientists' perspectives on researchable constraints on organic cocoa production in Ghana: Results of a diagnostic study. *NJAS-Wageningen Journal of Life Sciences, 52*, 261–284. http://dx.doi.org/10.1016/S1573-5214(04)80017-4

Batman, R. (2010). *Pesticide use in cocoa: A guide for training administrative and research staff*. London: ICCO.

Best, H. (2010). Environmental concern and the adoption of organic agriculture. *Society & Natural Resources, 23*, 451–468. doi:10.1080/08941920802178206

Bouagnimbeck, H. (2013). Latest developments in organic farming in Africa. In H. Willer, J. Lernoud, & L. Kilcher (Eds.), *The world of organic agriculture: Statistics and emerging trends 2013* (pp. 164–168). Frick & Bonn: FiBL & IFOAM.

Burton, M., Rigby, D., & Young, T. (2003). Modelling the adoption of organic horticultural technology in the UK using Duration Analysis. *The Australian Journal of Agricultural and Resource Economics, 47*, 29–54. http://dx.doi.org/10.1111/ajar.2003.47.issue-1

Djokoto, J. G. (2015). Technical efficiency of organic agriculture: A quantitative review. *Studies in Agricultural Economics, 117*, 67–71.

FAOSTAT. (2015). *FAOSTAT*. Retrieved from http://faostat3.fao.org/browse/O/*/E

Genius, M., Pantzios, C. J., & Tzouvelekas, V. (2006). Information acquisition and adoption of organic farming practices. *Journal of Agricultural and Resource Economics, 31*, 93–113.

Guesmi, B., Serra, T., Kallas, Z., & Gil Roig, J. M. (2012). The productive efficiency of organic farming: The case of grape sector in Catalonia. *Spanish Journal of Agricultural Research, 10*, 552–566. http://dx.doi.org/10.5424/sjar/2012103-462-11

Hattam, C. E., & Holloway, G. J. (2005). *Adoption of certified organic production: Evidence from Mexico*. Retrieved from http://orgprints.org/4367/4/4367-Hattam_Holloway_4p_revised-ed.pdf

International Federation of Organic Agriculture Movements. (n.d.). *Principles of organic agriculture*. Bonn: Author.

Jayawardana, J. K. J. P., & Sherief, A. K. (2012). Influence of socio-psychological characteristics in adoption of organic farming practices in coconut based homesteads in humid tropics. *COCOS, 19*, 101–104.

Kaiser, F. G., Wölfing, S., & Fuhrer, U. (1999). Environmental attitude and ecological behaviour. *Journal of Environmental Psychology, 19*, 1–19. http://dx.doi.org/10.1006/jevp.1998.0107

Kallas, Z., Serra, T., & Gil, J. M. (2010). Farmers' objectives as determinants of organic farming adoption: The case of Catalonian vineyard production. *Agricultural Economics, 41*, 409–423. http://dx.doi.org/10.1111/agec.2010.41.issue-5

Kassie, M., Zikhali, P., Manjur, K., & Edwards, S. (2009). *Adoption of organic farming techniques: Evidence from a semi-arid region of Ethiopia* (Discussion Paper Series, EfD -09-01). Gothenburg: Environment for Development.

Kisaka-Lwayo, M. (2008). A discriminant analysis of factors associated with the adoption of certified organic farming by smallholder farmers in Kwazulu-Natal, South Africa. *2007 Second International Conference*, 2007, August 20–22 (No. 52155). African Association of Agricultural Economists, Accra.

Läpple, D. (2013). Comparing attitudes and characteristics of organic, former organic and conventional farmers: Evidence from Ireland. *Renewable Agriculture and Food Systems, 28*, 329–337. http://dx.doi.org/10.1017/S1742170512000294

Läpple, D., & Rensburg, T. V. (2011). Adoption of organic farming: Are there differences between early and late adoption? *Ecological Economics, 70*, 1406–1414. http://dx.doi.org/10.1016/j.ecolecon.2011.03.002

Latruffe, L., & Nauges, C. (2014). Technical efficiency and conversion to organic farming: The case of France. *European Review of Agricultural Economics, 41*, 227–253. http://dx.doi.org/10.1093/erae/jbt024

Madau, F. A. (2007). Technical efficiency in organic and conventional farming: Evidence from Italian cereal farms. *Agricultural Economics Review, 8*, 5–21.

