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Sustainability performance of organic and conventional cocoa farming systems in Atwima Mponua District of Ghana

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ABSTRACT

The potential of organic agriculture to contribute to sustainable development in Ghana is unclear. This article assesses the sustainability performance of organic and conventional cocoa farming systems in Ghana. Data was collected from 398 organic and conventional cocoa farmers using the SMART-Farm tool. Compared to conventional cocoa farming systems, we found a higher environmental sustainability performance in organic cocoa farming systems regarding water withdrawal (+29%), species diversity (+26%), land degradation (+24%), genetic diversity (+24%) and greenhouse gases (+22%). The organic farming systems performed better compared to conventional in profitability (+20%) due to market premiums, gender equity (+27%), and verbally committed to sustainability topics (+25%). Agronomic practices had a strong influence on the observed sustainability performance, especially the environmental performance. Typical organic cocoa farming system has small farm sizes, spends more hours weeding manually since chemical weedicides are prohibited and has more diverse crops. Measures to improve performance is paramount for farming systems sustainability.

Introduction

In Ghana, cocoa is a major source of livelihood for smallholder farmers (Afriyie-Kraft, Zabel and Damnyag, 2020; Onumah et al., 2013). The crop generates about $2 billion in foreign exchange annually and accounts for 30% of the total export earnings (Bangmarigu and Qineti, 2018; COCOBOD, 2018). Ghana plays an important role on the international cocoa market being the second largest producer of cocoa beans in the world after Ivory Coast and representing about 20% of global production (ICCO annual reports as cited in Bangmarigu and Qineti, 2018).

Cocoa is produced using conventional practices (Amanor, Yaro and Teye, 2020; Akrofi-Atitianti et al., 2018). Agricultural land degradation is a global problem related to land clearance, such as clearcutting and deforestation (Bai et al., 2017; Nkonya et al., 2016; Gabriels and Cornelis, 2009). As a response to improve soil nutrients and reduce degradation, organic farming is often considered as one option towards ecological intensification (Sanz-Cobena, Aguilera Fernández and Guzmán Casado, 2018; Halberg, Panneerselvam and Treyer, 2015).

The concern for low cocoa production in cocoa farming systems is accompanied by economic, social and environmental challenges. At the economic level, there are issues with ageing cocoa farms (COCOBOD, 2018; Dormon et al., 2004) and low producer price of cocoa beans (Dormon, 2004). The social issues include the concern for child labour in cocoa production (Berlan, 2013; Baradaran and Barclay, 2011 and Schrage and Ewing, 2005), lack of labour for production activities (Dormon, 2004) and gender issues (Barrientos, 2013; Anglaaere et al., 2011). Soil fertility, air quality, biodiversity loss (Gockowskiet al., 2013; Ntiamoah and Afrane, 2008 and Asare, 2006), deforestation; 'misuse' of pesticides (WCF, 2016 and ICCO, 2012) are among the environmental concerns. Compared to conventional cocoa production, organic farming may have the potential to profitability increases through premiums from higher added value (Winter et al., 2020; Bonisoli et al., 2019; Berg et al., 2018).

Organic practices were introduced in Ghana in the late 1990s as an environmentally friendly option (Amanor, Yaro and Teye, 2020). Organic farming methods are also touted to lower greenhouse gas emissions (Akrofi-Atitianti et al., 2018). Furthermore, organic farming

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encourages on-farm agrobiodiversity, both through the diversity of plant varieties cultivated (Seufert and Ramankutty, 2017), and improves farmers economic profitability (Jouzi et al., 2017). Organic farming aims at creating a sustainable agricultural production system, including economic, environmental, and social sustainability (Seufert and Ramankutty, 2017; Rigby and Cáceres, 2001; Padel, 2001).

In Ghana, the potential of organic and its suitability as a future solution to some key farming system challenges is still not recognised. Studies on cocoa production in Ghana often focus on one dimension of sustainability (Ntiamoah and Afrane, 2008, 2009). Thus, this study to the best of our knowledge will provide the first holistic sustainability assessment of organic and conventional cocoa farming systems in Ghana. The study seeks to answer the question, does the sustainability performance of organic cocoa farming system in Ghana differ from conventional farming?

Materials and methods

Source of data

The Organic Farm System for Africa (OFSA) database made available by Research Institute of Organic Agriculture (FiBL) for analysis. The dataset provided information for over 300 indicators covering 6 themes and 14 sub-themes for the environmental integrity, four themes and 14 sub-themes for economic resilience, six themes and 16 social well-being sub-themes and five themes and 14 sub-themes for good governance (Table S1).

In Atwima Mponua District (AMD), a typical cocoa farming system is defined based on the predominance of smallholder cocoa farming households, engaged in either practicing conventional i.e., "business-as-usual" or based on initiatives termed environmentally friendly. Cocoa farming systems are characterised by the different crops grown, and the livestock types reared. Cocoa farming systems used both family and hired labour for farming activities. The organic cocoa farms are certified through Internal Certification System (ICS). These criteria guided the selection of 398 cocoa farmers, out of which 71 were organic cocoa farmers, with 327 conventional cocoa farmers. The OFSA covered three months data collection period from December 2016 to February 2017.

Study area

Location, drainage and soils

The Atwima Mponua District is located in the south-western part of the Ashanti Region in Ghana covering an area of about 1883.2 square kilometres (GSS, 2013) (see Fig. 1). The Atwima Mponua district is drained by the Offin and Tano rivers (GSS, 2013). There are 310 communities in the district, 5 of which were selected for the study.

