ISSN 1819-1894

Asian Journal of Agricultural Research

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Asian Journal of Agricultural Research 8 (4): 170-180, 2014
ISSN 1819-1894 / DOI: 10.3923/ajar.2014.170.180

Characterization of Organic Coffee Production, Certification and Marketing Systems: Ethiopia as a Main Indicator: A Review

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ABSTRACT

Coffee is the major traded commodity next to oil and thus plays a vital role in the economy of both developed and developing countries. Coffee guarantees a solid basis for promotion of economic development. Moreover, organic coffee is winning the interest of the premium market price across the world thereby increasing the economic return of coffee producers. Despite the market opportunities and better market price for organic coffee, there are several factors which drastically affect organic coffee production and profitability under small holder farmers. Therefore, the objective of this review study was to characterize the existing organic coffee systems; husbandry, post-harvest handling, certification and marketing systems followed by organic coffee producers focusing on Ethiopian case. The result of this review study revealed that a number of factors are constraining organic coffee systems. Demand for intensive and skill based management of organic coffee plantation, high cost of certification and market penetration related issues are the most challenging ones. These coupled with low economic development level with (capacity) of small-scale coffee producers aggravated the challenges the producer are facing. Based on the result of the current review study it can be concluded that, the organic coffee system can be improved through awareness creation training proper application of organic farming principles and practices forming and promoting cooperatives to minimize cost of certification and increase participation of small-scale organic coffee growers on the market decisions and market facilitation.

Key words: Organic coffee, coffee husbandry, nutrient management, certification, post-harvest

INTRODUCTION

Coffee (*Coffea arabica*), originated in Ethiopia, is the second major traded commodity following to oil (Bekeko, 2013; Gray *et al*., 2013) and thus plays a vital role in the balancing of trade between developed and developing countries. African coffee production has been reported to fluctuate time to time. For instance it was found to fluctuate annually in ten years between 0.84 and 1.14 million ton (Eghe *et al*., 2008). Coffee is an important foreign exchange commodity, contributing in various degrees to the national income of the producing countries (Patricia, 2011). Coffee guarantees a solid basis for promotion of economic development of the producing countries. About 33 million people in 25 African countries derive their livelihoods by growing coffee on their subsistence farms and particularly, in Ethiopia 15 million people directly or indirectly deriving their livelihoods from coffee system (Gray *et al*., 2013). The cultivation, processing, trading, transportation and marketing provide employment for a lot of people in all coffee producing countries. More than 50 developing countries are involved in coffee production but the consumers are at distant mostly industrialized countries namely USA, Finland, Sweden, Belgium and Japan among others. According to Rice

(2010) approximately 1,400 coffee growers in 8 countries and more than 45 roasters found in the U.S, Canada and the Netherlands. Ethiopia is the largest producer of coffee in Sub-Saharan Africa and is the fifth largest coffee producer in the world next to Brazil, Vietnam, Colombia and Indonesia, contributing about 7-10% of total world coffee production (Gray *et al*., 2013).

Organic agriculture means holistic production management systems that promote and enhance agro-ecosystem health, including biodiversity, biological nutrient cycles and soil fertility. Organic production systems are based on specific and precise production, processing and handling standards. The aim is to achieve optimal agro-ecosystems that are socially, ecologically and economically sustainable. Terms such as 'Biological' and 'Ecological' are also used in an effort to describe the organic production system more clearly (Patricia, 2011). Derived from the above concept organic coffee, also known as ecological or biological coffee, is produced using environmentally friendly cultivation methods. The major objective of organic coffee production is to eliminate from the production system all contamination with synthetic-inorganic chemicals and to develop a system of coffee plantation management that is sustainable in the long term. The main organic coffee producing countries include Mexico, Guatemala, Kenya, Nicaragua, Tanzania, Brazil and Ethiopia. The main certified organic coffee importer countries are Holland, Germany and U.S.A (Wintgens, 2009). The objective of this review study was to describe the organic coffee systems: The major agronomic practices implemented in organic coffee production including soil fertility management, pest management, harvest and postharvest handling as well as marketing and certification systems practiced in today's world. Constraining factors of organic coffee system and possible solutions are also discussed.

