Evaluating the barriers to adopting sustainable agriculture practices in smallholder coffee farming: implications for global value chains

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Abstract

Purpose: This study aims to access the perception of smallholder coffee farmers on barriers to the adoption of Sustainable Agriculture Practices (SAPs).

Methodology: Survey data were obtained through questionnaire, from 122 coffee producers in Nyeri County, the central region of Kenya. Data were subjected to factor-analysis using varimax rotation to identify key factors likely to hinder the adoption of SAPs.

Findings: Six factors were extracted through exploratory factor analysis, namely: deficient knowledge; materials and process encumbrances; financial challenges; cost-benefit rationality; capacity and market constraints; and lack of skills. Cronbach's alpha was used to ensure the reliability of the data and overall level of agreement amongst respondents.

Practical implications: The study concludes that the pathway to integrating coffee smallholders into sustainable global value chains should start with increasing awareness about the sustainability impacts of coffee agriculture, before implementing training programs on SAPs.

Keywords: Sustainable agriculture, coffee farming, smallholder, developing countries

1 Introduction

Agriculture is arguably the oldest industry in history; it has been an important part of every society from pre-Neolithic age (Mazoyer and Roudart, 2006), till the present day. There is an increasing pressure on the agricultural sector due to the need to sustain the rapidly growing global population. To keep up with this increasing demand for foods, farmers have had to resort to using synthetic chemicals and fertilizers to increase crop outputs. For those farmers that are unable to afford organic fertilizers and organic farming methods, the easy option is to cultivate more land in a bid to increase crop production, which also has implications for environmental sustainability i.e. deforestation (Acheampong et al, 2019). This is far from a viable solution however, as these farming techniques are unsustainable. They represent conventional industrialised agriculture practices which have negative implications for the wellbeing of both the environment and society relating to working conditions in agriculture (Horrigan et al. 2002). Although conventional agricultural practices could help to increase farm yields at a minimum cost, in comparison with sustainable alternatives such as organic certification (Barrett et al, 2001), there exists a new set of climate-related challenges capable of impacting on farmers' ability to meet the growing global demand for agricultural commodities. Therefore, to achieve sustainability in the present-day food systems that largely constitute conventional farming techniques; there is a need for wider implementation of sustainable agriculture practices (Rodriguez et al., 2009).

The adoption of sustainable agricultural systems – that is, the process of producing food from plants or animals by using different agricultural techniques aimed at protecting the public health, human lives, the environment, and animal welfare (Singh, 2008), offers several environmental, social and economic benefits. First, it can help farmers to manage the conditions imposed on them by climate change and global warming as the farming techniques involved are both conscious and protective of the environment. Secondly, sustainable agriculture can help farmers increase access to both markets and profits bearing in mind that most global multinational corporations now demand sustainable farm produce (DeLonge et al., 2016). Similarly, the reliance of sustainable agriculture on natural cycles helps farmers, particularly the smallholder farmers, improve plant performance, and in sustaining crop production (Local Harvest 2005). Many smallholders in developing countries do experience low yields due to infertile land and limited access to quality farm inputs (Njeru, 2015). Ensuring widespread adoption of sustainable agriculture practices thus emerges as a priority as doing so will likely enhance farming in general. Smallholders are more likely to reap the bulk of benefits as it involves farming techniques which forego the use of synthetic fertilizers, instead relying on naturally occurring materials (from plants and animals) to produce food. Despite the benefits and opportunities that sustainable agriculture offers to farmers, it has not been widely adopted, particularly by smallholder farmers (Njeru, 2015).

The involvement of smallholder farmers is vital for the development and growth of sustainable agriculture. It is estimated that 75% of food consumed across the world is produced by over 500 million smallholder farms in developing countries across Asia and Africa (Salami et al, 2010). Similarly, in Kenya, there are more than 150,000 farmers involved in coffee farming, 70% of which are smallholders. Some large multinational corporations have contributed to training Kenyan smallholder coffee farmers on sustainable farming practices (TechnoServe, 2013). For example, Nespresso has been working in conjunction with civil society organisations in Kenya to help coffee growers increase product quality through the adoption of SAPs since January 2014 (TechnoServe, 2013). However, the impact of these interventions has been very limited. Previous research (e.g., Kassie et al, 2013; Arellanes and Lee, 2003) brought to light the need for further inquiry in order to understand key facilitating and inhibiting factors for SAPs adoption amongst smallholders within developing countries. Based on this assumption, the present study seeks to analyse the key factors that are preventing many smallholder coffee farmers from adopting SAPs in Kenya.

SAPs offer opportunities for farmers to increase farm production efficiency and adapt to the effects of climate change (Corbeels et al, 2014), but the rate of adoption of sustainable farming practices amongst smallholder farmers remains low (Grover and Gruver, 2017). The low rate of adoption of sustainable agriculture practices is an issue that requires better understanding and further attention. Likewise, there are several studies on the adoption of sustainable agriculture, which have been widely reported in the literature (e.g. Jouzi et al., 2017; Wreford et al., 2017; McCarthy and Schurmann, 2014; Teklewold et al., 2013; Kassie et al., 2013; Chiputwa et al., 2011). While these reported some generic factors capable of influencing and inhibiting the adoption of SAPs, it should not necessarily be assumed that the impact of these factors will be the same on smallholder farmers in different countries, irrespective of the type crops they are cultivating.

With this in mind, the present study aims to access the perception of coffee farmers on the barriers reported in extant literature regarding the adoption of SAPs. The study used data collected from smallholder coffee producers in Nyeri County region in Kenya, with a focus on those who have attended training on SAPs. Exploratory factor analysis (EFA) was used to analyse the data to establish common factors underlying perceived barriers to SAPs adoption. Coffee production is critical to Kenya's economy and the majority (78%) of Kenyan farmers are smallholders who often use conventional agricultural methods e.g. chemical-based fertilizers and pesticides (Maina, 2017). These farming practices however impact negatively on the environment. It has been discovered that the main sources of CO2 emissions at the farm level in coffee production in Kenya are deforestation and the use of fertilizers (Maina, 2017). This study hence seeks to fulfil the following objectives:

- *To identify individual barriers to the adoption of sustainable agriculture practices as reported in literature*

- *To uncover complex patterns and relationships amongst these barrier variables through exploratory factor analysis technique and discuss the implications for integrating smallholder coffee farmers into global value chain.*

