CONILON Coffee

3rd Edition

Updated and expanded

The Coffea canephora produced in Brazil

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Sustainable Conilon Coffee Cultivation

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1 INTRODUCTION

Coffee (*Coffea arabica* L) was introduced in the State of Espírito Santo in the beginning of XIX century, due to the expansion of the cultivated areas of the Paraíba Valley, São Paulo. Coffee monoculture was the predominant activity in Espírito Santo agriculture at the end of this century. It occupied the first place in the economy and, from 1850, became the main vector of development and responsible for the formation of villages, towns and cities. At that time, the northern and central-mountain regions were great natural forest masses that were being replaced by the coffee cultivation with the arrival of the first Italian and German immigrants (BITTENCOURT, 1987). Up to 1920, only 28.6% of the territory was occupied by agricultural establishments and 17.6% were cultivated, despite the arrival of new European immigrants who received lands from the government for this culture. implantation. The northern region of Espírito Santo was isolated by the natural barrier formed by the Doce River and began to be occupied from 1928 onwards with the construction of the bridge in the municipality of Colatina (SEAG, 1988).

Between 1920 and 1950, it was very common to clear native forests for the coffee cultivation expansion. With the coffee prices fall, the land was abandoned or occupied by pastures, characterizing the cycle forest-coffee-pasture, responsible for the devastation of the native forest cover of great part of the Espírito Santo territory (VALE et al., 1989). The practice of burning with low use of firewood, the implantation of extensive livestock on lands of natural low fertility and climate limitations have led to soil erosion in the northern region, with the silting of rivers and water contamination (SCHETTINO, 2000). The deforestation process intensified after 1958 and the original forest cover was reduced to about 30% as a result of the beginning of the State industrialization and the international coffee crisis. In this scenario, the federal government promoted the eradication of 53% of the coffee plantations that occupied the northern region and comprised 71% of the total cultivated area in Espírito Santo.

The first conilon coffee commercial plantings (*Coffea canephora* Pierre ex A. Froehner) in the municipality of Sao Gabriel da Palha were motivated by the implantation of the Plano de Renovação e Revigoramento da Lavoura Cafeeira (Plan for the Renewal and Invigorating of Coffee Crop) actions, from 1971. This crop later expanded to the entire northern and southern regions of Espírito Santo. Currently, the conilon is the most cultivated variety in Espírito Santo in regions of altitude up to 500 m and warmer climate. It meets good development conditions in regions with annual water deficit of no more than 350 mm and ideal average temperature between 22° to 26°C (FERRÃO et al., 2012). The main producing municipalities are in the northern region and Jaguaré, Governador Lindenberg, Linhares, Nova Venécia, Pinheiros, Rio Bananal, São Gabriel da Palha, São Mateus, Sooretama and Vila Valério, can be highlighted for being responsible for about 52% of conilon coffee harvest in Espírito Santo (IBGE, 2014). The cultivation occupies about 300 thousand hectares in approximately 40 thousand properties, the majority of them of family base. There are 78 thousand families that depend directly on this cultivation (FERRÃO et al., 2011; CONAB, 2014). These coffee properties are characterized for presenting 74% of the total area of less than 50 ha, being 28% smaller than 10 ha and the average cultivation area is 9.4 ha; rural families are highly economically dependent on coffee, and 60 to 70% of the income from the farms comes from this cultivation (TEIXEIRA, 1998; SCHIMIDT; De MUNER; FORNAZIER, 2004).

The average productivity of 35 processed bags per hectare (bags/ha) (CONAB, 2014) can reach high levels (above 120 bags/ha) depending on the use of correct cultural practices and adoption of appropriate technologies such as inbred varieties, programmed cycle pruning, irrigation and adequate coffee nutrition (FERRÃO et al., 2012). The greatest need for service is given during coffee harvesting, where the most demanding labor is temporarily contracted. Many times this was a social problem, mostly in properties with plantations over 50 ha. The family farms also need an external workforce, usually supplied by the family in a partnership and collaboration system between neighbors. The predominant form of labor payment in the harvest season in the Capixaba conilon region is by production (94%) or productivity (harvested bags of ripe or dry coffee); (55%) or monthly salary (25%) (FETAES, 2006).

The coffee is predominantly commercialized processed, according to the property conditions and infrastructure. However, the processing service is usually performed by structured owners, intermediary buyers who provide this service and/or service providers with mobile equipment. Most of the production is commercialized with the intermediaries, exporters and cooperatives that operate in the region.

The public interventions, in partnership with the private sector, in the generation and adoption of technologies focused on high productivity and on the resistance to drought, increased the conilon coffee average productivity from 9 bags./ha in 1993 to 24.12 bags/ha in 2002, surpassing the Programa de Revitalização da Cafeicultura Capixaba (Capixaba Coffee Revitalization Program) goals (RECAFÉ) (De MUNER et al., 2003). Currently, the average productivity is at 35 bags./ha (CONAB, 2014). The agroecological zoning for coffee cultivation in the State of Espírito Santo shows that the areas suitable for conilon cultivation cover 404.601 ha (DADALTO; BARBOSA, 1997). Most of them are located in the central and southern mesoregions, where there is no tradition in this species cultivation and constitutes a great potential for the conilon coffee development in a more sustainable way.

2 THE SUSTAINABILITY CHALLENGE

The sustainability conceptual basis lies in the recognition that natural resources are finite and the planet's biophysical limitations restrict the economic growth. The sustainability coverage has as its main challenge the change in consumption patterns and can not prevail the logic of the market over the needs (FERRAZ, 2003). The environment, resources provider, receives all the waste from human activity, however the availability of resources and the assimilation capacity of these residues are limited. The economic growth is confused with development and the search for alternatives to this model has led to the sustainable development direction.