CROP HUSBANDRY

Organic coffee production and soil fertility management: Nutrient management is among the key factors determining productivity and sustainability of coffee in any kinds of production system. Specialty coffees such as organic coffee rely for nutrient inputs solely on biological sources; litter fall from coffee and shade trees and compost, though the use of compost appears to be very limited to coffee orchards near homestead. Relying on organic system of coffee production has multiple potential environmental, economic and health related benefits. Coffee fields store carbon from the atmosphere and protect watersheds by slowing down runoff. In addition, practicing organic coffee production replaces inorganic fertilizers with organic fertilizers as well as pesticides and fungicides with less harm alternatives to the ecosystem, lesser production cost compared with conventional system and human health friendly approach, also prohibits genetically modified organisms. Ecologically sustainable organic coffee production is certainly possible by applying best agronomic practices, crop protection and post-harvest processing. Of the best and alternative agronomic practices managing soil fertility with organic fertilizers to maintain optimum soil quality and crop nutrient levels is the most important aspects (Bekeko, 2013). The challenge with organic coffee production however, is that more shade trees and low intensity farming methods also imply lower yields which is problematic from the rural development and poverty reduction point of view (Perfecto *et al*., 2005). Different methods can be used as a source of bio-fertilizer in organic coffee farming system; the system is detailed below.

Vermicomposting: Vermicomposting contains plant nutrients including N, P, K, Ca, Mg, S, Fe, Mn, Zn, Cu and B. The uptake of the aforementioned nutrient has a positive effect on plant nutrition, photosynthesis, the chlorophyll content of the leaves and improves the nutrient content

of the different plant components (roots, shoots and the fruits). The high percentage of humic acids in vermicompost contributes to plant health, as it promotes the synthesis of phenolic compounds such as anthocyanins and flavonoids which may improve the plant quality and act as a deterrent to pests and diseases (Theunissen *et al*., 2010). In 1985, observations of *Eisenia festida* and *Perionyx excavates* confirmed their potential use for recycling organic waste (Wintgens, 2009). The rearing of *E. andrei*, *E. fetida* and *P. excavates* under laboratory conditions has shown that the three earthworm species perform fairly well as coffee pulp, growing, reproducing and transforming organic matter into an earthy stable casting. According to Wintgens (2009) in the tropics *P. excavates* plays a crucial role in vermicomposting. The most widely known organic waste used to produce vermicompost in Mexico is coffee pulp but cattle manure, sugarcane filter cake and domestic residues are also commonly used. The "Earthworm fertilizer" is an efficient soil improver, biological reactivator of fertility and nutrient regulator in the soil. It is an important source of nitrogen, phosphorus and potassium, as well as the micronutrients including, iron, manganese, zinc and copper. The vermicompost is a stabilized product with neutral pH and is naturally free of seeds, pathogens, pesticides and heavy metals. Some nutrients are immediately absorbed by the coffee plant from the vermicompost while others are only released at slow rates, ensuring long lasting nutrition. Vermicomposts offer better germination and improved faster plant growth. A research conducted in Ethiopia on Vermicomposting as a Sustainable Practice to Manage Coffee Husk, Enset waste (*Enset ventricosum*), Khat waste (*Catha edulis*) and Vegetable waste amended with Cow Dung using an epigeic earthworm Eisenia Andrei indicated that vermicomposting could be a good option to improve solid waste management performance of Ethiopian cities and towns through the production of excellent bio fertilizer for agronomic purpose (Degefe *et al*., 2012). Which has the potential to minimize the cost of environmental degradation treatment, production and human health through recycling wastes while producing a food commodity of high nutritional value (Theunissen *et al*., 2010) and better final profit for specially of small scale farmers.