1.1. The Coffee Industry in Kenya

Coffee, not being endemic to Kenya, was brought there over a century ago during colonial rule. It has since remained a critical aspect of the country's agricultural sector. The economic importance of coffee to the Kenyan economy cannot be overemphasised. First, the coffee industry contributes significantly in terms of foreign exchange earnings; it is the 4th biggest cash crop after tea and horticulture (Mithamo, 2013). Secondly, the industry contributes up to 30% of the total employment figures in the agricultural sector (Monroy et al., 2013). Many smallholder farm systems in Kenya produce coffee as cash crops through a cooperative system. Thus, coffee has a significant economic impact in terms of job creation, particularly for the various players making-up the value chain such as farmers, cooperatives, processing companies and exporters. Yet, despite the social and economic value of coffee, the industry has suffered a drop in output in recent times (e.g Asayehegn Gebreeyesus et al, 2017; Maina, 2017), particularly among smallholder farmers. The drop in coffee production has been attributed to different factors, including a lack of access to credit, poor infrastructure and most importantly, climate-related issues like shortage of rainfall and drought (Shawiza, 2017).

Typically, coffee farmers use conventional agricultural techniques, which involves chemical fertilizers and pesticides. These in turn affect the environment and the people living in the coffee-growing communities negatively (Loland and Singgh, 2004). As the chemicals build up in soils over time, they percolate through the soil and its layers into water supplies (Mwanthi, 1998). In Kenya, coffee is grown primarily in specific regions / provinces such as Machakos, Nyeri, Kiambu, Murang' a Kirinyaga, Meru, Nakuru and Embu (Craves, 2008). Farming activities have a negative impact on biodiversity hotspots in Kenya such as Mount Kenya, an Endemic Bird Area (EBA) where more than three-quarters of restricted-range species are found (Carsan et al,. 2013). The mountains in Kenya are part of the ecosystem services playing a critical role in supporting human livelihood. For instance, the forests on Mt. Kenya are freshwater sources and thus also feed into the hydroelectric power generating plants in the country (Notter et al., 2007). This has important implications for the sustainability of coffee production in the country as coffee farmers depend on water for irrigation.

According to Agriculture and Food Authority (Coffee Directorate), coffee cultivation in Kenya covers approximately 162,479 ha of land, owned by smallholder farmers who are often organised in cooperatives or farm-based associations[1]. Hence, smallholder farmers are important to the Kenyan coffee supply chain. With an annual production at 32,700 tonnes, they cultivate 78% of land used for coffee plantation in the country, though continuing to experience low yield levels (Maina, 2017). This indicates a need for smallholder farmers to renew farming practices in favour of those which facilitate sustainable productivity. SAPs such as organic farming are not alien to Kenyan farmers; it started formally as early as in the 1980s following the founding of the first organic farming training institutions in the country (Njeru, 2016). Since then, organic farming has been adopted as an alternative agricultural practice to promote crops that require less chemicals. Even though certified organic coffee remains scarce in Kenya, as most of the coffees are still chemically grown (Laube, Breitbach and Bohning-Gaese, 2008), sustainable agriculture is developing at a significant rate (Njeru, 2016).

Historically, less than 1% of the total agricultural land in Kenya has been cultivated using organic farming (IFOAM & FiBL (2006) cited in Njeru (2015)). While contemporary statistics indicate the extent of adoption of sustainable farming in Kenya remains limited, recent evidence shows SAPs being promoted by different stakeholders including but not limited to non-governmental organizations (NGOs), farm-based organisations, faith-based organizations and cooperatives or community-based organizations (CBOs). It is worth noting that the private sector also contributed to the growth of organic farming in Kenya through export promotion (Jessica, 2005). Some of the key factors motivating the promotion of organic agriculture in Kenya were government policy to address insecurity, deteriorating farm outputs triggered by soil degradations and the poverty level amongst farmers, which prevented them from gaining access to capital needed for farm inputs (Njeru, 2015).

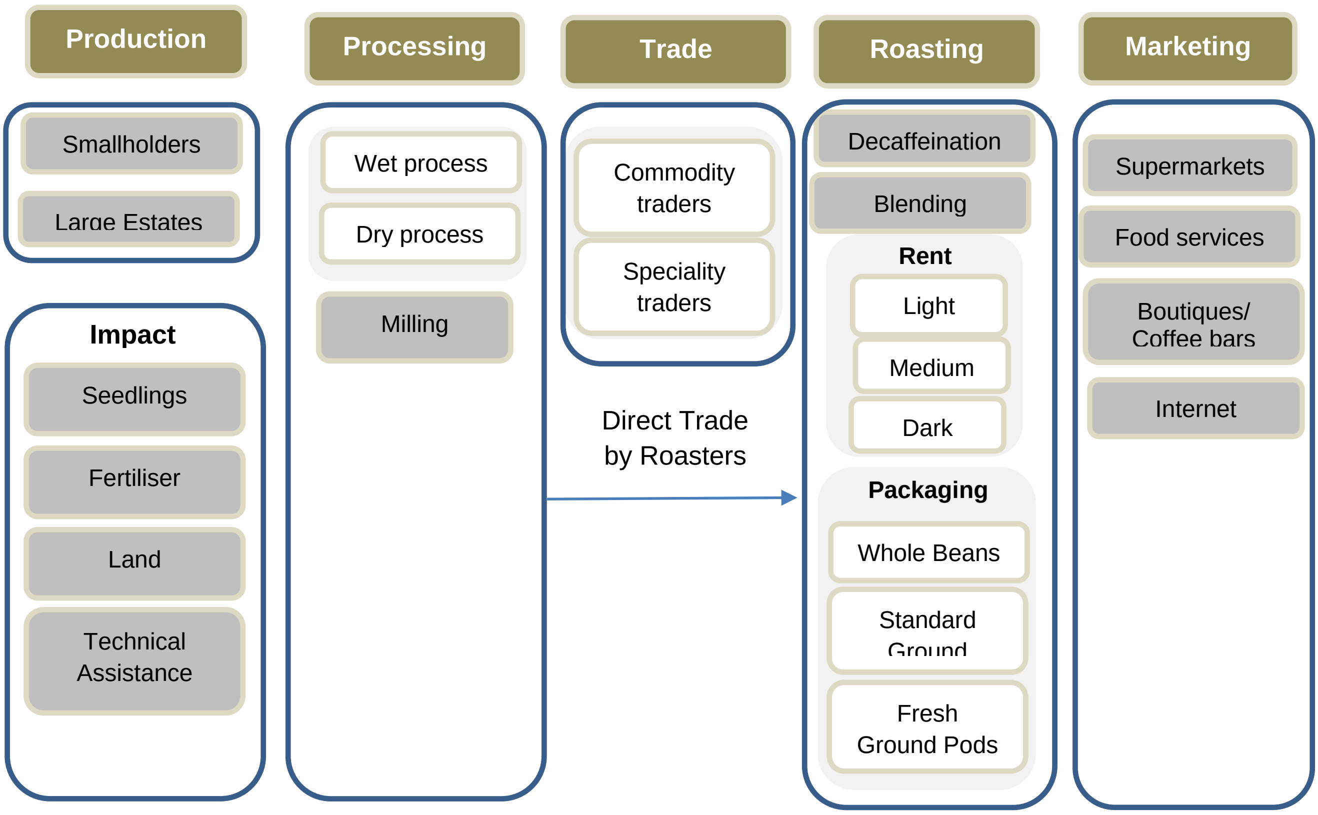
1.2. The coffee global value chain: an overview