The concept of "Ecodevelopment"[1], emphasized in the "Stockholm Declaration"/United Nations Conference on the Environment/1972, evolved into "Sustainable Development" advocated by the Brundtland Commission in the Report "Our Common Future"/1987, in which it was the main agenda of the 1992 Rio Conference and other succeeding world conferences on development. However, sustainable development is not a finished concept, but an idea that transits between development, understood as the socioeconomic and political stage of a community and sustainability, which refers to the biosphere's capacity for support. It is a goal to be pursued with the aim of ensuring its preservation in a vision of the future. We understand development as allometric growth (relations variation between the parts) of the sustainability dimensions[2].

Historically, development theories have not incorporated environmental costs into man's relationships with nature. In this way, natural resources have always been considered as an economy subsystem. The sustainability scope presupposes that the economy considers the biophysical aspects of the goods and services production and the internalization of the involvement and integration vision of the productive system (MARTINS, 2002). The western modernization production and consumption model makes development unsustainable. It is considered the need to involve the whole society in the structuring of sustainability (BOFF, 2003). The elaboration of sustainable processes passes through a holistic approach and the need for collective construction of a network of interactions. Capra (1997) suggests imitating nature for understanding the functioning of systems and to comprehend the interdependence of the various factors that make up this complex network.

Although the crucial role of agriculture in human development is recognized, it is considered that agricultural processes are the anthropogenic activities that use the most fundamental natural resources such as land and water. Conventional agriculture is considered to be highly environmentally degrading and the main cause of forest devastation, soil depletion, rivers

[1]Ecodevelopment is a development style that in each ecoregion insists on specific solutions to its particular problems, taking into account ecological data in the same way as cultural, immediate as well as long-term needs (...) without denying the importance of exchanges "(SACHS, 1986).

[2]Would the call be to define sustainability? According to Guzmán Casado, Gonzales de Molina and Sevilla Guzmán (2000), "In its broadest meaning the concept of development means the unfolding of the potentialities of an identity, whether biological or socio cultural. It is about reaching a higher state, or fuller than the preexisting state". These authors cite as a pioneering conception of the use of the term development that presented in the XVIII century in the field of Natural Sciences, when Caspar Friedrich Wolff defined embryonic development as the allometric growth of the parts towards the proper form of the human being. This definition may contribute, in a similar way, to consider the idea of development from an agroecological perspective.

silting, water contamination by agrochemicals and biodiversity impoverishment (VAN RAIJ, 2003; FOLEY et al., 2011; FORESIGHT , 2011).

The "Green Revolution", an agriculture model spread in the 1970s, intensified this process of degradation. Technological packs were developed based on the genetic breeding of seeds associated to the intensive use of agrochemicals, in mechanization and techniques to increase production and productivity. It worked, above all, to expand the commercialization of inputs, machinery and equipment in the name of the agriculture modernization. However, it generated dependence on external elements and rupture of traditional production patterns (BRUM, 1987; BEDDINGTON, 2010).

The monoculture systems of the conventional production model based on agricultural chemistry reduce the energy efficiency of the production systems. This is caused, among other factors, by the low soil coverage, associated to the high dependence of external inputs and high energy costs (LI et al., 2002; SOUZA et al., 2008; De MUNER et al., 2015). Energy expenditure imposes serious concern due to the amount of energy invested in food production, since it has often been higher than the energy return obtained from the products, generating a negative balance and compromising sustainability (GRÖNROOS et al., 2006). Energy and food production are related and any impact on the oil cost is transmitted and expanded along the food chain. This is because fossil energy plays a vital role in agricultural production systems and its price affects all the costs of the production chain (CAMPOS, Alessandro, CAMPOS, Aloísio, 2004).

However, sustainability presupposes emphasizing the use of renewable energies in order to guarantee long-term production. Sustainable agriculture seeks income through the use of technologies and management practices that improve the system efficiency (ALTIERI; NICHOLS, 2004; TILMAN et al., 2011). It was defined as the management and the natural resources base conservation and the orientation of technological and institutional changes in order to ensure the acquisition and continuous satisfaction of human needs for present and future generations. Such sustainable development in agriculture should result in soil, water and animal and plant genetic resources conservation and should not degrade the environment but be technically appropriate, economically viable and socially acceptable (FAO, 1991).

Although there may be dissonance regarding the set of basic attributes that must have a management system to be considered sustainable, it must consider, in a holistic and systemic way, the ecological, economic and social dimensions. The construction of sustainable rural development from the Agroecology concepts application is based on six basic dimensions related to each other: ecological, economic and social (first level), cultural and political (second level) and ethics (third level) (CAPORAL; COSTABEBER, 2007) (Figure 1).

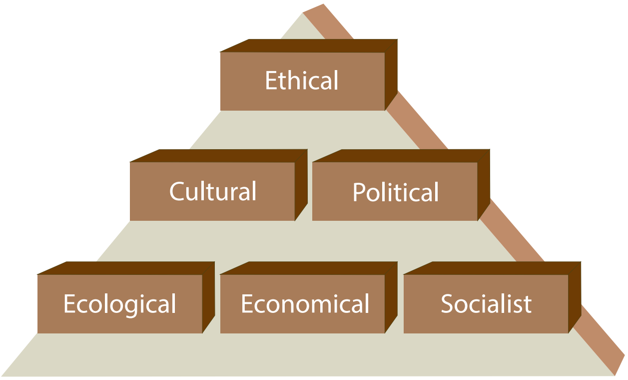

Figure 1. Sustainability hierarchical dimensions.

Source: Caporal and Costabeber (2007).

In the *ecological dimension*, the conservation and improvement of the chemical, physical and biological conditions of soil, biodiversity, water sources and natural resources are generally considered to be the basis for achieving sustainability. It is important to keep in mind the holistic approach and the systemic approach, giving integral treatment to all the elements of the agroecosystem combined with strategies for materials and energy reuse and the elimination of toxic inputs.