Other nutrient sources in organic coffee production: The coffee bean is a nutrient rich fruit and its production requires a large amount of nutrients which can be provided for through organic fertilizers. Organic fertilizers are also crucial as they can increase soil organic matter content, then by water infiltration and water holding capacity. Part of the nitrogen needed can be provided for by nitrogen fixing shade trees. Coffee plants require the major nutrients N, P and K as well as minor nutrients. The precise amount of fertilization required depends on soil quality and how much coffee is produced, that is the quantity of nutrients removed each year as coffee beans. Van der Vossen and Walyaro (2009), estimated that in shade coffee production; 53, 85 and 150 kg of N and roughly equal amounts of K must be applied per hectare so as to correct nutrient balance of farms with per hectare coffee production of 500, 1500 and 2000 kg, respectively. To fulfill the nutrient requirement of coffee crop in organic farming system in addition to that of the widely used sources of bio-fertilizer the following is also commonly used to increase coffee crop productivity.

Coffee pulp: According to Valkila (2009), nearly 40% of the wet weight of the nutrient rich coffee fruit is in the form of coffee pulp. This is usually discarded by conventional coffee farmers as waste but organic coffee farmers use the coffee pulp to fertilize their fields upon compositing. However, still the coffee pulp is not recycled but taken away from the farm with the coffee beans (Van der Vossen and Walyaro, 2009) which maximize the environmental effect of the wastes from the farming system and unable to efficiently utilize the residues as alternative cheap production inputs.

Cattle manure: The nutrient content of cattle manure varies but a rough estimate is that cattle manure contains 1% N, 0.5% P and 1% K. Some organic farmers who also keep cattle, use manure originating from their farms as a source of bio-fertilizer. Others may buy cattle manure from those farmers keeping cattle. Although, manure has paramount importance in organic farming fields nutrient concentrations in manure are usually small and vary greatly depending upon source, conditions and duration of the storage time which calls for selecting of the appropriate source of manure and improved management (Yadav *et al*., 2013).

Bocachi and compost: Bocachi is a type of compost with recommendations on the mix of materials to be used. This specially type of compost-bocachi for instance used in Nicaragua. Bocachi might be prepared having a variety of materials ranging from coffee pulp, household organic waste, cattle or poultry manure, ashes, molasses, yeast, stems from bean production through other organic waste. A simple mix can also be used to prepare bocachi. When a simple mix used for example it might contains only coffee pulp, cattle manure and bean stems, in this case it is commonly called compost (Valkila, 2009).

Chicken manures and bio-green: It is found another important source of bio-fertilizer in organic coffee farming. Chicken manure is rich in nutrients. Although small-scale chicken farming is widespread, few chicken farms have large quantities of manure for own application and sale. Similarly Bio-green is a poultry manure-based organic fertilizer which can be used in organic coffee farm. For instance bio-green is found to be used in Nicaragua (Valkila, 2009). Yadav *et al*. (2013), in their review study of organic farming for sustainable agriculture in Northern India, reported that highest pod yield, as well as higher biological yield and harvest index was attained due to application of manure which shows the economic feasibility of this source as a bio-fertilizer.

Mulching: Mulching is used in organic coffee production as a soil management tool to protect the soils against excessive water loss. Mulch also prevents weed growth and aids water infiltration. Mulching material can be generated from several sources including by- products of coffee hulls and harvest residues of for example maize and sorghum clover, bean and soya haulms. A research conducted by Bekeko (2013) in Western Ethiopia revealed that using maize stover as a mulch in coffee crop revealed a significant yield increment, bean yield of 1070 and 520 kg ha^{-1} were 8 and 0 t ha^{-1} maize stover applied, respectively. According to Yunianto (1986) application of mulch found to reduce over bearing and dieback in Arabica coffee and sustains its biological productivity for longer period of time.