The district is marked by a double maximum rainy season. The major rainy season begins in March and ends in July, with a peak in May. The average annual rainfall for the main season is about 1700 mm–1850 mm per year. The minor rainfall season begins in August and ends in November, with an annual average of 1000 mm - 1250 mm per year. From December to February, the weather is dry, hot, and dusty with an average daily temperature of about 27 °C, with monthly average temperature levels ranging from 22 °C to 30 °C throughout the year. The climate and the soils of the district is ideal for growing cash crops and food crops such as cocoa, plantain, rice, and all kinds of vegetables.

Activities of non-governmental organisation (NGO)

The district exemplifies an area organic farming system are

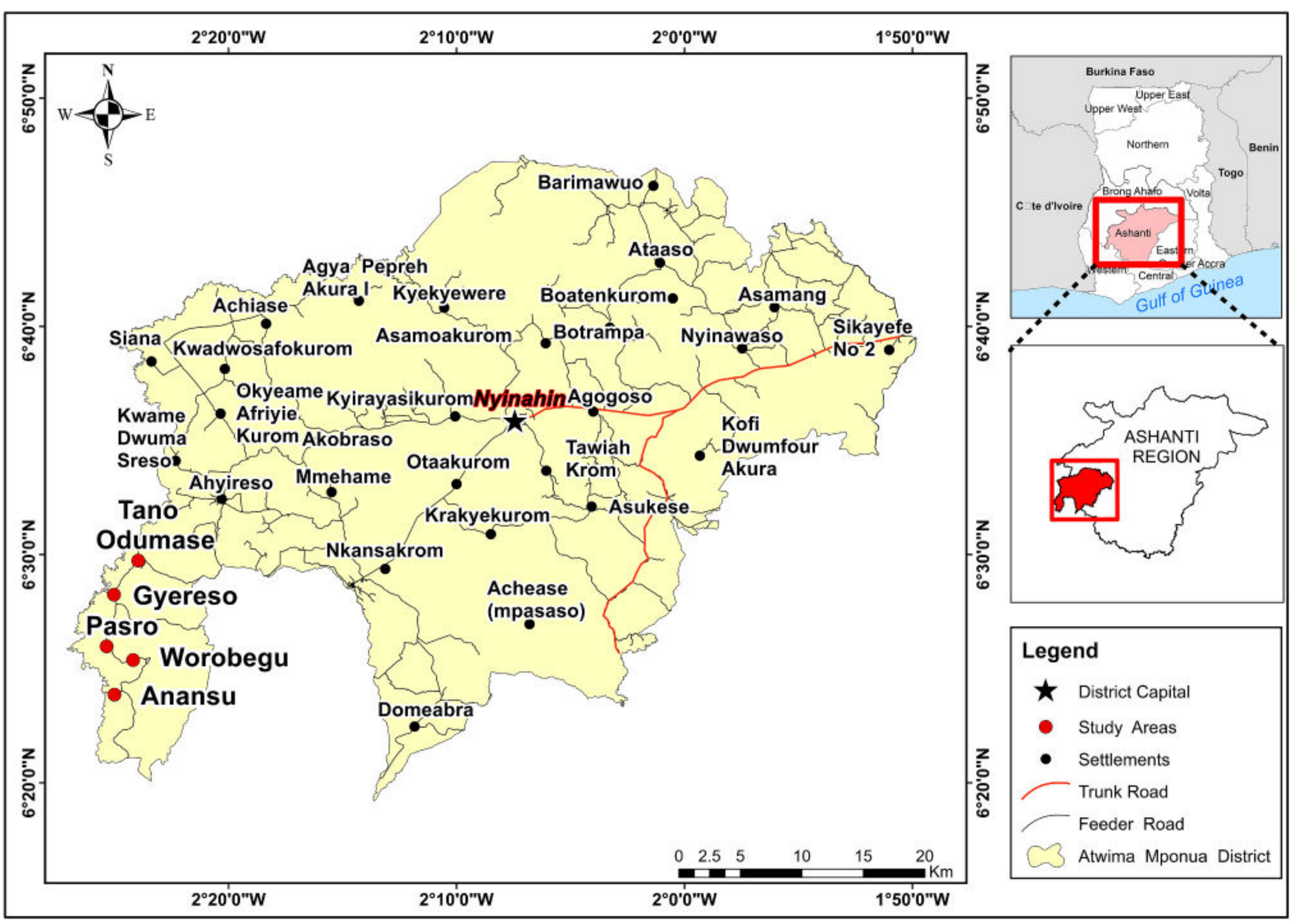

Fig. 1. Map of the study area.

implemented with other voluntary sustainability standards including Rainforest Alliance (RA) since 2011 by Agro Eco Louis Bolk Institute (Agro Eco-LBI) (Akrofi-Atitianti et al., 2018). The conventional cocoa farming system is the commonly practiced system in Atwima Mponua District.

The studied organic cocoa production system was an initiative of Non-Governmental Organisations (NGOs) in the district from 2011 to 2017 to enable them to access the organic cocoa market in Europe (Agro Eco- LBI). They provided training and other support services to farmer cooperatives like the Tano-Biakoye Organic Cocoa Farmers' Co-operative Society Limited for which the farmers received certification in 2012. Trained organic farmers under the Tano-Biakoye Organic Cocoa Farmers' Co-operative Society Limited are Rainforest Alliance certified, a pre-requisite for joining this organic farming group.