The *social dimension* represents another basic pillar of sustainability and includes the continuous search for better levels of quality of life. It approaches the production and consumption of foods with superior biological quality and the perspective of equitable production distribution. It implies less inequality in the distribution of assets, capabilities and opportunities.

In *the economic dimension*, the sustainability is not only about increasing production and agricultural productivity at any cost, since the maintenance of the natural resource base is fundamental for future generations. The logic of the economic sustainability is not always manifested through the intention of profit, but also in other respects, such as the subsistence and consumer goods production, in general, which do not usually appear in conventional monetary measurements. It also presupposes obtaining positive agroenergy balances from the compatibility of the relationship between production and consumption of non-renewable energies. However, it should provide enough financial returns for the current and future agricultural activities continuity, maintenance/expansion of farmers' quality of life, and their social aspirations satisfaction.

At the second level, the *cultural dimension* considers that the knowledge and values of local populations should be the starting point for rural development processes. The agriculture must be understood as a product of the historical relationship, involving the social and ecological system and must reflect the "cultural identity" of the people who live and work in the agroecosystem.

The *political dimension* encompasses the social organizations and representations networks of the various segments of the rural population and participatory and democratic processes. In sustainable rural development, it is considered that farmers should be the protagonists and decision makers of social change processes, with decisive participation in appropriate public policies.

The sustainability notion has given rise to a series of sustainable rural development currents. Of these, it highlights the agroecological current that suggests the massification of management processes and the sustainable agroecosystems design from a systemic and multidimensional perspective.

Other currents are guided by the search for market niches and by the economic prize expectation, focusing its attention on the reduction of the chemical inputs use or its substitution by organic or ecological inputs. In the agroecological approach, the equilibrium of the agroecosystem must be optimized and the complex relationships between people, cultivation, animals and the environment that support the notion of sustainability must be understood; one should not focus on the production maximization of a particular activity

(CAPORAL; COSTABEBER, 2007).

The sustainability of an agroecosystem is directly related to the ecological processes enhancement. For this purpose, it must optimize the availability and balance of nutrient flow, protect and conserve the soil, preserve and integrate the biodiversity and exploit the adaptability and complementarity of animal and plant genetic resources. In the socioeconomic aspect, it is necessary to optimize the synergies between the different activities in the productive processes, to strengthen the cooperation and solidarity mechanisms and to enforce the local capacities and abilities, favoring, above all, the rural properties self-management. In this way, sustainable rural property is characterized as a productive unit that uses good agricultural practices to maximize and diversify incomes, conserve and recover natural resources (water, soil and forest) and respect environmental and labor laws. It aims at the continuous improvement of the quality of life of rural families and their future generations through the development model that considers all the sustainability dimensions. Its basic premise is to create conditions so that farmers can build an agriculture at more and more sustainable levels. A new challenge for the implementation of technological development and the actions of Assistência Técnica e Extensão Rural- Ater (Technical Assistance and Rural Extension) is then presented through participatory and strategic methodological approaches for sustainable rural development (BRASIL, 2003; CAPORAL; COSTABEBER, 2007; EMBRAPA, 2006).

3 SUSTAINABILITY EVALUATION

Evaluation and monitoring processes are important tools in identifying problems and limitations, as well as in the strategies definition of that promote changes necessary to improve the performance of a given system. However, the sustainability evaluation in agriculture has been a major challenge due, mainly, to the complexity of environmental, socioeconomic and cultural aspects, considering the holistic and systemic perspective. It is a dynamic and complex process that evolves over time and there are no common parameters or universal criteria that allow to evaluate all this complexity. Furthermore, conventional procedures, such as cost-benefit analysis, are insufficient and unsuitable (SARANDÓN, 2002; ASTIER et al., 2012).

Several authors have developed and applied methods for the sustainability evaluation. Some of them have emphasized the definition of environmental, social and economic indicators, others to establish qualification levels, but without a clear mark that allows to integrate the analyzes results (HAMMOND et al., 1995; AZAR; HOLMBERG; LINDGREN, 1996). There are also those who propose a methodological framework for the criteria and indicators definition that will be used in the evaluation (FAO, 1994; MASERA; ASTIER; LÓPES-RIDAURA, 2000; ASTIER; MASERA; GALVÁN-MIYOSHI, 2008).

The main advantages of evaluation frameworks are that they provide an analytical reference for the study and comparison of alternative management systems on a multidimensional base. In addition, they allow to prioritize and select a set of indicators to monitor the adopted management system and guide planning and decision-making processes (GALVAN-MIYOSHI; MASERA; LOPEZ-RIDAURA, 2008).

The Marco para a Avaliação de Sistemas de Manejo de Recursos Naturais Mediante Indicadores de Sustentabilidade- MESMIS (Framework for the Evaluation of Natural Resource Management Systems through Sustainability Indicators) has been widely used in Mexico and Latin America (LOPEZ-RIDAURA; MASERA; ASTIER, M., 2001; ASTIER; MASERA; GALVÁN-MIYOSHI, 2008; ASTIER et al., 2012). This method considers seven main interrelated attributes: productivity, stability, resilience, confidence or security, adaptability or flexibility, equity and autonomy (Table 1). Its results and conclusions are applied to identify the critical points of sustainability and intervention in production systems, in order to gradually achieve sustainability. The method is valid for specific production systems in a given sociopolitical context, on a given spatial and temporal scale. It is a participative activity that requires the perspective of an interdisciplinary work team. It has a comparative or relative character, that is, sustainability can only be evaluated by comparing the evolution of the same system over time or by simultaneously confronting two or more alternative systems with another one as a reference.