Shading: Changes in the economics of coffee are leading the producers to reduce dependency on agrochemicals and thereby increase the use of shade (Haggar *et al*., 2011). Usually, organic coffee is grown under shade and this has a number of advantages. Of these suppression of weed growth especially of grasses and sedges is amongst the advantage which result in reduced cost weeding. Reduction of oxidation and rate of decay of organic matter in the soil also improved due to shade. Shade also play a role in maintaining regular flowering since it reduces plant metabolism. The shade trees enrich the soil through organic material from twigs and leaf fall. Moreover, leguminous shade trees fix atmospheric N thereby improves oil fertility of the organic coffee farm. However, the potential ecological services legume shade trees have for associated coffee this depends on the extent of management of the completion from those trees planted with coffee for their ecological

services (Haggar *et al.*, 2011). Shade is also important as it provides a reduction in *Cercospora* spp. and of attacks by the white stem borer. It also provides soil protection against erosion. In the tropics, different trees may be used as shade trees in organic coffee production depending on adaptability to local conditions. For example: *Leucaena leucocephala* is used as shade tree in Malaysia while *Hevea brasiliensis*, rubber tree, is commonly used in Thailand. Banana trees, *Mimosa scabrtella, Calliandra calothursus* and *Glividicia sepium* are commonly used in Mexico (Grossman, 2003).

Organic coffee production and pest management: Pests are among the different factors causing tremendous yield reduction in organic coffee. For many years coffee farmers across the world were relying on chemical measures to control pests and this is not more a solution in organic farming system. Researches already illustrated different possible problems come with applications of synthetic chemicals applied to control pests in coffee crop. Different pest management strategies can be implemented in organic coffee production to minimize or control yield lose due to pests and maximize the profitability of organic coffee production system. Researches for the last couple of years showed remarkable success in application of organic control measures on different crops either in single or combined application in controlling pests and increasing crop yield. Moreover, studies so far not came out with any hazardous effects on environment, human health, water that would be caused by applications of organic control measure in a single or in compatible combination use. Different pest management strategies can be implemented in a single or/and integrated approach in organic coffee system including cultural methods, use of resistance variety, biological control, non-synthetic chemicals and mechanical management methods. The strategies are detailed below.

Cultural methods: Several cultural control methods developed to manage serious pests in organic coffee production system such as: (1) Pruning, to increase the vigor of the plant and to create unfavorable environment for insect pests, (2) Mechanical method, where picking up and destroying the infected plant is implemented, (3) Mulching: Used to reduce pests that thrive under hot condition by modulating the microclimate, (4) Growing of healthier and robust coffee bush to increase the ability of the plant to resist against pests and compensate for the damage, (5) Trapping: Other environmentally friendly way of controlling insect pests. Trap crops planted along the edges of crop fields or within the field have the potential to limit damage by offering the pests a food source they prefer over the crop itself (Shennan, 2014). (6) Mycorrhizal fungi which enhance tolerance to fungi and also survival rate of transplanted coffee since, it enhances growth and increases nutrient availability through nitrogen fixation for the young coffee plant (Muleta *et al.*, 2007). Some insect pests survive from season to season in berries like Coffee Berry Borer (CBB). The CBB, *Hypothenemus hampei* which is endemic to Central Africa is the most devastating pest of coffee beans worldwide and threatens the economic viability of coffee growing in many of these areas. The biology of CBB is the main challenge in implementing a management practice since its adults bore inside the berry and lays their egg in the endodermis. To control this pest picking up and destroying of ripe, over ripe or dried fruits from the trees and the ground at the end of season can be practiced which is known as mechanical control method.