The SMART-Farm Tool

There are several tools used in measuring sustainability performance of farms (Giovannucci et al., 2008; Schader et al., 2014; Coteur et al., 2020). These tools are mostly categorised according to geographic scope, primary purpose, thematic scope, and perspective on sustainability (Schader et al., 2014). In terms of geographic scope, the applicability of the tool either utilised in Europe or developing countries or both matters. Most of the common tools are the COSA; RISE; SMART-Farm tool and the FSA (Coteur et al., 2020). Majority of the tools follow the traditional environmental, social, and economic thematic scopes. Few focus on only one of the three, whiles others include governance as the fourth thematic scope (e.g. SMART-Farm Tool). Based on the primary purpose, geographic and thematic scope, the Sustainability Monitoring and Assessment Routine (SMART-Farm Tool) was selected for this study.

The SMART-Farm Tool models the sustainability performance of a farm (Schader et al., 2016; Schader et al., 2019; Ssebunya et al., 2019; Winter et al., 2020; Coteur et al., 2020) and allow for the assessment of the level of goal achievement (Table S1). The degree of goal achievement was estimated to compare the sustainability performance of organic and conventional cocoa farming systems.

Mathematically, the degree of goal achievement (*DGAix*) of a farm *x* concerning a sub-theme ***i*** is defined as the ratio of the sum of impacts of all indicators (n = 1) that are relevant for a sub-theme ***i*** (*IMni*) multiplied by the actual performance of a farm ***x*** concerning an indicator ***n*** (*ISnx*) and the sum of the impacts multiplied by the maximal performance possible on these indicators (*IS*max*n*). The impacts thus serve as "weights" for the different indicators in assessing the degree of goal achievement for a sub-theme.

$$DGA_{ix} = \frac{\Sigma_{n=1}^{N}(IM_{ni}\ X\ IS_{ns})}{\Sigma_{n=1}^{N}(IM_{ni}\ X\ IS_{maxn})} \quad (1)$$

Where:

$\boldsymbol{x}$ = farm
*i*sub-theme
IM_{ni} = all indicators relevant to the sub-theme i
IS_{nx} = actual performance of a farm x with reference to an indicator n
IS_{maxn} = maximal performance with reference to n indicators

The level of goal achievement scale ranged from 0% to 100%, as explained illustrated in Fig. 2.

Sustainability polygon was used to show the degree of goal achievement for each theme, and sub-theme variables of the dimensions. The non-parametric Mann-Whitney *U* test was used to test for significant differences between organic and conventional farming systems based on the four dimensions: environmental integrity, economic resilience, social well-being, and good governance. The significance level was p = 0.05 (Baarda and van Dijkum, 2019; Berbeć et al., 2018). Calculations were performed using the IBM Statistical Package for the Social Sciences (SPSS) version 25.0.

Results

Agronomic differences between organic and conventional cocoa farming systems

In the case study, there exist two types of farming systems. Though the two farming systems are differentiated based on the types of inputs used, there are other agronomic practices that show differences as shown in Table 1.

Farm sizes in organic farming system are smaller compared to conventional. Labour hours spent in carrying out farm operations is high for the organic farming system. Especially for manual weeding, the conventional farmers use chemical herbicides in weed management and control.

Sustainability performance based on the dimensions

Environmental integrity

Sustainability performance in terms of environmental integrity is illustrated in Fig. 3. The five sub-themes, waste reduction and disposal, energy use, material use, genetic diversity and species diversity showed the highest sustainability performance between 60% and 80% for both organic and conventional cocoa farming systems. The lowest sustainability performance was shown by soil quality and freedom from stress for both organic and conventional farming systems that fell between the scale of 20% and 40%.

Sustainability performance with respect to greenhouse gases fell within the scales 61%–80% and 40%–60% for organic and conventional farming systems, respectively.

Sustainability performance of animal health and land degradation fell within the scales 41%–60% and 21%–40% for organic and conventional farming systems, respectively.

Mean rank difference between the different farming systems based on the sub-themes of Environmental Integrity is shown in Table 2.

Mean rank scores for the organic farming system ranged between

Table 1
Agronomic differences between cocoa farming systems.

Variable	Organic	Conventional	Mean diff.	P-value
Mean farm size	2.26	3.23	−0.97	0.000***
Labour hours per season				
Manual weeding	33.69	28.55	5.14	0.000***
Pest and Disease management	3.62	4.01	−0.39	0.014*
Pruning	7.68	7.25	0.43	0.296
Harvesting	6.04	5.63	0.41	0.001***
Pod breaking	6.88	5.95	0.93	0.000***
Fermentation	6.51	7.59	−1.08	0.003***
Average hours spent on cocoa	12.04	10.05	1.59	0.000***
Crop counts	17.00	15.00	2.00	0.031*

***1%, **5% and *10% significance.

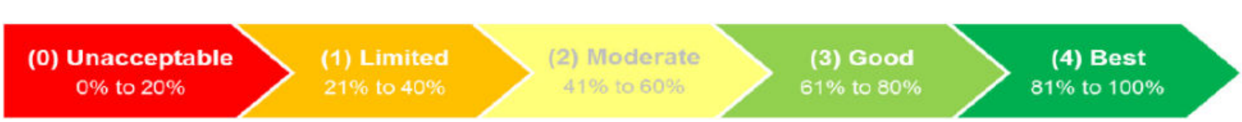

Fig. 2. Level of goal achievement on a sustainability scale.