Global value chains (GVCs) have been defined as the full range of people and activities involved in the production distribution, sales, consumption, and disposal of a product/service, carried out on a global scale (Gereffi and Fernandez-Stark, 2011). Figure 1 below suggests that there are four key dimensions of GVCs; an input-output structure that describes the converting

[1] The Coffee Directorate, Agriculture and Food Authority (AFA). https://www.agricultureauthority.go.ke/coffee-board-of-kenya/

of raw materials into finished products; a geographical factor; a structure for controlling the value chain (governance); and an institutional factor, which describes the sector/industry in which the value chain is situated (Daly *et al*, 2018). GVCs connect firms, employees and consumers across the globe and often provide opportunities for producers of agricultural products in developing countries to integrate into the global economy. This relates to the concept of upgrading which describes how firms move between different stages in the GVC (Humphrey and Schmidt, 2002). This dynamic movement can be in the form of economic, social, and environmental upgrading (Islam and Polonsky, 2020), and has been widely viewed as a strategic lever for increasing the competitiveness of developing countries through human capital development and value-added production. Nevertheless, there is still considerable debate among researchers about the extent to which such upgrading is taking place, and the implications for agribusiness in Africa (Balie et al, 2019).

Figure 1. The Coffee Global Value Chain



Source: Daly *et al* (2018)

Coffee is a significant source of livelihood for farming households and employment for local communities **(**Mithamo, 2013**).** However, the activities involved in coffee production have environmental, social, and economic ramifications, which in turn have attracted considerable attention by researchers, policymakers, and multinational organisations (DeLonge et al., 2016; Njeru, 2015; Technoserve, 2013). Thus, contemporary analysis of GVCs now focus not only on the activities of the firms participating at different levels across the GVC (upstream or downstream), but also on how they address sustainability impacts. The corporate visions of most international agricultural markets are characterized by action on social and environmental impact of farming practices (Mboga, 2017). Apart from seeking to understand the requirements for participating in GVCs, firms should further endeavour to participate in GVC in a sustainable manner. This reinforces our initial argument that it is important to increase the adoption of

SAPs by smallholder farmers in Kenya's coffee sector. The ability of smallholder coffee farmers to adopt SAPs is a vital condition for their effective integration into GVCs and future sustainability at large. By adopting SAPs, smallholder farmers can tap into the potential for upgrading possibilities in coffee value chains.

This research is important for several reasons. Firstly, to develop strategies for enhanced adoption of SAPs, it is important to understand the barriers faced by smallholder farmers that are involved in growing coffee. Secondly, there is a gap in the literature on the relationship between perceived barriers to and actual implementation of sustainable agriculture practices amongst smallholder coffee farmers. Therefore, our findings can contribute by offering useful insights into the focus areas for addressing the barriers limiting smallholder farmers from implementing SAPs. Thirdly, major coffee companies in the world have increased sustainability considerations in their coffee sourcing (Mboga, 2017) to cope with increasing demand for environmentally friendly food products and in response to climate change threats. Thus, increasing the adoption of sustainable agriculture will help smallholder farmers to create sustainable competitive advantage in the global coffee value chain.

1.3. Sustainability in Agriculture

Before discussing sustainable agriculture, it is important to first define sustainability as a concept. The Cambridge Dictionary (n.d) defines sustainability as "the idea that goods and services should be produced in ways that do not use resources that cannot be replaced and that do not damage the environment". Although this meaning of sustainability seems to focus more on the environmental aspect, this has historically been the case as various scholars (e.g. Grace et al, 2003; Martins et al, 2010) have viewed sustainability more in the sense of environmental aspects with a focus on ecology, pollution, human activities and ecosystem devastation. There remains widespread consensus amongst scholars that sustainability involves more than concern over environmental problems but includes social and economic issues (e.g. Christen and Schmidt, 2012; Giddings, Hopwood and O'brien, 2002; Sneddon, Howarth and Norgaard, 2006). To reflect the broader environmental, social and economic issues, sustainability, and sustainable development have been used interchangeably (Waas et al, 2011). Even though debate regarding issues of “how” and even “whether” these terms differ remains unresolved (Gibson, 2001). In this chapter , we define sustainability as the connection between environmental social and economic factors consistent with the triple bottom line of sustainable development (Giddings et al, 2002).

With regards to sustainable agriculture, it is difficult to arrive at a universally accepted definition (Rajović and Bulatović, 2016) because the debate involves different worldviews from a variety of stakeholders (e.g. government, private sector, NGOs, Academia). For example, Dogliotti et al (2014) define sustainable agriculture as the act of ensuring a sustainable increase in food production, resource efficiency and enhancing profit of farmers in environmentally friendly ways. This seems to echo Ikerd’s (1993, p.30) earlier definition which describes sustainable agriculture as “capable of maintaining its productivity and usefulness to society over the long run. (…) it must be resource-conserving, economically viable and socially supportive and commercially competitive” . According to Gold (2016), sustainable agriculture is a system of agribusiness that can produce food consistently and still offer benefits to the wider society indefinitely. This is a farming system that is expected to make money from food production, reduce the impact on the environment and support social development. What these definitions depict is the interrelationships between agriculture, environment, and the society at large.