Plants as a biological control agent: Plant resistance is of the methods used as a bio-control means against different pests. According to Choudhary and Johri (2009) plants naturally own a

range of defence mechanisms and these active defence mechanisms are expressed during the occurrence of biotic stress. The effectiveness of the active defence mechanism of plants depends on the timing of the response against the particular effect. Several crops develop resistant genes against different pests. For instance plants develop genes and provide an important role to cope up with nematode infestation (Brand *et al*., 2010). Additionally, the identity of the species and the diversity contributes into suppression of pests (Sohlenius *et al*., 2011). Moreover, the quantity of root material deposited in the soil as well as the chemical composition varies from one plant species to the other plant species (Sohlenius *et al*., 2011) and the behaviour of plants to exude substances that are harmful to pests vary. The resisting ability of plant to pests may be specific or broad over several species.

Breeding for resistance and high yielding coffee varieties is potentially an ideal management in organic coffee production. For instance Robusta coffee when used as root stock provides effective protection against (Meloidogyne and Pratylenchus) *Nematode* spp. in Coffee Arabica plantation (Fredrick, 2005).

Biological control method: Pest populations reduced by natural enemies. These natural enemies include predators, parasitoids, parasites and pathogens. Conservation, classical and augmentation methods of biological control are the major techniques used to overcome insect pest problem in organic coffee production. Classical biological control method used against exotic pests which introduced to a new region leaving their natural enemies in their original region and resulted in higher population in the new area of introduction (Davis *et al*., 1998). Conservation of natural enemies already present in the given environment used to prevent elimination of natural enemies used as biological control agents (Fredrick, 2005) and then by used as a bio-control agent. The augmentation strategy of biological control applied to boost population of native natural enemies which are already in the ecosystem but unable to prevent the pests from reaching damaging level. As mentioned above CBB is the main devastating pest of coffee in the tropics and the control also difficult since the insects spend the majority of their life cycles cloistered within coffee berries. Introduction of parasitoids and fungal entomopatogens are the main biological control mechanisms applied to reduce the effect of CBB in organic coffee production. Among these *Beauveria bassiana* is the most widely used entomopathogenic fungus for coffee berry borer, *Hypothenemus hampei* (Coleoptera, Scolytidae) in different countries like Cameroon, Congo etc. (Rehner *et al*., 2006).

Non-synthetic chemicals: Non-synthetic fungicide which fit with the organic standards is the other option of organic coffee pest management. For instance, captafol is used to control leaf rust. Now a day's captafol in combination with copper used to control Coffee Berry Disease (CBD) (Dickinson and Lepp, 1985). Botanicals are also used as a means of pest control methods in organic coffee production systems. They are suitable for small scale farmers since they are locally available and less costly and totally compliance with the organic standards.

WEED MANAGEMENT IN ORGANIC COFFEE PRODUCTION

Cultural weed control method: Different cultural weed control methods applied in organic coffee production including: (1) Physical removal of weed plants from the surrounding of the coffee, (2) Mulching, (3) Increasing population density, (4) Hand weeding, (5) Intercropping with stable food and cash crops (6) Burning of refuge areas of grass and weeds adjacent to the crop, (7) Fallowing, (8) Slashing and (9) Planting of cover plant species (Muleta *et al*., 2007). According

to Muleta *et al.* (2007), whenever, there is dense population, the aggressive understory weeds are either totally absent or rarely encountered in coffee plantation. Hand weeding, mulching, intercropping with stable food and cash crops are among the most agronomic practices to overcome weed problems in organic coffee production (Mekuria *et al.*, 2004). Goetz *et al.* (2004), reported fallow as one of the cultural weed control methods even if the effectiveness against weed control depends on the duration of the fallow period. According to Aguilar *et al.* (2003), slashing also helps to suppress aggressive weeds and increases coffee vigor.

Organic coffee production and biological weed management: Certain fungi are used to control weeds either as classical biological control agents or as microbial herbicides. In classical biological tactic, pathogens are imported from their area of coevolution with their host and released in to new geographical area where the host already exist whereas in microbial herbicide method microbes applied in to the targeted weed in the manner similar to chemical herbicides. The host plant ranges of biological control agents considered as labile and it demands continues investigation and follow up weather the practice is still efficiently applicable for the targeted control or not since, organisms perceived constantly evolving (Marohasy, 1996). Similarly, in selecting agents for the biological control of weeds, it is important to demonstrate that the organisms selected are sufficiently specific to the weed; so as to an introduction to a new country, no damage will be done to plants of economic importance (Wapshere, 1974).