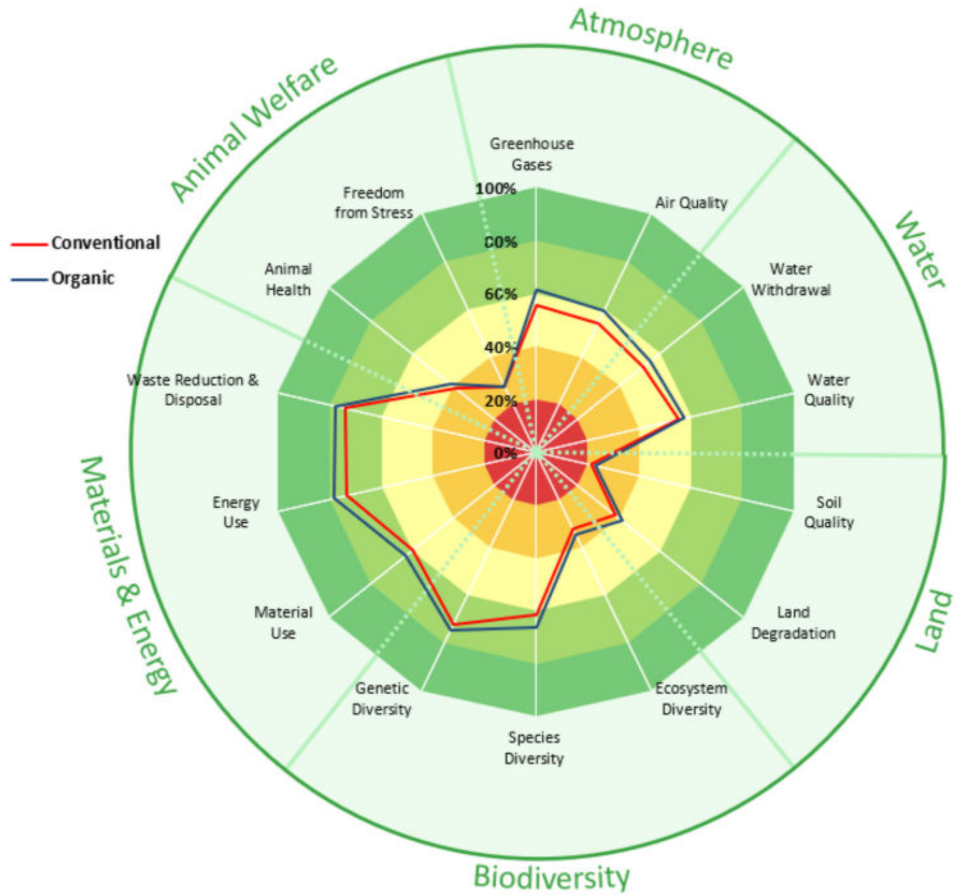

Fig. 3. Polygon view of environmental integrity sustainability performance of cocoa farming systems.

Table 2
Mean rank difference for environmental integrity sub-themes of cocoa farming systems.

Themes/sub-themes	Mean ranks		Mean rank difference	P-value
	Organic	Conventional		
Atmosphere				
Greenhouse Gases	243.8	189.9	53.9	0.000***
Air Quality	258.7	186.7	72.0	0.000***
Water				
Water Withdrawal	260.6	186.2	74.3	0.000***
Water Quality	242.3	190.2	52.1	0.001***
Land				
Soil Quality	225.5	193.9	31.6	0.035*
Land Degradation	249.1	188.7	60.4	0.000***
Biodiversity				
Ecosystem Diversity	231.2	192.6	38.5	0.010**
Species Diversity	253.9	187.7	66.2	0.000***
Genetic Diversity	247.8	189.0	58.8	0.000***
Material use and energy				
Material Use	234.5	191.9	42.5	0.005**
Energy Use	129.0	103.2	25.8	0.041*
Waste reduction & disposal	126.3	103.6	22.7	0.072
Animal welfare				
Animal Health	227.0	193.5	33.5	0.026*
Freedom from Stress	199.0	199.6	−0.6	0.970

***1%, **5% and *10% significance.

126.3 (waste reduction and disposal) and 260.6 (water withdrawal). Mean rank scores for conventional farming system ranged between 103.2 (energy use) and 199.6 (freedom from stress). The two cocoa farming systems differed significantly for all the sub-themes except for waste reduction and disposal, and freedom from stress, where the p-values were above p = 0.05.

Economic resilience

Economic resilience sustainability performance is illustrated in Fig. 4. The risk management and profitability sub-themes showed the highest sustainability performance between 61% and 80% for both organic and conventional cocoa farming systems. The seven sub-themes, community investment, long-ranging investment, the stability of production, the stability of the market, product information, liquidity and value creation showed moderate sustainability performance for both organic and conventional farming systems that fell between the scale 41% and 60%.

A lower sustainability performance was shown by internal investment and stability of supply for both organic and conventional farming systems that fell between the scale 21% and 40%.

Food safety and local procurement showed the lowest sustainability performance between the scale 0%–20%, for both organic and conventional farming systems.

Mean rank difference between the different farming systems based on the sub-themes of Economic resilience is shown in Table 3. Mean rank scores for the organic farming system ranged between 191.2 (stability of production) and 259.2 (liquidity). Mean rank scores for conventional farming system ranged between 186.6 (liquidity) and 202.0 (stability of supply).