Sustainable Agricultural Practices are techniques or methods used to address the social and environmental impacts of farming activities. This terminology has also been used interchangeably with the term organic farming. As seen in Table 1, SAPs include, though are not limited to, the adoption of organic manure, biological pest control, crop rotation, cover crops, drip irrigation, avoidance of child labour and use of protective equipment in farms (Licht, 2016; Mwangi et al., 2015; Mugo et al., 2011; Water Resources Group, 2016).

Table 1. Sustainable Agricultural Practices

Common Types of SAPs	Description	Sources
Crop rotation	Involves growing a mix of crops and rotating their locations on the same farmland. There are various benefits associated with crop rotation such as enhanced soil nutrients, soil properties, weed control and pest control.	Brankatschk and Finkbeiner (2015), Mazvimavi and Twomlow (2009)
Growing cover crops	Cover crops are planted to protect the soil from erosion that weakens soil quality, replace soil nutrients with organic matter, and prevent weeds from growing on the farmland. Farmers can also reduce the need for herbicides through cover crops.	Licht (2016), Mwangi et al. (2015)
Biological pest control	Involves adapting mechanical and biological pest controls as a substitute for chemical pesticides/ insecticides. The purpose is to reduce the spread and population growth of pests on farmlands in a sustainable manner.	Mugo et al. (2011)
Drip irrigation	A sustainable irrigation system for addressing water shortage and reduce excessive water consumption	Keller and Blienser (1990)
Mixed Farming	A system of agriculture which encompasses the growing of crops with animal production. The crops become a source of feeds for the animals, while the animals produce manure to grow the crops.	Powlson and Johnston (2015)
Organic manure	Commonly relies on non-chemical-based fertilizers, which are derived from plants (compost manure) and/or animal waste	Zingore et al. (2008), Tripathi et al. (2017), Han et al. (2016)
Protecting health and safety of workers in agriculture (e.g. u sing personal protective kits, first-aid)	Involves practices to ensure the safety and health of farmers on the farm.	Kanyenze (2004), Mureithi (2008)

2.1. Barriers and challenges to the adoption of SAPs

Barriers to the adoption of SAPs by smallholder farmers have been widely discussed in the literature. Findings from our review of extant literature identified a total of twenty-one barriers as summarised in Table 2.

The financial constraints associated with sustainable agriculture have been widely discussed by scholars (e.g McCarthy and Schurmann, 2014; Drost, 1996; Teklewold et al., 2013). These can manifest in different ways such as lack of access to credit (Presley, 2014; Wreford et al, 2017), high cost of certification (Barrett et al, 2001) and cost of buying raw materials required for making organic manures. What seems to have been the most important concern over sustainable agriculture, particularly regarding organic farming is certification costs, which can run between US$200 – US$1500 depending on the size of farm outputs and the accredited agency used for certification (Kginter, 2010). Although the cost of certification might vary wildly from country to country, it puts further restrictions on smallholders' capacity to adopt organic farming because they are typically characterised by resource limitations and insufficient capabilities. Similarly, some smallholder farmers doubt whether the adoption of sustainable agriculture will help them improve profitability (Teklewold et al, 2013). However, the perceived impact of these barriers on the adoption of sustainable agriculture amongst coffee farmers in Kenya might differ.

Furthermore, researchers have identified a range of barriers relating to lack of management expertise, lack of awareness of conservation issues, lack of technical knowhow and lack of knowledge of government support programmes (e.g Drost, 1996; Presley, 2014; Wreford et al, 2017; Jouzi, et al, 2017). These six barriers are categorised as capability constraints hampering the adoption of sustainable agriculture amongst smallholder farmers. Sustainable farming requires a large amount of labour input (Wreford et al, 2017), and the challenge of soil nutrient management was another barrier cited in the literature. For example, small farmers lack the resources required to convert plant and animal remains into organic fertilizers (Njoroge, 2000; KIOF, 1999). All the above-mentioned barriers reflect a lack of possession of appropriate skills, information, and ability of smallholder farmers to meet the requirements for implementing sustainable agriculture effectively. The intensity of these barriers may be higher in smallholder coffee farmers in a developing country such as Kenya where there are low literacy levels and considerably higher poverty rates.

There are several barriers cited in the literature, which relate to demands and supply aspects of implementation of sustainable agriculture. These include lack of market access, concerns over customers' ability to afford sustainable farm products, the administrative constraints faced when seeking certification for exporting organic farm products, shortage of compost materials and the fact that organic farmers often come into conflict with promoters of inorganic chemicals (e.g. McCarthy and Schurmann, 2014; Jouzi, et al, 2017; Barrett et al, 2001; Vorley, Fearne and Ray, 2016; Njoroge, 2000). As global coffee companies increase their efforts directed towards sustainable sourcing, structural barriers may have important implications for smallholder farmers as they consider themselves unable to influence prices in the value chain (Fayet and Vermeulen, 2014). This perhaps explains why various supply chain assurance systems have emerged in recent times, i.e. training and other capacity development programmes established by coffee companies to help their small farmers increase adoption of sustainable agriculture (Fayet and Vermeulen, 2014).

Other barriers identified relate to the role of government institutions in promoting the use of non-organic fertilisers and the bureaucracies involved in the organic certification process (McCarthy and Schurmann, 2014; Wreford et al, 2017). Barriers such as these are sometimes challenging and harder to overcome as they constitute the regulative elements, which may threaten smallholder farmers' legitimacy, ability, and licence to operate (Scott, 2008) in the organic markets. Furthermore, some smallholder farmers may be using organic manures to grow coffee, but they are not recognised as a certified organic farmer due to their inability to fulfil the administrative requirements. Farmers in this category (i.e., non-certified organic farmers) are likely to face institutional barriers such as lack of reliable marketing linkages (Barrett et al, 2001; Fayet and Vermeulen, 2014), and an inability to attract support from external development agency or aids from the government to enable them to practise sustainable agriculture consistently (Vernooy, 2017). These institutional constraints, if not addressed, can discourage smallholder farmers from practicing sustainable agriculture.