ORGANIC COFFEE PRODUCTION AND MECHANISMS OF DISEASES CONTROL

Host resistance: Host resistance is one of the crucial strategies for reliable production of coffee organically. The pre-selection test and other estimates of varietal resistance identification in the field and laboratory assays is crucial even if pre-selection is preferred since, it shorten the breeding period to obtain the desired resistance variety of coffee arabica against different devastating coffee diseases (Dancer, 1986). According to Dancer (1986), there is a wide range of resistance in cultivars of Arabica coffee (*Coffee arabica* L.) against Anthracnose (*Colletotrichum coffeanum*) which causes Coffee Berry Disease (CBD). The CBD is a serious threat in Ethiopian coffee production. To solve this problem breeding is in progress since many years back primarily to develop cultivars which help to overcome CBD problem. To achieve this goal germplasm collection, selection and hybridization is used as a main means (Bellachev, 1997). The CBD disease induces 80% yield loss in Cameroon farmers' plantation in areas severely infected by this diseases. To overcome this problem and maximize yield breeding is used as a main mechanism (Regazzoni *et al.*, 1997). Therefore, using resistance variety is the main and plausible alternatives in organic coffee production system.

Cultural diseases control method: Cultural method is also one of the main disease control means in organic coffee production system. Cultural control method mainly implemented by keeping coffee tree healthy and vigorous to reduce infestation. Organic disease management in coffee production is based on agronomic practices which result with healthier and vigorous coffee tree having the ability to resist disease attack (Mekuria *et al.*, 2004). Cultural of coffee protection is economically plausible means since proper application of agronomic practices to control disease at the same time contribute for yield increment.

ORGANIC COFFEE AND POST-HARVEST MANAGEMENT

Organic coffee harvesting: Mostly organic coffee under the small holder is harvested by hand and the harvest processes can be categorized into two ways: Selective picking and strip picking.

Selective picking is more time consuming and requires more labour thus contributing for high cost of production but, it guarantees quality coffee since only the full ripen fruits are picked up carefully. For highly mechanized farmers, special automated harvesting machines can be used (Dill and Rose, 2009). However, the machine makes the ripe fruit to fall down and also mixes unripe or over ripe fruits. In this system beans of different maturity stage can be mixed resulting with compromised quality. For organic coffee production, the harvest procedure should be followed by the certification and verification process (Dill and Rose, 2009). The equipment and container used during harvesting should not contain or be treated for prohibited substances. If any of them previously contained non-organic material, they must be cleaned and be completely free of any non-organic material and residue.

Organic coffee processing: To prevent the pulp decay or contamination, processing must start immediately after fruit picking. Coffee fruit can be processed by two ways: Dry method and wet method. Dry method is the traditional, cheapest and simplest method of processing coffee. The harvested fruits are sorted and cleaned to spread the non-ripe, damaged and diseased fruits and to remove residue such as leaves, soil or branches. Ripe fruit is then spread out to dry under sunlight, or sometimes in driers during the wet season (Hicks, 2001). In this method, the berries are dried to 10-12% moisture and stored. Wet method, requires the use of specific equipment and substantial quantities of water to move the pulp. The beans are stored in fermentation tanks for 24-36 h depending on the temperature. This facilitates removal of residual flesh and the mucilage from beans by natural enzymes. When the fermentation is completed, beans are washed with clean water in tanks or in special washing machines. In organic coffee processing care should be given to avoid contaminants coming from chemicals, synthetic substances and any non-organic material residues.