The two cocoa farming systems differed significantly for most sub-themes with the exception of, community investment, long-ranging

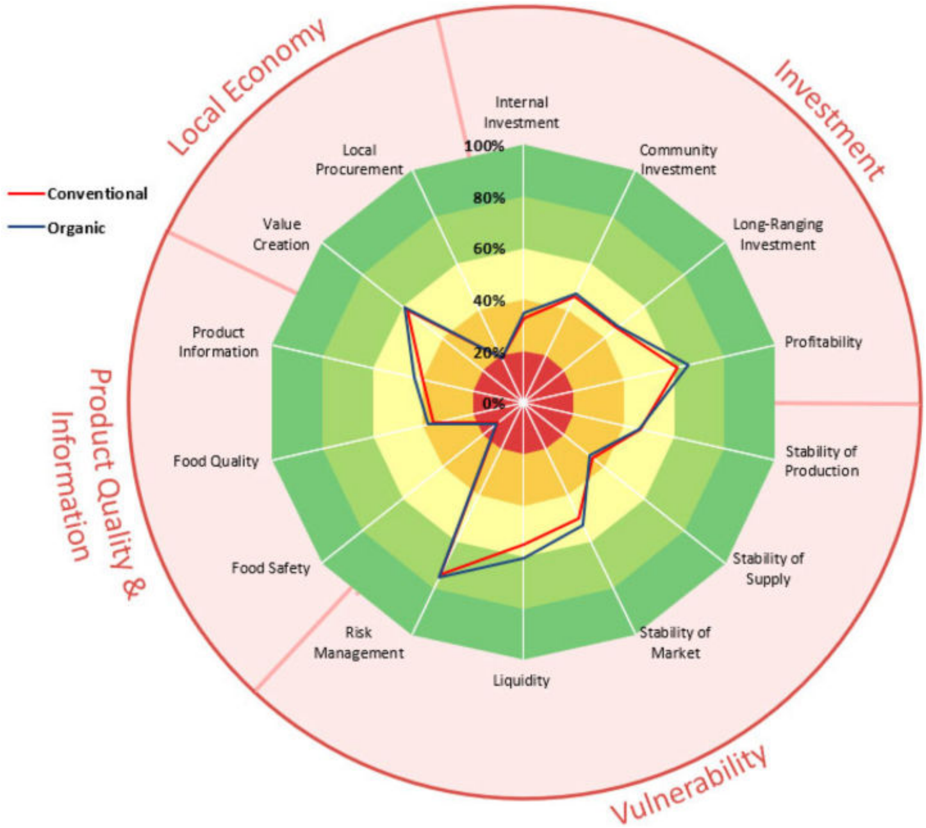

Fig. 4. Polygon view of the economic resilience sustainability performance of cocoa farming systems.

Table 3
Mean rank difference for economic resilience sub-themes of cocoa farming systems.

Theme/sub-themes	Mean rank		Mean rank difference	P-value
	Organic	Conventional		
Investment				
Internal Investment	224.03	194.17	29.85	0.047*
Community Investment	222.56	194.49	28.06	0.062
Long-Ranging Investment	215.04	196.13	18.91	0.208
Profitability	239.16	190.89	48.27	0.001***
Vulnerability				
Stability of Production	191.24	201.29	−10.05	0.504
Stability of Supply	187.80	202.04	−14.24	0.34
Stability of Market	251.56	188.20	63.36	0.000***
Liquidity	259.16	186.55	72.62	0.000***
Risk Management	213.56	196.45	17.11	0.254
Product quality and information				
Food Safety	199.69	199.46	0.23	0.988
Food Quality	227.46	193.43	34.04	0.023*
Product Information	225.22	193.92	31.30	0.036*
Local Economy				
Value Creation	220.19	195.01	25.18	0.094
Local Procurement	202.20	198.91	3.29	0.826

***1%, **5% and *10% significance.

investment, the stability of production, the stability of supply, risk management, food safety, value creation and local procurement, where the p-values were above p = 0.05.

Social wellbeing

Social wellbeing sustainability performance is illustrated in Fig. 5. Workplace safety and health provisions showed the highest sustainability performance between 60% and 80% for both organic and conventional cocoa farming systems. The lowest sustainability performance was shown by seven sub-themes, capacity development, rights of suppliers, forced labour, child labour, freedom of association and bargaining rights, non-discrimination and food sovereignty for both organic and conventional farming systems that fell between the scale 20% and 40%.

Sustainability performance of fair access to means of production fell within the scales 21%–40% and 0%–20% for organic and conventional farming systems, respectively.

Sustainability performance for gender equality and support to vulnerable people fell within the scales 61%–80% and 41%–60% for organic and conventional farming systems, respectively.

The mean rank differences between the two farming systems within the sub-themes of Social well-being are shown in Table 4. Mean rank scores for the organic farming system ranged between 189.2 (public health) and 266.2 (support to vulnerable people). Mean rank scores for conventional farming system ranged between 185.0 (support to vulnerable people) and 201.7 (public health).

The two cocoa farming systems differed significantly for some sub-themes with the exception of, quality of life, capacity development, fair access to means of production, responsible buyers, rights of suppliers, employment relations, forced labour, workplace safety and health provision, public health and food sovereignty, where the p-values were above p = 0.05.

Good governance

Good governance sustainability performance is illustrated in Fig. 6. Stakeholder dialogue showed the highest sustainability performance between 81% and 100% for both organic and conventional cocoa farming systems.

The sustainability performance for sub-themes, responsibility,

Fig. 5. Polygon view of the social wellbeing sustainability performance of cocoa farming systems.

Table 4
Mean rank difference for social wellbeing sub-themes of cocoa farming systems.