Moreover, there is evidence indicating that sustainable agriculture might yield lower harvests in comparison to conventional farming systems, therefore requiring more resources (e.g., land, capital) to maintain food productivity (De Ponti et al, 2012; Seufert, Ramankutty and Foley, 2012). However, the differences in yield depend on various contextual factors such as type of sustainable farming practices, farm location and farmers' level of expertise (Seufert, Ramankutty and Foley, 2012). Similarly, a concern may arise when smallholder farmers consider the adoption of sustainable agriculture. There is also a perception that sustainable agriculture is not an effective approach to controlling pests on farmlands (Njeru, 2015). It is important to address productivity concerns associated with sustainable agriculture as the possibility of decreased productivity is likely to demotivate adoption by farmers. In addition, the potential impact of sustainable agriculture on human health has been reported in the literature. Techniques like organic farming may present some health risks to farmers given that it relies on the natural process of decomposition of materials. Brandt and Mølgaard (2001) show that farmers who adopt SAPs are likely to exhibit symptoms such as sneezing, coughing and skin infections from handling organic manures from plants and animal extracts.

As Horrigan et al. (2002) have argued, most previous studies seemingly place more emphasis on human health benefits associated with consumption of organic foods in comparison to the potential negative health impacts of organic agriculture. The health effects of SAPs might be an important point of consideration for smallholder farmers in Kenya, a developing country where there is limited access to quality healthcare services. While these previous studies seem to suggest that using chemicals is healthy compared to using natural substrates, it is important to re-examine the idea that farmers could contact diseases from preparing organic manure. Such health-related concern is likely to affect farmers' enthusiasm towards adoption of SAPs. Scholars have similarly emphasized that land tenure issues are important barriers to adoption of SAPs in both the developing and developed countries (Antle and Diagana, 2003; Arellanes and Lee 2003). The problem here is property rights issues, which influences a farmers' decision to either use the conventional or sustainable type of agriculture. In studies conducted in the US (e.g., Rodriguez et al., 2009), farmers who engage in SAPs tend to farm less land than conventional farmers. While it can be argued that farmers with insecure property rights will not care whether the use of conventional farming practices will degrade the soil structure, it is less clear if land tenure has affected the adoption of SAPs in developing countries.

For example, farmers growing coffee in protected areas in Kenya may want to adopt SAPs because of the restrictions to expand their operations on land. Just like land tenure issues, lack of infrastructure presents a threat to wider adoption of SAPs (Khanna et al, 1999). It has been suggested that countries must invest in physical infrastructures such as communication networks, irrigation, and transportation links to enhance the adoption of SAPs (Pretty and Hine, 2001). Therefore, the lack of infrastructure can be an important barrier affecting the adoption of SAPs in developing countries where infrastructural problems have been recognised. For example, smallholder farmers in Kenya might find it difficult to adopt SAPs without the existence of functional supporting infrastructure.

Table 2: Key barriers to the adoption of sustainable agriculture

Barriers identified in the literature	Authors
1. Financial limitations / lack of access to credit 2. Not cost-effective (need to maintain profitability) 3. The high cost of certification	McCarthy and Schurmann (2014), Drost (1996), Teklewold et al. (2013), Presley (2014), Wreford et al. (2017), Barrett et al. (2001).
4. Lack of knowledge of government support programmes 5. Lack of management skills 6. Lack of awareness of conservation issues 7. Educational needs of small holders 8. Management of soil nutrients is difficult and labour intensive (hard work in turning of the compost manure) 9. Lack of technical know-how	Drost (1996), Presley (2014), Wreford et al. (2017), Jouzi et al. (2017), Njoroge (2000), KIOF (1999)
10. Market demand - affordability for customers 11. Market access issue 12. Smallholder farmers consider the certification rules for exporting organic products to be very rigorous. 13. Shortage of raw materials (for manure/compost) or s carcity of over-the-counter organic chemicals 14. Conflict with promoters of inorganic chemicals	McCarthy and Schurmann (2014), Jouzi et al. (2017), Barrett et al. (2001), Vorley, Fearne and Ray (2016) Njoroge (2000), KIOF (1999)
15. Inability to influence prices in the value chain. 16. Too many paperwork requirements for certification	McCarthy and Schurmann (2014), Wreford et al. (2017), Barrett et al. (2001), Fayet and Vermeulen (2014)
17. Lower yields in comparison to conventional farming systems 18. Ineffective for eliminating pests	McCarthy and Schurmann (2014), Jouzi et al. (2017), Njeru (2015)
19. Health side effects on farmers	Wreford et al. (2017), Njeru (2015)
20. The insecure land tenure system 21. Lack of transport links	Antle and Diagana (2003), Pretty and Hine (2001), Khanna et al. (1999)

Although earlier studies have presented numerous barriers facing smallholder farmers in the adoption of SAPs in any type of agriculture, there is limited empirical research describing the underlying dimensions of these in the context of coffee farming. Even if common barriers had been identified in other studies, some may be perceived as more relevant to smallholder coffee farmers in specific countries, given that entrepreneurs' attitude and perceptions are controlled by cultural and country specifics (Torrès, 2000). Therefore, it could be argued that smallholder coffee farmers in Kenya might have a different perception of the impact of SAPs barriers, otherwise frequently cited in the literature. This study will bridge the gap in existing knowledge by generating explanatory constructs on barriers facing Kenyan smallholder farmers in adopting SAPs in the coffee sector. We will also discuss the implications of findings on better integration of these smallholder farmers into GVCs.

3. Methods

3.1. The survey instrument and sampling process

A survey questionnaire was developed based on the literature review. It consists of 21 questions that portray a list of barriers to SAPs adoption, generated from the existing literature as summarised in Table 2. Survey research was considered appropriate because it is a method that "allows the collection of a large amount of data from a sizable population in a highly economical way; often obtained by using a survey administered to a sample, these data are standardised, allowing easy comparison" (Saunders et al., 2012; p. 168). The presented study collected data from a relatively large audience, consisting of smallholder coffee farmers across Nyeri County in Kenya. Second, the survey helps to gather data in numerical forms to quantitatively analyse the respondents' opinions and attitudes about the subject under investigation (Creswell, 2013). The use of a questionnaire as the survey instrument facilitated the standardisation of the questions by enabling participants to respond to the same stimuli.