Table 1. Attributes, criteria and sustainability indicators for the evaluation of natural resource management systems

(to be continued)

Attribute	Criteria	Indicators[1]	Scope
Productivity	Efficiency	Yield; energy efficiency	A
		Cost-benefit ratio; inversion (money and labor); labor productivity; entry	E
Stability; resilience; reliability	Diversity	Managed and present species; polycultures; rotations	A
		Number of crops; degree of production and marketing integration	E
		Number of ethnicities involved in resources management	S
	Resources conservation	Soil and water quality	A
		Ratio between input and output of critical nutrients	A
		Number of creole varieties used	A
		Capacity of recycling and saving on the use of natural resources	E
	System fragility	Pests and diseases incidence	A
		Trends and yield variation	E
	Distribution of risks	Access to credit, insurance and other mechanisms	E
	Quality of life	Quality of life indices	S
Adaptability	Learning process strengthening	Members qualification and training	S
		Local adaptations of the proposed systems	S
	Capacity for change and innovation	Evolution of the number of producers per system	S
		Generation of knowledge and practices	S
Equity	Costs and benefits distribution	Number of beneficiaries according to ethnicity, gender and social group	S
	Employment evolution	Demand to relocate the work place	E

(conclusion)

Attribute	Criteria	Indicators[1]	Scope
Autonomy (self-management)	Participation	Implication of beneficiaries in the different stages of the project	S
	Self-sufficiency	Degree of dependence on critical external inputs	A
		Level of self-financing	E
	Control	Property rights (individual or collective) recognition	S
		Use of local knowledge and skills	S
		Decision-making power over critical aspects of system operation	S
	Organization	Type, structure, decision-making process	S

Source: Adapted from Masera, Astier, Lópes-Ridaura (2000).

[1]The Table does not necessarily present all the indicators, being adapted for each specific management situation, taking into account the three basic areas: social (S), environmental (A) and economic (E).

Sustainability is considered as a system under construction, which evolves and stabilizes at increasing levels and adapted to each regional socioeconomic and cultural reality. Thus, the notion of sustainability does not mean something absolute, but relative. One can move towards sustainability or, on the contrary, generate more degradation, according to the practices, technologies, forms of management and socioeconomic relations present in each strategy adopted. For this reason, systematic monitoring (evaluation) of processes, with participatory methods, is fundamental.

The presentation and integration of the results obtained by the MESMIS method should be a transparent, participatory and easy-to-understand tool to be useful in making decisions about the changes needed to improve the proposed management systems. This method was used in Brazilian arabica coffee cultivation (FERRARI, 2002; De MUNER, 2012), highlighting that families using more agroecological techniques presented greater autonomy and less dependence on external resources than those with conventional techniques. The best economic returns were observed in the system of good agricultural practices with techniques that enabled economically acceptable coffee productivity. The activities diversification made it possible to optimize the use of labor and the natural and economic resources available. So, production diversification is a determining factor in the food security of rural households (De MUNER, 2012).

Food security, the value of a healthy diet, the rural workers' health costs, the value of the conserved soil and the monetary value of several environmental services provided to the community by farmers who are implementing agroecological systems are difficult to value. Such services examples are the protection and conservation of springs and watercourses through reforestation and proper soils management; fauna conservation through the planting of native and fruit species for the birds feeding; and agrobiodiversity conservation and enhancement. Many economic impacts are not necessarily "monetary", and it is fundamental to find ways to value them in sustainability analyzes (FERRARI, 2002).

Another limitation in the sustainability evaluation is directly related to the time factor, since the transition to sustainability presupposes the identification of efficient systems in the long term, which makes it difficult to prove results (LAL, 1994; SARANDÓN, 2002). While economic evaluation is done, usually after a series of harvests, evaluations of biophysical and social aspects may require decades or even centuries (Table 2).

Table 2. Time scale for the evaluation of different aspects of sustainability

Aspects	Time scale
Economic evaluation of profitability	One or several harvests
Yield Trends	Five to twenty years
Soil characteristics	One to several decades
Hydrological characteristics	One to several decades
Ecological Parameters	Several decades to centuries
Social and cultural aspects	Few to several generations

Source: Adapted from Lal (1991).

The energy analyzes have provided greater security in the long-term studies, as well as in the comparison between cultures, systems and agricultural activities developed in several places (FERRARO JÚNIOR, 1999; SOUZA et al., 2008). However, any methodological framework for assessing sustainability related to natural resources needs to be properly adapted for its application in a wide range of agroecosystems in various regions.

In the State of Minas Gerais, it has been adopted the system of Indicadores de Sustentabilidade em Agroecossistemas- ISA (Sustainability Indicators in Agroecosystems- SIA), composed of a set of 23 parameters that include the social and economic balance, property management, soil and water quality, management of production systems and diversification of the landscape and conservation status of native vegetation (Table 3).

Table 3. Description of the seven sub-indices and the 23 indicators used in the system of Sustainability Indicators in Agroecosystems (SIA), in the State of Minas Gerais, Brazil

(to be continued)

Subscripts	Indicators
Economic balance	1- Productivity and sales price determined
	2- Income profile and diversification
	3- Wealth evolution
	4- Level of indebtedness
Social balance	5- Basic services available
	6- Food safety around the houses
	7- Education/Directed courses /agroforest pasture activities
	8- Occupation quality and employment generated
Rural establishment management	9- Enterprise management
	10- Information management
	11- Waste and effluent management
	12.Occupational safety and health and the use of pesticides and veterinary products
Soil productive capacity	13- Soil fertility
Water quality	14- Surface water quality
	15- Groundwater quality
	16- Risk of water contamination by pesticides

(conclusion)

Subscripts	Indicators
Production systems management	17- Areas with soil in degradation stage
	18- Degree of adoption of conservation practices
	19- Conservation status of internal and external roads
Agricultural landscape ecology	20- Native vegetation- phytophysiognomies and conservation status
	21-PPAs
	22- RL
	23- Agricultural landscape diversification

Source: Ferreira et al. (2012).