Themes/sub-themes	Mean rank		Mean rank difference	P-value
	Organic	Conventional		
Decent livelihood				
Quality of life	209.39	197.35	12.0	0.416
Capacity development	214.14	196.32	17.8	0.230
Fair access to means of production	214.01	196.35	17.7	0.197
Fair trading practices				
Responsible Buyers	212.13	196.76	15.4	0.305
Rights of Suppliers	214.32	196.28	18.0	0.208
Labour rights				
Employment Relations	202.14	198.93	3.2	0.692
Forced Labour	222.49	194.51	28.0	0.057
Child Labour	237.97	191.15	46.8	0.001***
Freedom of ass. and right to bargaining	238.54	191.02	47.5	0.001***
Equity				
Non-Discrimination	231.25	192.61	38.6	0.008**
Gender equality	256.71	187.08	69.6	0.000***
Support to vulnerable people	266.19	185.02	81.2	0.000***
Human safety and health				
Workplace safety and health provision	193.58	200.79	−7.2	0.619
Public health	189.16	201.74	−12.6	0.399
Cultural diversity				
Indigenous knowledge	229.51	192.98	36.5	0.015**
Food sovereignty	206.09	198.07	8.0	0.594

***1%, **5% and *10% significance.

conflict resolution, and full cost accounting, for both organic and conventional farming systems, fell between the scale 61% and 80%. The lowest sustainability performance was shown by sub-themes, mission statement and, the legitimacy for both organic and conventional farming systems that fell between the scale 0% and 20%.

Mean rank difference between the different farming systems based on the sub-themes of good governance is shown in Table 5. Mean rank scores for the organic farming system ranged between 187.9 (legitimacy) and 251.2 (full cost accounting). Mean rank scores for conventional farming system ranged between 188.3 (full cost accounting) and 202.0 (legitimacy).

The two cocoa farming systems differed significantly for three sub-themes, mission statement, sustainability management plan and full cost accounting. The remaining eleven good governance sub-themes had p-values above $p = 0.05$.

Discussion

Agronomic differences between cocoa farming systems

In a review of farming systems by Seufert & Ramankutty (2017), they also concluded that overall farm sizes of organic production are smaller. The current study is consistent with a study by Seufert & Ramankutty (2017) who found that organic farming is labour intensive in terms of weeding. Overall, the organic cocoa farming system spends more labour hours per season on various cultural activities compared to conventional. The organic farming system requires more labour than conventional systems (Pimentel et al., 2005), especially for labour-intensive commodities, fruits, and tree crops (Seufert and Ramankutty, 2017).

Sustainability performance based on the dimensions

Environmental integrity

As suggested in the literature, organic can have positive effects on environmental outcomes (Seufert, 2017). In the case study, a limited to good performance was found in the two cocoa farming systems, not only for the organic farming system. Indeed, the studied conventionally managed cocoa farms are characterised by low-input operations with low use of synthetic fertilisers and pesticides. The organic farms, on the

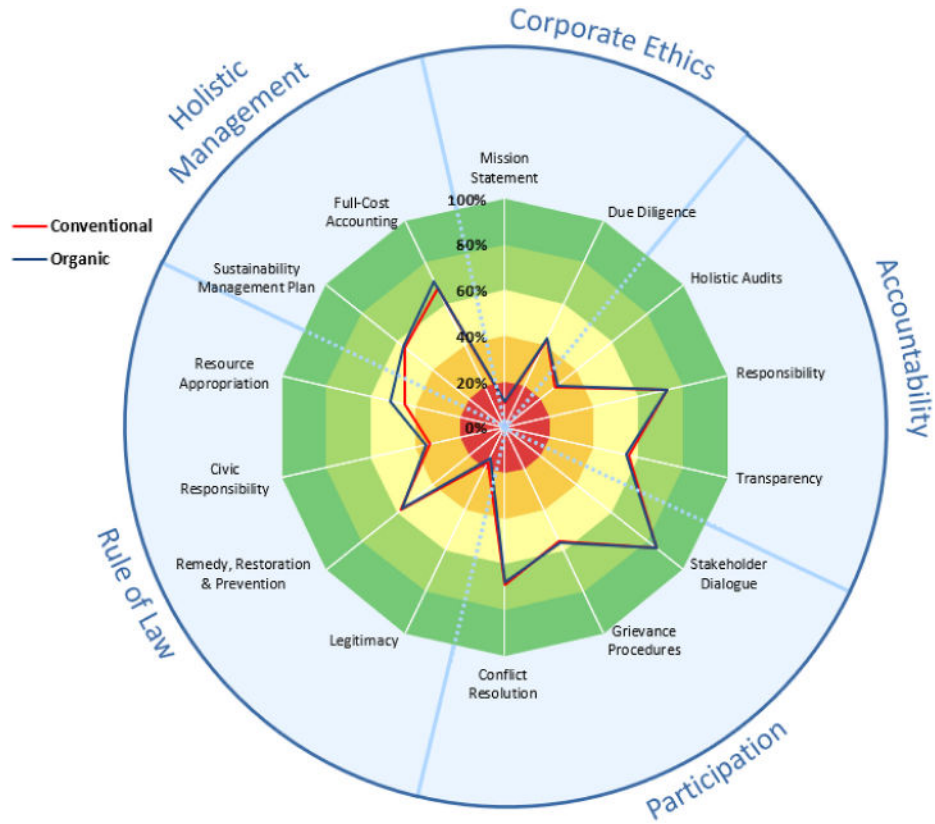

Fig. 6. Polygon view of the good governance sustainability performance of cocoa farming systems.

Table 5
Mean rank difference for good governance sub-themes of cocoa farming systems.