The purpose of the inquiry was to detect which barriers were more frequently perceived as the most important among smallholder coffee farmers in Kenya with regards to the adoption of SAPs. The first section of the questionnaire was designed to collect information on the general description of the respondent's demographic information, as well as awareness of SAPs and their current implementation. The second section contained a set of closed-ended questions with 21 Likert scales items designed to measure the respondents' perceptions towards barriers to SAPs adoption. The initial draft of the questionnaire was piloted amongst a panel of 15 students studying sustainability-related degree courses, to ensure the validity and reliability of the survey instrument. Due to the lack of access to a central database for small-scale coffee farmers in Kenya, we adopted the purposive sampling technique (Jankowicz, 2005) to distribute the questionnaire to a total of 320 smallholder coffee farmers. The sample consists of individuals that own, manage or work in small-scale coffee farms in the Nyeri country region in Kenya. The questionnaire was administered physically through self-administration at various small farmers' association events and via emails.

Out of the questionnaires distributed, 143 were returned, representing a response rate of 44.7%. We consider this response rate adequate as Saunders et al. (2013) recommended that a sample size of more than 30 represent a convenient rule of thumb for statistical analyses. After the initial screening of the returned questionnaires, where answers from respondents who had not yet attended the training(s) on SAPs and incomplete submissions were removed, 122 responses were retained for further analysis. The respondents consisted of coffee farm owners (45.1%), coffee farmer owners' spouses (18.9%), farmworkers (26.2%) and other members of the household (9.8%). Most respondents indicated that they practiced more than one type of SAP, but 31.1% had not applied any SAP techniques yet. The bulk of the respondents were male (80.3%), suggesting that the range of our sample was not proportionate based on gender distribution. However, this could be due to sampling error, and while coffee in Kenya has been a 'man's crop' (IWCA Kenya, 2012), there is evidence suggesting that women in Africa contribute significantly to the workforce employed in farms. None of the respondents had less than 10 years' experience in growing coffee and most of them (86.8%) had undergone more than the basic level of education (i.e. primary school).

4 Results and discussion

4.1. Descriptive analysis

Table 3 presents the mean scores and standard deviations associated with the variables used to assess each of these barriers. As shown in the table, the data produced the mean for all the 21 items in the questionnaire ranging from 3.18 to 4.10. A total of 14 variables show relatively high mean scores ranging from 3.58–4.10 points. For example, the following obtained mean scores of 3.68, 3.75, 3.8, 3.84, 3.95 and 4.1, respectively: "*smallholder farmers lacking technical know-how for sustainable agriculture practice", " shortage of raw materials to make compost manure", "organic farmers usually disagree with promoters of chemical fertilizers", "the usual/conventional practices are more cost-effective than sustainable alternatives", "smallholder farmers lack awareness of sustainability impact of farming activities", and "the processes for organic certification is too rigorous for smallholders"*. The lowest mean score (3.18) relates to producers of sustainable farm products being unable to gain access to the right market.

A t-test was performed on the data to determine whether statistically significant differences exist between farmers who have adopted one or more types of SAP (N=84) and those that use conventional practice throughout (N= 38) their cultivation process. The findings will help us determine whether different kinds of policy interventions would be required for promoting the adoption of SAPs amongst smallholder coffee farmers, which fall within these different categories. The results show no statistical difference between the two groups of respondents for all variables, except for *"the high cost of organic certification is discouraging for small farmers"* ($t_{48.563}$ = 1.842, $p <$ 0.000), *and "smallholder farmers lack awareness about government's support for sustainable agriculture"* ($t_{52.808}$= 2.854, $p <$ 0.000). These two variables have p-values below the chosen significance level of α = 0.001. One possible explanation of the result is that there is government support for assisting coffee farmers with the high certification costs, but people do not know about it

Table 3: Mean scores and standard deviations

Variables	*Mean*	*Std. Deviation*	*N*
1. Shortage of financial resources	3.61	.787	122
2. Conventional practices are more cost-effective	3.84	1.029	122
3. The high cost of organic certification	3.61	.984	122
4. Lack of awareness on available government's support	3.47	.972	122
5. Lack of required management skills to use SAPs	3.34	.993	122
6. Lack of awareness of the sustainability impact of farming	3.95	.952	122
7. More education needed to increase SAPs adoption	3.64	1.045	122
8. Composting is a difficult and labour-intensive process	3.66	.933	122
9. Lack of technical know-how for sustainable agriculture practices	3.68	.836	122
10. Customers cannot afford sustainable farm products	3.51	.874	122
11. Lack of access to the right market	3.18	1.068	122
12. The organic certification process is too rigorous	4.10	.536	122
13. Shortage of raw materials to make compost manure	3.75	.796	122
14. Possible disagreement with promoters of chemical fertilizers	3.80	.749	122
15. Inability to influence market prices	3.58	.898	122

16. Too much paperwork requirements for certification	3.32	.893	122
17. SAPs do not give better yields	3.29	1.095	122
18. It is difficult to achieve desired benefits from using SAPs	3.59	.994	122
19. Compost making present some health challenges	3.65	1.020	122
20. The land tenure system does not permit some SAPs	3.65	1.060	122
21. Lack of transport infrastructure	3.45	.919	122

4.2. Exploratory Factor Analysis

Exploratory factor analysis (EFA) was used to establish the common factor structure underlying perceived barriers to the adoption of SAPs as perceived by smallholder coffee farmers in Kenya. EFA is considered to be a theory-generating procedure as opposed to a theory-testing technique (Stevens, 1996), which helps determine whether a set of underlying factors exist to improve knowledge about the barriers facing smallholder coffee farmers in adopting SAPs. The data collected from the questionnaire was transferred to a spreadsheet and further uploaded into SPSS software, which enabled us to examine the internal consistency of the items and derived factors. In computing the factor analyses, the Kaiser-Meyer-Olkin measure of sampling adequacy on the variables was calculated to be 0.74. This suggests a high correlation score and shows that the data collected through the questionnaire item is suitable for the intended purpose (Hair et al., 2003). Also, the Bartlett test of sphericity was significant (p = 0.000). Likewise, the spearman's correlation (r), which shows a considerable number of scores exceeding, also confirms the suitability of the data for EFA. When the 21 variables were subjected to the principal component factor analysis, using varimax rotation, a six factor solution emerged with eigenvalue ≥ 1 (as shown in Table 4). The six factors described 71.6% of the total variance – these are considered satisfactory based on the reliability tests of Cronbach's alphas, which are all above 0.6.