SIA allows the automatic generation of graphs and tables by aggregating the indicators into themes. The use, land occupation and identification of Permanent Preservation Areas (PPAs) are determined with the support of satellite imagery, field surveys and the use of geoprocessing techniques. This system has shown sensitivity to inter and intraregional variations related to the different management standards, production systems and coffee properties management that are part of several certification programs. (FERREIRA et al., 2012).

4 SUSTAINABILITY IN COFFEE CULTIVATION

Coffee has a key role to play in the development of a large number of poor countries in tropical areas, being responsible for a significant portion of their export earnings and primary source of income for around 25 million families of small producers all around the world (ICO, 2004). Coffee is a source of many jobs, not only in rural areas, where it is a factor of social stability, but also in the urban areas of the producing countries, as well as in the consuming and transforming/reprocessing countries.

The permanent imbalance between supply and demand has lead to historical price oscillations, whose levels, in most of the producing countries, have not allowed to cover the production costs, intensifying the poverty indices and the increase of the rural exodus towards the urban centers peripheries (ICO, 2004). This justifies greater concern with the various sustainability dimensions.

The social dimension is usually only superficially approached in many projects. However, the economic, social and ecological, cultural, political and ethical dimensions must be reconciled in the permanent search for new points of balance in increasing levels of sustainability. Critical views regarding the social well-being and the participants income guarantee, especially the rural family, must be taken as the most fragile link in the productive chain.

This point is visible in the coffee cultivation of Espírito Santo's conilon and the social and economic impact of cyclical crises can be perceived more dramatically with family farmers. These abandon their farms or live from extraction activities and the rural workers lose their jobs. Meanwhile, the income from coffee cultivation is concentrated in the transforming countries (COELHO, 2002). This is due, in part, to the existing imbalance in the supply chain. In the early 1990s, worldwide retail coffee sales were US$30 billion/year, one-third (US$10-12 billion) of which was destined for producing countries. In 2001, only US$5.5 billion of the US$70 billion handled with coffee reached the producing countries. In a decade, the business more than doubled. However, the producers economic income was halved, and profit sharing was four times lower (ICO, 2002).

The fall in prices paid in the international market is significantly reflected in the sustainability indicators. This means a fall in agricultural income, lower wages for rural workers and fewer jobs, with the farmers always being the most affected. The robusta coffee's low price in the international market determines a reduction of revenues and creates a vicious circle that hinders the mobilization of resources for investments, particularly in the production methods with environmental respect. This generates impacts on productivity and income, including abandonment of harvests (ICO, 2006).

The price falls are increasing the pressure on the environment as coffee growers are forced to expand production areas to compensate the decline of incomes. Many Central American countries abandoned their traditional methods of coffee production, specially the shaded cultivation that conserves soil, water, flora and fauna species and constitutes a natural moderator of the microclimate. The need to introduce high-yielding varieties to face a competition of lower-cost producers led to the intensive use of agrochemicals, causing the biodiversity reduction (ICO, 2002).

The coffee sector history is marked by inadequate infrastructure developments and the use of agronomic techniques, systemic deficiencies in the supply chain and market imperfections that have generated environmental, economic and social challenges. However, due to the growing tendency of the supply chain and more transparent market relations, greater market differentiation and intentional adoption of best practices in favor of sustainability, it is seeks to achieve greater sustainability and stability in the coffee production system (PEREIRA; BLISKA; GIOMO, 2007).

The Programa Cafés Sustentáveis do Brasil (Brazilian Sustainable Coffees Program) an initiative of the Associação Brasileira da Indústria de Café - ABIC (Brazilian Coffee Industry Association), came up in 2007 with the proposal to stimulate sustainability in coffee production, with quality and certification. It sought to introduce the new world trend of conscious consumption of products with proven respect for environmental, economic and social sustainability in the Brazilian market. It aims to broaden the partnerships between industry, coffee growers and their cooperatives. The program distinguishes roasted and ground coffee brands that add quality and sustainability. The seal on the packaging proves that 60% of the *blend's* composition, that is, the basic raw material for premium and *gourmets* coffees, comes from sustainable suppliers (ABIC, 2015).

Coffee plays an important role in establishing the agricultural population and in the creation of jobs in rural areas, providing a better income distribution among the families from these areas. In the state of Espírito Santo, coffee cultivation generated more than 362 thousand jobs, distributed among owners, partners and employees, of which 209 thousand workers were connected to conilon, involving more than 78 thousand families (TEIXEIRA, 1998).

These aspects carry risks and change the profile of labor relations, as this family-based coffee cultivation becomes more and more dependent on hired labor and temporary workers. Regarding the arabica coffee from the family-based agriculture in the State of Espírito Santo, for example, about 31% of the workers are over 50 years old and only 13% are young people under 17 years old (De MUNER; FORNAZIER; SCHIMIDT, 2009). This situation threatens the coffee economy sustainability in regions and municipalities that depend heavily on coffee to obtain what is essential for their survival.

Regarding social organizations in the State of Espírito Santo, cooperatives of conilon coffee producers are in various stages of technical and administrative development, with differentiated participation in the coffee classification and in the product trading. Some of them promote the processing and reprocessing as well as the storage for the associates. They act in the co-operative sector of Capixaba conilon coffee cultivation, the Cooperativa dos Cafeicultores do Sul do Estado do Espírito Santo - Cafesul (Cooperative of Coffee Growers of the South of the State of Espírito Santo), Agropecuária Centro-Serrana - Coopeavi (Agricultural and Livestock of the Center Mountain Region Cooperative) and the Cooperativa Agrária dos Cafeicultores de São Gabriel- Cooabriel (Agrarian Cooperative of São Gabriel Coffee Growers). The latter has the largest storage space, located in the municipality of Sao Gabriel da Palha, considered the largest conilon cooperative in Brazil, with reception capacity of more than 1 million bags.