Themes/sub-themes	Mean rank		Mean rank difference	P-value
	Organic	Conventional		
Corporate ethics				
Mission Statement	227.18	193.49	33.7	0.022*
Due Diligence	205.57	198.18	7.4	0.623
Accountability				
Holistic audits	202.26	198.90	3.4	0.823
Responsibility	196.47	200.16	−3.7	0.805
Transparency	193.72	200.76	−7.0	0.634
Participation				
Stakeholder dialogue	203.67	198.59	5.1	0.724
Grievance procedures	204.64	198.38	6.3	0.675
Conflict resolution	191.47	201.24	−9.8	0.502
Rule of law				
Legitimacy	187.92	202.02	−14.1	0.345
Remedy, restoration & prevention	190.54	201.44	−10.9	0.466
Civic responsibility	213.15	196.54	16.6	0.269
Resource appropriation	218.75	195.32	23.4	0.108
Holistic management				
Sustainability management plan	225.61	193.83	31.8	0.034*
Full-cost accounting	251.18	188.28	62.9	0.000***

***1%, **5% and *10% significance.

other hand, use low or no organic inputs explaining the greenhouse gases scales of 61%–80% and 40%–60% for organic and conventional farming systems. Akrofi-Atitianti et al. (2018) also found low input use in Atwima Mponua District. Similarly, in Ethiopia, Winter et al. (2020) found a moderate to good environmental performance for conventional and certified coffee systems and attributed it to the low use of external inputs.

Our analysis showed that the organic farming system is better in greenhouse gases emission reduction and in terms of improvement in air quality. According to Akrofi-Atitianti et al. (2018), a major driving force for an improved performance for organic in terms of greenhouse gases is the low or no use of inputs. Similar studies in Ecuador by Bonisoli et al. (2019) for banana cropping system is consistent with the findings. The finding is also verified by Fess and Benedito (2018) that organic farming promotes carbon sequestration and reduce greenhouse gas emissions.

Organic farming systems showed better water management practices, such as the treatment of waste water in terms of disposal or reuse, water storage capacity and the use of rainwater compared to the conventional farming system. Studies conducted by Bonisoli et al. (2019), Berbeć et al. (2018) and De Olde et al. (2016b) found a statistical difference between organic and conventional in Poland, Denmark, and Ecuador, respectively.

We observed measures that reduce land degradation in organic farming system to be significantly higher compared to the conventional farming system. Other studies show that organic farming contributes to soil building and soil structure by improving the cation exchange capacity of soil biotic and physical properties (Reeve et al., 2016; Fernandez et al., 2016).

In our case study, organic farming systems are more diverse in terms of ecosystems, species and genetics compared to conventional. Those findings are consistent with Bandanaa et al. (2016) who found high flora diversity in organic cocoa farming system compared to conventional in the same geographic context. In terms of material use, energy use and waste reduction, the current study found the organic farming system to be significantly better in performance compared to conventional. The literature says organic farms tend to be more energy-efficient than conventional (Bonisoli et al., 2019; Lee, Choe & Park, 2015; Pergola et al., 2013).

Economic resilience

Our results showed that in most sub-themes, the sustainability performance ranged from unacceptable to good performance for both organic and conventional cocoa farming systems. In many sub-themes such as, community investment, long-ranging investment, the stability of production, the stability of the market, product information, liquidity and value creation, the performance is moderate for both organic and conventional farming systems. Moderate performance exposes farmers of both cocoa farming systems to market shocks in terms of cocoa prices. In the case study, the organic market is not well established. Some farmers sell most of their organic beans as rain forest beans (RA) or conventional. This is because the premium obtained by selling organic beans is often delayed. Winter et al. (2020) also made similar observations for coffee farming systems in Ethiopia, as farmers sell their coffee to private buyers as conventional produce.

The mean difference between organic and conventional farming systems explained that six of the sub themes in organic were significantly different from conventional. Other empirical studies (Bonisoli et al., 2019; Berg et al., 2018; Kamali et al., 2017; Crowder and Reganold, 2015; Panneerselvam et al., 2015) showed that organic farming is economically better than conventional in terms of investment. The organic farming system is more profitable than the conventional system due to price premiums, most especially so when the crops are grown for exports. The current study found in many subthemes, such as "Internal Investment," "Profitability," and "Liquidity," that organic farming system is significantly better than conventional. Though both cocoa farming systems are exposed to market shocks, organic cocoa farmers will always receive a premium on the cocoa beans either sold as organic or RA. Also, the organic farming system enhances food quality and product information compared to the conventional due to improved traceability.

Social wellbeing

The social wellbeing sustainability performance ranges from limited to good performance. The lowest sustainability performance of most sub-themes was labour related. In the case study, mostly family labour or hired labour is used in farm operations. Berlan (2013) verifies the finding on the use of family labour in cocoa production in Ghana but adds that, it is unacceptable if children are being involved in hazardous activities. Other studies (e.g., Oluyole et al., 2013; Akanni and Dada, 2012) in Nigeria confirms the use of family or hired labour in cocoa production and suggests sharecropping as a dominant labour option due to dishonesty and dedication of family/hired labour.

Capacity development, forced labour, child labour, freedom of association and bargaining rights were among the lowest for both organic and conventional farming systems. Especially for child labour, there was no difference between the farming systems because children within the case study were not engaged in hazardous works. According to a U.S. Embassy-Accra, January 2020 report, there is low incidence of child labour in the cocoa sector due to the enforcement of child labor laws and the "conduct of national dialogue on Child Labor Free Zones in the cocoa industry".