Table 4: Total variance explained

Component	*Initial Eigenvalues*			*Extraction Sums of Squared Loadings*			*Rotation Sums of Squared Loadings*		
	Total	*% of Variance*	*Cumulative %*	*Total*	*% of Variance*	*Cumulative %*	*Total*	*% of Variance*	*Cumulative %*
1	6.248	29.750	29.750	6.248	29.750	29.750	3.130	14.905	14.905
2	2.230	10.620	40.370	2.230	10.620	40.370	3.018	14.373	29.278
3	2.064	9.827	50.198	2.064	9.827	50.198	2.808	13.370	42.648
4	1.819	8.662	58.860	1.819	8.662	58.860	2.359	11.234	53.883
5	1.519	7.233	66.093	1.519	7.233	66.093	1.878	8.942	62.825
6	1.154	5.497	71.590	1.154	5.497	71.590	1.841	8.765	71.590
7	.995	4.736	76.326						
8	.753	3.584	79.911						
9	.612	2.916	82.826						
10	.569	2.711	85.537						
11	.507	2.412	87.949						
12	.454	2.160	90.109						
13	.418	1.992	92.101						
14	.390	1.855	93.956						
15	.282	1.341	95.297						
16	.230	1.096	96.393						
17	.192	.914	97.307						
18	.170	.811	98.118						
19	.166	.791	98.909						
20	.141	.671	99.580						

21	.088	.420	100.000						
Extraction Method: Principal Component Analysis									

According to Hair et al. (1998), variables with a loading of more than 0.30 are deemed important, a loading of more than 0.40 means more important, and a loading of 0.50 or more is very significant. Therefore, we used SPSS to filter and suppress scores below 0.5 to discover variables with significant loadings when computing the factor analysis. It was decided from the analysis that only a factor loading of 0.60 or better is significant for absorbing an item in its respective factors. The results of the rotated factor matrix are shown in Table 5 and the factors are discussed subsequently. As seen in this table, the variables loaded against the six factors described below ranged from 0.923 to 0.631, suggesting largely higher reliability factors:

- **Factor 1: capacity and market constraints.** The first factor consists of four variables with loading ranging from 0.685 to 0.850, an eigenvalue of 6.348 and 29.7% variance. The variables included in this factor are: composting is a difficult and labour-intensive process; lack of technical know-how relating to sustainable agriculture practices; customers inability to afford sustainable farm products; and lack of access to the right market. It can be argued that issues relating to smallholders' capacity to implement SAPs and influence the markets of sustainable coffee products constitute barriers in the Kenyan context. However, there are other factors which might influence the high loading of this factor such as the respondents' experience with SAPs and their agency level . For example, it is expected that farm owners will have more control and knowledge about the ease or difficulty of substituting conventional agricultural practices with sustainable alternatives when growing coffee, given their experience, and as compared to their spouses or hired employees who rarely work on the farmlands. Notwithstanding, the results reinforced previous studies highlighting that the capacity required to adopt new SAP can be significant (Murray et al. 2016) such that the lack of capacity can discourage adoption amongst small scale farmers.

- **Factor 2: cost-benefit rationality.** The factor consists of four variables with loading ranging from 0.711 to 0.837, and with an eigenvalue of 2.230, it accounts for 10.6 % of the rated variance. The variables included in this factor are: SAPs do not give better yields; it is difficult to achieve desired benefits from using SAPs; compost making presents some health challenges, and the land tenure system does not permit some SAPs. From a rational point of view, this is consistent with previous findings that farmers are motivated to adopt SAPs if the demonstrated gains exceed the cost or difficulties associated (Mwangi et al., 2015). The fact that chemical fertiliser is comparatively cheaper (Han et al., 2016) than organic manure, which usually requires considerable time to decompose (McCarthy and Schurmann, 2014), suggests that incentives might be necessary to change the attitude towards the adoption of SAPs.

- **Factor 3: material and process encumbrances.** The factor consists of four variables with loading ranging from 0.631 to 0.885, an eigenvalue of 2.064 and 9.8% of the variance. The variables included in this factor are: possible disagreement with promoters of chemical fertilizers; shortage of raw materials to make compost manure; organic certification process is too rigorous; and too many paperwork requirements for certification. The variable labelled "organic certification process is too rigorous" was scored highly by respondents irrespective of their level of adoption of SAPs. It obtained mean scores of 4.15 and 3.97 from respondents grouped as implementers and non-implementers of SAPs, respectively. This explains why there are more non-certified organic farmers in Kenya than those with certifications (Goldberger, 2008). Previous studies have shown that farmers are discouraged by excessive paperwork requirements for organic certification (Barrett et al, 2001; Fayet and Vermeulen, 2014). Interestingly, this barrier was ranked least by those respondents who were yet to implement any type of SAP on their farm (mean = 3.05). One explanation for this result is that only those who have experienced the process of organic certification can potentially make a valid judgement on the rigour involved.

- **Factor 4: financial challenges**. The factor consists of three variables with loading ranging from 0.792 to 0.875, an eigenvalue of 1.819 and it accounts for 8.7 % of the rated variance. The variables included in this factor are: the high cost of organic certification; conventional practices are more cost-effective; and shortage of financial resources. Previous research has established that smallholder farmers have a limited choice when it comes to the methods of cultivation due to financial constraints, leaving them unable to afford sustainable alternatives (Kabyanga et al. 2018). This can explain the perception of Kenyan farmers – especially the smallholder farmers, who live mostly in remote communities (Okoko et al., 2017). It can be argued therefore that if smallholder coffee farmers are more able to control their economic circumstances, their likelihood for adopting SAPs increases.

- **Factor 5: Deficient knowledge.** The factor consists of two variables with loading ranging from 0.862 to 0.923, an eigenvalue of 1.519, and accounts for 7.2% of the rated variance. The variables included in this factor are the lack of awareness of the sustainability impact of farming, and more education needed to increase saps adoption. Previous research has highlighted the link between farmers' awareness of the sustainability impacts of farming and their attitudes towards the adoption of SAPs (Wreford et al., 2017). This might explain the results of this study because a lack of awareness of sustainability impact received the highest factor loading (0.923) out of the entire 21 variables examined in this study, and was ranked high (mean value = 4.05) by respondents who have implemented SAPs on their coffee farms. A key insight from this result is that farmers might not be enthusiastic about adopting SAPs if they are not knowledgeable about the wider impact of farming activities on the environment and society at large.