Mader, P., Fliessbach, A., Dubois, D., Gunst, L., Fried, P., & Niggli, U. (2002). Soil fertility and biodiversity in organic farming. *Science, 296*, 1694–1697. http://dx.doi.org/10.1126/science.1071148

Mayen, C. D., Balagtas, J. V., & Alexander, C. E. (2010). Technology adoption and technical efficiency: Organic and conventional dairy farms in the United States. *American Journal of Agricultural Economics, 92*, 181–195. http://dx.doi.org/10.1093/ajae/aap018

Mzoughi, N. (2011). Farmers' adoption of integrated crop protection and organic farming: Do moral and social concerns matter? *Ecological Economics, 70*, 1536–1545. http://dx.doi.org/10.1016/j.ecolecon.2011.03.016

Opoku-Ameyaw, K., Baah, F., Gyedu-Akoto, E., Anchirinah, V., Dzahini-Obiatey, H. K., Cudjoe, A. R., … Opoku, S. Y. (2010). *Cocoa manual: A source book for sustainable cocoa production*. New Tafo-Akim: Cocoa Research Institute of Ghana.

Paull, J. (2013). A history of the organic agriculture movement in Australia. In B. Mascitelli & A. Lobo (Eds.), *Organics in the global food chain* (pp. 37–60). Ballarat: Connor Court Publishing.

Ragasa, C. (2012, August). Gender and institutional dimensions of agricultural technology adoption: A review of literature and synthesis of 35 case studies. *2012 Conference* (pp. 18–24). International Association of Agricultural Economists, Foz do Iguacu.

Rana, S., Parvathi, P., & Waibel, H. (2012, September 19–21). Factors affecting the adoption of organic pepper farming in India. *Conference on International Research on Food Security, Natural Resource Management and Rural Development*, Tropentag, Göttingen.

Rogers, E. M. (1995). *Diffusion of innovations* (4th ed.). New York, NY: Free Press.

Rogers, E. M. (2003). *Diffusion of innovations* (5th ed.). New York, NY: Free Press.

Sarker, M. A., Itohara, Y., & Hoque, M. (2009). Determinants of adoption decisions: The case of organic farming (OF) in Bangladesh. *Extension Farming Systems Journal, 5*, 39–46.

Takagi, C. (2010). *Adoption of organic vegetable production practices in West Java and Bali, Indonesia* (Doctoral dissertation). Michigan State University, Lansing, MI.

Thapa, G. B., & Rattanasuteerakul, K. (2011). Adoption and extent of organic vegetable farming in Mahasarakham province, Thailand. *Applied Geography, 31*, 201–209. http://dx.doi.org/10.1016/j.apgeog.2010.04.004

Tiffin, R., & Balcombe, K. (2011). The determinants of technology adoption by UK farmers using Bayesian model averaging: The cases of organic production and computer usage. *Australian Journal of Agricultural and Resource Economics, 55*, 579–598. http://dx.doi.org/10.1111/ajar.2011.55.issue-4

Tovignan, D. S., & Nuppenau, E. A. (2004). Adoption of organic cotton in Benin: Does gender play a role. In *Proceedings: Conference of Rural Poverty Reduction through Research for Development and Transformation* (p. 1e10). Deutscher Tropentag, Berlin

Tzouvelekas, V., Pantzios, C. J., & Fotopoulus, C. (2002). Technical efficiency of alternative farming systems: The case of Greek organic and conventional olive-growing farms. *Food Policy, 26*, 549–569.

Wollni, M., & Andersson, C. (2014). Spatial patterns of organic agriculture adoption: Evidence from Honduras. *Ecological Economics, 97*, 120–128. http://dx.doi.org/10.1016/j.ecolecon.2013.11.010

World Health Organization (1946). Definition of health. *Preparatory Committee of the International Health Conference*. Geneva: Author.

Yayra Glover Limited. (2008). Retrieved from Yayra Glover Limited website: http://yayraglover.com/index.php/company-profile

Yayra Glover Limited. (2013). Retrieved from Information available from Yayra Glover Limited: http://yayraglover.com/

Appendix 1.

	AgeFamer	Gender	HHS	FarmExp	Educat~n	ExtnAc~s	FarmAge	FarmSize
AgeFamer	1.0000							
Gender	−0.0295	1.0000						
HHS	0.3277	0.0448	1.0000					
FarmExp	0.6700	0.0316	0.2395	1.0000				
Education	−0.1728	0.1396	−0.1039	−0.1301	1.0000			
ExtnAccess	−0.0296	0.0044	−0.0403	−0.0237	0.0590	1.0000		
FarmAge	0.4142	0.0488	0.2238	0.6314	−0.0733	0.0355	1.0000	
FarmSize	0.2203	0.1531	0.1460	0.2587	−0.0242	0.0444	0.3084	1.0000
CSSVD	0.1143	0.0868	0.0759	0.1741	0.0110	0.0079	0.2649	0.2470
CrediAcc	0.0589	0.0035	0.0359	0.1630	−0.0023	0.0343	0.2763	0.0495
FBO	−0.0503	−0.0412	0.0324	−0.0075	−0.0467	0.2237	0.0176	0.0046
	CSSVD	CrediAcc	FBO					
CSSVD	1.0000							
CrediAcc	0.0533	1.0000						
FBO	0.0195	0.0844	1.0000					