In pursuit of a balance in income distribution along the production chain, the efforts have focused on the opening of new niches for specialty coffees and differentiated markets for green beans and exports of roasted and ground coffee; the promotion of consumption of coffee and its by-products; the encouragement for the association for trading; the improvement of coffee quality; production certification and traceability; and the diversification of the coffee property activities in order to aggregate value and increase the rural families income.

The economic and social factors of sustainable development are such important issues that may obscure environmental concerns, especially in low prices periods. However, the boost of a sustainable coffee cultivation must take all these different aspects into account and give them the same priority degree. In this context, coffee growers who wish to become part of the gradual transition process of their property to a more sustainable agriculture styles should note:

• **In the social dimension**: respect for the workforce, represented by contracted rural workers, partners and sharecroppers, through full compliance with labor law, fair remuneration and decent housing, as well as the possibility of access to education, health and recreation, with fair and human relations between capital and labor. The organization and social participation should be promoted. The social dimension of sustainability must be understood as a means of reducing inequalities and poverty in rural areas, with equity among members of society, better distribution of assets, capacities and opportunities for the less favored, providing access to health, education, credit and culture.

• **In the ecological dimension**: the use of water, soil and natural resources should be rational, planned and defined by the adoption of simple technologies and procedures within the reach of all producers. The promotion of the properties environmental adequacy through the water sources and springs protection, the conservation of riparian zone along the springs and at the top of the hills, the correct disposal of domestic sewage and the wastewater reuse from coffee pulping and livestock should be stimulated. Soil degradation within harvests, roads and access corridors should be systematically combated through the use of proper techniques such as cutting spontaneous weed and the construction of dry boxes to capture rainwater surplus. There should be diversification in harvests and adoption of technologies that minimize/eliminate the agrochemicals use, such as integrated pest management and organic production. RL areas should be maintained and degraded areas should be recovered by favoring the biodiversity conservation and the establishment of ecological corridors.

• **In the economic dimension**: it is necessary for the rural producer to ensure the financial survival, well-being and food security of the families under his dependence, monitoring his expenses and revenues, avoiding waste by optimizing the synergies between animal production systems and adding value to agricultural products, diversifying productive activities and income sources and seeking the property self-management. The access to trading channels, credit and technical assistance should be facilitated. At the same time, trading channels must be built to assure farmers a higher autonomy degree and income, just as strategies that reduce dependence on the input market should be sought.

5 SYSTEMS TRANSITION: GOOD AGRICULTURAL PRACTICES

Four key levels can be distinguished in the transition process to sustainable agroecosystems: (a) increasing the efficiency of conventional practices to reduce the use and consumption of expensive, scarce and often environmentally harmful *inputs* has been the main emphasis of agricultural research, resulting in many practices and technologies that help reduce the negative impacts of conventional agriculture; b) the substitution of conventional *inputs* and practices for alternative practices whose goal is the use of products and practices that are more environmentally benign than those that are more resource intensive and environmentally degrading. At this transition level, the basic structure of the agroecosystems would be little altered, and therefore similar problems to those of conventional systems could occur; c) the agroecosystem redesign, so that it works as a new set of ecological processes. At this level, one would seek to eliminate the causes of the problems that still exist at the two previous levels; d) the ethics and values change, which prioritizes the relationship between producer and consumer, based on the latter's education, since what he consumes is not only the product itself, but the result of a complex process that generates environmental and socioeconomic impacts. This will guide the decisions to be taken by farmers. It relates to conscious production and consumption (GLIESSMAN, 2001; GLIESSMAN et al., 2007).

The conilon coffee development model in the State of Espírito Santo has been privileging the economic dimension to the detriment of the other sustainability dimensions. It is observed the increasing technological contribution aiming at raising productivity and reducing production costs. The option for this monoculture development model, mainly in the northern region of the State, has demanded expressive investments in the acquisition of irrigation equipment, higher fertilizer doses and an increase in the use of pesticides. This system has favored the pests and diseases incidence, such as coffee-borer, cochineal, rosette-caterpillar, mining bug and coffee rust, which are becoming more and more relevant in the plantations.

The conventional coffee production system, when compared to others with greater diversification, or "more agroecological"ones, indicated to be less sustainable, although it presents higher production. The crops diversification, however, allows the increase of the aggregate income value in the agricultural property (FERRARI, 2002). The conilon coffee in Espírito Santo is conventionally produced and although it has more than doubled the average state productivity, it has not prevented many coffee growers, mainly of family base, from still conducting their plantations in areas with little vocation and without the use of available technological inputs.

The characterization of the conventional management and of more sustainable management systems, with good agricultural practices used by the coffee family farmers from Espírito Santo is presented in Table 4.

Table 4. Conilon coffee management systems characteristics of conventional family coffee cultivation and good agricultural practices in the State of Espírito Santo

(to be continued)

Agroecosystem determinants		Conventional	Good agricultural practices
Technologies and Management	Prevailing farming system	Monoculture with traditional and/or inbred varieties	Monoculture with inbred varieties and use of associated farming systems
	Harvest density	From 2 to 3 thousand plants/ha; variable number of stems/ha	Average of 3 thousand plants/ha; from 12 to 15 thousand stems/ha
	Mechanization level	Low to medium	Low to medium
	Labor	Family and eventual contracts in the harvest phase	Family and contracts in the harvest phase
	Coffee plantations fertilization	Chemistry; eventual use of soil analysis	Chemistry and organic, using coffee straw based on soil analysis
	Water and soil conservation practices	Contour and less use of these practices	Contour plowing, hedge and carrier management, mowing and use of windbreaks. Rainwater collection through dry boxes
	Spontaneous plants management	Hoeing, mowing and herbicide use	Predominant use of mowing and controlled use of herbicides
	Management (pests and diseases)	Chemical control and/or no control	Monitoring and use of the Integrated Pest and Disease Management (IPDM)
	Management and irrigation systems	Predominance of dry cultivation and sprinkler systems	Predominance of localized irrigation systems and water management
	Harvesting and post-harvesting	Less adoption of good harvesting and post-harvesting practices	Proper use of good practices in harvesting, drying and processing for the production of high quality coffees
	Property and harvest area	Predominance of areas smaller than 50 ha and harvest with mean area of 9.4 ha	Predominance of areas smaller than 50 ha and harvest with mean area of 9.4 ha