- **Factor 6: skills gap.** The sixth factor consists of two variables with loading ranging from 0.786 to 0.790, with an eigenvalue of 1.154 and account for 5.5% of the rated variance. The variables included in this factor are: lack of required management skills to use SAPs; and lack of awareness of available government support to promote SAPs adoption. It could be argued that these two variables are not closely related, with regards to factor labelling. According to Sardinha and Pinto (2019), the higher the factor loading, the greater role that variable plays in the functional interpretation of the factors. Therefore, due to the higher loading of item "lack of required management skills", it was used for attributing a label to factor 6. Nevertheless, the overall mean score on that same variable (i.e. "lack of required management skills to use SAPs") is considerably low (3.34) when compared with "lack of awareness on available government's support". Yet, the two variables are deemed as lower perceived barriers; with an average mean score lower than 3.5.

Table 5: Factor Rotation

Variables	***Factors***					
	Factor 1: Capacity and market constraints	Factor 2: Cost-benefit rationality	Factor 3: Materials and process encumbrances	Factor 4: Financial challenges	Factor 5: Deficient knowledge	Fac Skil
Composting is a difficult and labour-intensive process	.850					
Lack of technical know-how for sustainable agriculture practices	.830					
Customers cannot afford sustainable farm products	.808					
Lack of access to the right market	.685					
SAPs do not give better yields		.837	.			
It is difficult to achieve desired benefits from using SAPs		.836				
Compost making present some health challenges		.835				
The land tenure system does not permit some SAPs		.711				
Possible disagreement with promoters of chemical fertilizers			.885			
Shortage of raw materials to make compost manure			.853			
The organic certification process is too rigorous			.655			
Too many paperwork requirements for certification			.631			
Inability to influence market prices						
The high cost of organic certification				.875		
Conventional practices are more cost-effective				.839		
Shortage of financial resources				.792		
Lack of awareness of the sustainability impact of farming					.923	
More education needed to increase SAPs adoption					.862	
Lack of required management skills to use SAPs						.796
Lack of awareness on available government's support						.786
Lack of transport infrastructure						
Extraction Method: Principal Component Analysis. **Rotation Method: Varimax with Kaiser Normalization.**						
a. Rotation converged in 6 iterations.						

Furthermore, the mean and standard deviation scores of each factor identified from the factor analysis was computed and ranked in order of importance. The result is shown in Table 6. Subsequently, the method of ranking advocated in previous studies was adopted (Borchert 2005) the six factors. Based on this, the average mean values of the factor loadings were calculated and ranked according to their importance. The closer the mean to 3, the higher the factor is to be considered important. The grand means of the factors ranged from 3.41 to 3.80. Consequently, the factors are ranked in the followed order:

Factors	No. of variables	Mean	SD	Ranking
Factor 5: Deficient knowledge	2	3.80	0.999	First
Factor 3: Materials and process encumbrances	4	3.74	0.744	Second
Factor 4: Financial challenges	3	3.69	0.933	Third
Factor 2: Cost-benefit rationality	4	3.55	1.042	Fourth
Factor 1: Capacity and market constraints	4	3.51	0.928	Fifth
Factor 6: Skills gap	2	3.41	0.983	Sixth

Table 6: The relative importance of the factors

5 Conclusions and implications for GVCs

In summary, this chapter examines the barriers perceived to be most significant by smallholder coffee farmers regarding their adoption of SAPs in Kenya. The findings revealed that SAP adoption barriers are underpinned by several factors, but the most notable ones are related to limited knowledge about the sustainability impacts of agriculture; the burden posed by the process related to organic certification and lack of material resources to make compost manure. Previous efforts to create awareness about SAPs (e.g TechnoServe, 2013) might not have yielded the expected results because farmers perceived that unconventional agricultural techniques are cumbersome, resource-demanding, and more expensive. Similarly, while all the participants have received some training around SAPs, evidence suggests that not all have used the knowledge acquired. Therefore, the pathway to integrating coffee smallholders into sustainable global value chains should start with increasing awareness of the sustainability impacts of coffee agriculture, rather than a training program on SAPs.

Governments and NGOs are implored to increase awareness amongst smallholders about the environmental and social issues in coffee farming, to promote the adoption of SAPs. This can also help increase the farmer's enthusiasm and ability to apply knowledge gained through training into practice. Also, there are growing niche markets for organic or fair-trade certified coffee products (Elder, Zerriffi and Le Billon, 2012), which farmers can leverage as a conduit for better integration into GVCs. However, this may not facilitate the inclusion of non-certified organic coffee farmers in Kenya into GVCs because many of our respondents raised concerns about the rigour and administrative requirements in the organic certification process. This institutional constraint disincentivises smallholders' interest in certification programmes and further restricts their chances of integration into global agricultural value chains, as Kilelu et al. (2017) have previously highlighted. Given that smallholders in developing countries are typically poor and resource constrained (Kabyanga et al. 2018), it is unlikely that they can influence this barrier, to take advantage of the upgrading opportunity in GVCs.

While GVC serve as a route for linking smallholders from developing countries to international markets (van Dijik & Trienekens, 2012), they need to increase their adoption of SAPs to achieve this goal. For example, Kaplinsky and Morris (2001) argue that small farmers can participate in the GVC through product upgrading, which requires improving in product quality and value. However, our findings suggest that smallholder coffee farmers in Kenya still face certain barriers that would hinder their upgrading in the GVC through this means. Specifically, our findings show that barriers relating to the rigour and paperwork requirements for organic certification have a factor loading greater than 0.60, with higher reliability. Essentially, smallholder coffee farmers need help with the process of organic certification. The critical recommendation, therefore, is that governments, policymakers, civil society organisations and multinational corporations in the coffee sector should provide financial aids or subsidies targeted at reducing certification costs for smallholder farmers, and provide assistance with the bureaucratic process. With such incentives, they can create more opportunities for smallholders to access certified international markets, and consequently gain further market acceptance into the GVCs. Finally, this study has some limitations which offer opportunities for future research. The sample was limited to a region in Kenya (Nyeri) and not randomly selected; future studies should consider probability sampling to enhance the generalizability of results. Despite its limitations, the study contributes to knowledge on the contextual impact of common barriers to SAPs, particularly from a developing country's perspective and the implications of these barriers on integration into GVCs.

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