The organic and conventional farming system mean rank scores for social wellbeing showed significant differences for mostly labour related sub themes. The results for 'Freedom of association' and 'right to bargaining' suggest that organic farmers have access to more external labour and the workers bargaining rights. This finding is consistent with Giovannucci et al. (2008) study of certified coffee farming system in Kenya, Peru, Costa Rica, Honduras, and Nicaragua. With regards to gender equality, child labour, and support to vulnerable people, there is a significant trend in favour of organic farming system. Studies (Iddrisu et al., 2020; Bandanaa et al., 2016; Pandey and Singh, 2012) in Asante Bekwai, Atwima Mponua Districts and India have suggested that organic cocoa farming is a welfare and livelihood enhancer, and promotes gender equality in the workplace and encourages full participation for vulnerable in vibrant rural communities.

The organic farming system performed significantly better compared to conventional in terms of indigenous knowledge since traditional and cultural knowledge used by farmers is protected. This is consistent with findings by Ssebunya et al. (2019) on coffee farming systems in Uganda and Schader et al. (2016) in Africa (Ghana and Kenya) and Europe (Switzerland, Austria, and Germany).

Good governance

The performance of both farming systems mostly ranges between the scale unacceptable and best performance for this dimension. The lowest sustainability performance was shown by the sub-themes' mission statement' and 'legitimacy' for both organic and conventional farming systems. Employment conditions on farms are not stable, explaining the low performance in legitimacy. Organic farmers are verbally committed to sustainability topics more than conventional, hence better performance in full cost accounting and mission statement. Similarly, Winter et al. (2020) found mission statements to score low among coffee farming systems in Ethiopia. This was explained as Ethiopian coffee farmers partial commitment to sustainability topics and their lack of evidence to show for specific planned improvements.

The mean difference for good governance between organic and conventional farming systems was significantly different for sub-themes, mission statement and full-cost accounting. For instance, 'Mission statement' was significantly better for organic as organic farmers were aware of their cooperative certification and what it stood for. Similarly, in Ssebunya et al. (2019), the governance dimension recorded low scores.

Managerial implications for assessing farming systems sustainability performance

The sustainability performance of farming systems has several important implications for cocoa farm managers/farmers. The context in which farmers manage their cocoa farms has changed rapidly, often with little warning. The environmental specifications for producing cocoa, the socially stringent measures of abolition of child labour ensure fairness in labour conditions. These create uncertainty regarding future threats and potentials of producing cocoa through the organic or conventional farming system. This article emphasises the need to think about sustainability at the farm level at a basic level rather than the crop level. This underscores the need for improvement across the value chain.

Notably, the paper highlights that farm level activities are within broader social and natural boundaries. An accurate picture of the sustainability performance of a farming system cannot be developed if these boundaries are ignored. Explicit recognition of these points in managerial decision-making would represent a marked departure for crop level that have thus far been reluctant to look beyond their walls. The SMART-FARM Tool provides the needed basis for measuring the economic, environmental, good governance and social impacts of farming systems. This, in turn, would help decision-makers better understand their sustainability risks and opportunities. This is needed because farming systems must be proactive in addressing any potential economic, environmental, good governance and social challenges that could emerge throughout their value chains.

Given the significant number and variety of these sustainability challenges, farming systems must prioritise the issues that need the most urgent attention. The sustainability performance of farming systems using the SMART-FARM tool provides a basis for developing comprehensive strategies to improve performance and informed decision-making towards prioritising farm outputs. Implementing these strategies comes at a cost so that farmers need to tackle the inevitable trade-offs between efficiency and adaptability. However, unless farmers master this challenge, they cannot ensure the sustainability of their farms.

Limitations of the study

In Ghana, organic cocoa production has been practised in the Suhum

Municipal enclave by Yayra Glover Ltd. since 2007, which has an established market in Switzerland. Other projects encourage farmers to practise organic farming in the Atwima Mponua District. For future comparison of organic and conventional cocoa farming systems sustainability, the Suhum Municipal in the Eastern of Ghana could be explored.

Conclusion and recommendations

The paper focused on the sustainability performance and mean differences of organic and conventional cocoa farming systems. Based on the four dimensions of sustainability, this paper concludes that, for environmental dimension, the organic farming system performs better in terms of greenhouse gases and land degradation. Also, organic farming system was better compared conventional in water management practices, biodiversity (e.g., ecosystems, species, and genetic diversity), energy use, and waste reduction.

Regarding the economic dimension, there was no difference in farming systems performance in terms of risk management. However, the organic farming system was different from conventional in terms of the profitability, liquidity, product information and food quality.

In the social dimension, organic farming system performed better in terms of gender equality. Also, organic farming system differed significantly from conventional in terms of child labour, freedom of association and right to bargaining, non-discrimination, support to vulnerable people and indigenous knowledge.

Organic and conventional farming system were sustainable in terms of stakeholder dialogue in the governance dimension. Organic farming system differed from conventional in terms of the farms' mission statement, sustainability management plan, and full-cost accounting (verbal commitment to sustainability topics).

For the environment, economic, social and governance dimensions of farming systems, measures that will reduce land degradation, improve profitability, enhance gender equity and accountability including commitment to sustainability issues are the main driving forces to ensure farming system sustainability performance. Efforts by Tano Biakoye Organic Farmer cooperative, cocoa health, and extension division (CHED) of COCOBOD, Local Government department of agriculture, should be encouraged to improve the sustainability dimensions.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

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