ORGANIC COFFEE CERTIFICATION AND MARKETING

Organic coffee certification: Certification is "confirmation of quality". It is accomplished through continuous and controlled assessment at each production and processing point (Daviron and Ponte, 2005). It helps growers to communicate with their distant customers through symbolic or logo representation. Since coffee is an export commodity to be consumed elsewhere in the world, it has to be certified for its organic way of production. This is because certification, helps to ensure price stability. However, the cost and applicability of certification, as well as knowledge and choices of certifier are the major challenges for small holder organic coffee growers. International certification and inspection are very expensive. For example, in 2000, Singapore Accreditation Council (SAC) charged individual producers a certification fee of £200 plus inspection cost of £350 per day per inspector plus airfares, accommodation and other expenses. In the same year Ecocert (Germany) charged £303 per inspector per day, plus £350 travel time plus travel and subsistence at cost price, plus taxes (Barrett *et al*., 2002). Therefore, this cost might not be affordable especially of by small scale farmers which demands for devising alternative mechanisms to bring this cost to reasonable level. Forming cooperatives can be considered as one of the options to reduce cost of certification. According to Paul *et al*. (2014) certification is a recent phenomenon in Ethiopia. However, these days certifying agricultural products is getting attention in the country. Mover, in Ethiopia, certification focuses mainly on coffee, this is because coffee is a main export commodity and has high potential to be marketed as specialty gourmet product on the world's major coffee market. Similarly, Ethiopian government is trying a lot to overcome coffee certification and marketing

related issue through forming cooperatives. Even some years back, to increase effectiveness of cooperatives, the government restructured the sector and has established coffee cooperative unions with the objective to provide protection, resources and expertise to coffee cooperatives, so that they can overcome coffee export related problems and receive a better return from coffee sales. Currently 10 coffee cooperative unions are functioning in the country (Paul *et al*., 2014).

Organic coffee marketing: Many international agreements were made to harmonize the price of coffee in the international market. According to Daviron and Ponte (2005), from the beginning of the 20th century to 1989, producing countries took control of world stocks, held real market power and influenced international prices. They lost much of their market power with the end of the International Coffee Agreement (ICA) system. From the 1990s to the present, consuming country actors (especially roasters) have been driving the chain. The collapse of the International Coffee Agreement (ICA) and its production quotas, increased productivity through high-yielding coffee varieties, higher intensity farming and some mechanization of production (Valkila, 2009; Bacon, 2005) resulted in chronic oversupply that led to generally decreasing level of international coffee prices in the last decade (Daviron and Ponte, 2005; Bacon, 2005). However, the marketing system and price is difference most of the time not only cross region but also cross country. For instance the coffee marketing in Ethiopia and Kenya are more centralized compared to Uganda with corresponding effect on price transaction. Similarly, coffee prices in Kenya responded better to world compared to Ethiopia and Uganda (Paul *et al*., 2014).

CONCLUSION

From this review study it can be concluded that organic coffee production can be achieved potentially through carful application of agronomic practices which aim at improving, conserving and maintaining biological, chemical and physical soil fertility which is responsible to have vigor and healthy coffee plantation this in-turn secure self-regulation ability of the system. Some of important agronomic practices used to achieve these include mulching, shading, vermicomposting, use of green manures, cattle and chicken manures, coffee pulp and other organic wastes. To avoid organic products from contamination carful management from production, through post-harvest handling need to be applied, since it is very detrimental of the final quality of the produce. To ensure production of high quality organic coffee, production techniques should be applied according to the standards of organic farming. Insect pests, weeds and diseases are controlled through a number of methods which include cultural, biological and mechanical methods which fit the standards of organic system. Organic coffee to be recognized as organically produced commodity in the market and win the interest of the market and thereby to realize premium price there is a need for certification. Certification confirms quality thus protects both the producer and the consumer through creating transparency. Certification can however be a challenge especially for small-scale farmers as it is attached with payment. However, certification cost related problems can be potentially solved through forming cooperatives, since it creates a chance to get training and reduces costs of certification of individual farms.

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