(conclusion)

Agroecosystem determinants		Conventional	Good agricultural practices
Socioeconomic	Average productivity	Less than 35 bags/ha	more than 50 bags/ha
	Production type and quality	Predominance of type 7/8	Predominance of type 6, 6/7 and peeled cherry (PC)
	Management, association, trading and technical assistance	Low level of management, association with predominant sales for intermediaries and little technical assistance	Better management, cost-benefit monitoring, associative management and sales for cooperatives, regional intermediaries and exporters, and better public and private technical assistance
	Production goal	Obtain monetary entries	Monetary entries and sustainable coffee that can be verified/certified with price differential

Source: Adapted from De Muner (2008).

One of the great environmental challenges is to look for agricultural production systems adapted to the environment in such a way that the dependence of external inputs and non-renewable natural resources is reduced (TOMAZ; AMARAL; JESUS JUNIOR, 2008).

Systems transition implies replacing polluting, degrading and capital-dependent technologies and unsuitable management techniques with others that should need to be less capital demanding and more locally accessible and that allow the biological diversity maintenance and soil productive capacity.

Several management techniques considered as alternatives, less dependent on external inputs and the use of agrochemicals, such as agroecological zoning for the harvest implantation; the correct preparation of the area and the adequate location of the crops in the properties; the use of varieties less susceptible to pests and diseases: spacing and planting densities better suited to variety architecture; chemical and organic liming and fertilization; pruning; soil and water conservation practices; ecological management of spontaneous plants and of pests and diseases, irrigation and harvesting and post-harvesting, are being made available to farmers.

The conilon coffee plantations of Espírito Santo are predominantly located in Natural Zones of Hot Lands (FEITOZA; STOCKING; RESENDE, 2001; FEITOZA et al., 2010). The vast majority of cultivated areas of this species are located in rainy/dry and dry transition areas, with a water *deficit* ranging from 140 to 600 mm/year, covering areas with annual dry periods that may vary from four to eight months (CONAB, 2014; GEOBASES, 2014).

In these areas, characterized as suitable areas with climatic constraints, production is more dependent on irrigation, increasing production costs and raising the natural risks of crop frustration. The irrigation has been used as a tool to overcome this water *deficit* in more than 50% of conilon plantations in the State, which represents more than 150 thousand hectares. The choice of the most appropriate irrigation system depends on several factors, such as topography, spacing, amount and quality of available water, soil and edaphoclimatic conditions, technological and economic levels of the producer and equipment costs. It predominates the localized irrigation (micro sprinkler and drip irrigation), in which water consumption is closer to demand, with less waste. This item is the main limiting factor for the maintenance and growth of the conilon farming area in Espírito Santo.

The irrigated area is limited by the water availability, which has been a conflict motivator, including judicial, especially in periods of greater water restriction. It is considered that the water availability is the main sustainability factor of coffee production in Espírito Santo. The use of environmental management technologies such as reforestation and shaded plantations should be encouraged, besides the adequate water use management and techniques for their production and conservation in rural properties.

Most of the regions suitable for conilon coffee cultivation in the state of Espírito Santo show soils and declivity that require the use of conservation practices to control erosion. The degradation rate of soils cultivated with arabica coffee and conilon in Espírito Santo reaches 118.706 ha. However, about 18% of the cultivated area in the northwest region is degraded, where conilon cultivation predominates (BARRETO; SARTORI; DADALTO, 2012). Intensive practices of mowing in coffee lines with native vegetation preservation decreased soil, water and nutrient losses in relation to fully hoed crops (LANI et al., 1996). However, it has been found that these practices have been little used by farmers. The use of animals associated with crops has been presented as an alternative of multiple functions. Chickens have served in weeding, fertilization and control of coffee borer bugs, slugs and other insects in crops, besides being a factor of production diversification, guaranteeing food security and alternative income source for family agriculture in Espírito Santo (GUELBER SALES, 2013).

The development of participatory research and observations on associated tree cultivation and the integration livestock x conilon coffee is strategic for this coffee cultivation sustainability in Espírito Santo, considering the threats of climate change, the water scarcity in family properties and the coffee growers' low diversification of income. Among the main challenges of coffee grown in a shaded environment is the competition for light, water and nutrients with the trees (FRANCK; VAAST, 2009; PADOVAN et al., 2015). Several successful experiences of the productive intercrop of coffee with banana, papaya, pepper, peach palm, rubber tree, among others, are reported. In addition to these, intercropping with annual species such as pumpkin, beans and corn is traditional in the first two years of crop development. Initiatives such as these will contribute effectively for the improvement of the coffee cultivation sustainability in Espírito Santo.

The characterization of the cultivation areas of coffee intercropped with trees in Espírito Santo (SALES; ARAÚJO, 2004) showed that these should be compatible with the coffee tree, with a predominance of fast growing ones. Diversification with forest species, especially if associated with other perennial crops, is a low-cost investment that adds value to the plantation, functioning as a medium and long-term savings and allows the income generation during the crops renewal. Higher tree growth rates have led to lower coffee production in agroforestry systems.

In situations of conilon coffee prices fall, intercropping could ensure income and represent the transition to more diversified systems. Brum et al. (2007) found that the cultivation of conilon coffee intercropped with peach palm (*Bactris gasipaes* Kunth) in the southern region of Espírito Santo brought an economic increase when compared to single coffee cultivation. The cedar (*Toona ciliata* M. Roem.) was the species that most competed with conilon production, but it was the one with the highest vegetative growth in the period evaluated. The jequitibá [*Cariniana legalis* (Mart.) Kuntze] did not compete with the coffee tree, but it was the least developed species (SALES et al., 2013). The best average yields of conilon coffee clones cultivated in an intercropping system with rubber tree were obtained, when the rubber tree was implanted in spacing of 30 and 40 m in double lines. Spacing of 20m presented lower coffee productivity due to its greater shading; however, a further 100 rubber plants are added per hectare and this should be considered in times of low coffee prices, as well as profitability over the rubber tree useful life. Some conilon coffee materials of clonal origin with great production potential in a partially shaded intercropped system were identified (MACHADO FILHO, 2010).

The cultivation of conilon coffee with macadamia (*Macadamia integrifolia* Maiden & Betche) in the southern region of Bahia decreased the incidence of active photosynthetic radiation on coffee plants, reduced the incidence of wind and caused alterations in the thermal regime and relative humidity. The mean maximum air temperature was 2.2 °C lower than full-sun cultivation and indicated that afforestation of coffee plantations may have a promising possibility to mitigate the effects of climate change on coffee cultivation (PEZZOPANE et al., 2010).

Pests and diseases become a limitation only if the agroecosystem is not in equilibrium (ALTIERI; NICHOLS, 2004; VANDERMEER; PERFECTO; PHILPOTT, 2010). In this sense, the productivity is not affected by specific causes, and pests are only the symptom of a more ecosystemic disease.

In Espírito Santo, the main conilon coffee pest is the coffee borer [*Hypothenemus hampei* (Ferrari, 1867)], whose annual damage to the coffee harvest has been estimated at more than R$40 million, in years favorable to its population development (De MUNER et al., 2000). The main recommendation adopted for its management, aiming at reducing the use of pesticides, is the use of better and suitable practices with the biodiversity maintenance and the system balance through crop control- with the removal of all fruits of the plant and the cultivation area- and the well-harvested crop and the transfer (FORNAZIER et al., 2000). Also, there is the adoption of biological control through the release of natural enemies in the plantations (BENASSI, 1989), although it is still carried out in an incipient way. It is only after the use of such control methods and systematic monitoring of the borer population that the chemical intervention is allowed, located in plots of higher pest incidence.

Production pruning and programmed cycle pruning are considered to be important management practices for the Capixaba conilon coffee crop, as they are not only low cost and environmental impact technologies, they also create jobs. Crops conducted with systematized pruning showed a productivity increase of more than 50%, rose the coffee shelf life, reinvigorated crops, reduced the biannual effect, facilitated harvesting, allowed more productive plants per area and provided organic matter from vegetative parts removed from the plant (SILVEIRA et al., 1993; FERRÃO, et al., 2012).

The conilon coffee genetic breeding in the State of Espírito Santo has been aimed at increasing the agronomic efficiency of crops and optimizing the adequate use of natural resources in the crop and adapted to the production system. The clonal varieties Emcapa 8141-Robustão Capixaba, Vitória Incaper 8142, Diamante ES8112, ES8122 - Jequitibá, Centenária

ES8132 and Marilandia ES8143 and the variety propagated by Emcaper 8151- Robusta Tropical seed were developed. The first one has as its main characteristic drought tolerance (FERRÃO et al., 2000a, 2000b, 2014, 2017). The 'Robusta Tropical' comes to recover the basis of conilon coffee breeding for being a highly productive, drought-tolerant and seed-multiplied variety, which allows the preservation of the genetic variability resources found naturally in conilon Capixaba. This variety is recommended for farmers, preferably the family-based ones, with coffee production in water *deficit* regions and with financial limitations for the use of irrigation and other technologies, such as the acquisition of higher cost clonal seedlings. However, there is a need to observe the behavior of these genetic materials in a shaded environment and/or in cultivation associated with trees and with rubber trees.

The recommendations for chemical fertilization, organic and liming (COSTA; BRAGANÇA; LANI, 2000; LANI; De MUNER, 2001; PREZOTTI, 2014) for conilon farming in Espírito Santo were developed specifically for the state's production conditions.

Coffee production can have its sustainability levels improved by replacing non-renewable energy inputs (chemical fertilizers, fossil fuels and lubricants) with lower energy costs such as biofuels and organic fertilizers. There are a series of actions that allow to combine the energy aspects with the nutritional requirements of the coffee; if adopted together to globally improve the cultivation sustainability. One of them is in the leguminous species cultivation for green fertilization aiming at the nutritional increment in the system, mainly of nitrogen (N), highly limiting of the energy conversion and, most of the times, it is obtained by non-renewable energy sources (De MUNER et al. al., 2015).

Another way would be to properly use the by-products that come from coffee processing, such as straw and wastewater from coffee washing and pulping, used improperly most of the times. They have been important to balance the cost-benefit ratio in increasing the conilon coffee productivity, rationalizing the amounts of fertilizer used.

The use of organic compounds and coffee straw is a recommended practice, which aims at the use of organic residues in the property, in partial replacement of chemical fertilization(BRAGANÇA et al., 1995; ARAÚJO et al., 2007; SILVA et al., 2013). Another practice is the use of green manure and the these legumes management in the coffee lines, such as calopogonium, crotalaria, galactia and pigeon pea, providing high green mass production and high N input to the soil through biological fixation (RICCI; ARAÚJO; FRANCH, 2002; MOURA et al., 2005; ARAÚJO et al., 2013, 2014; CARDOSO, 2013), allowing the farmer less dependence on resources and external inputs. They also provide protection against sheet erosion and promote the nutrients cycling between the soil layers (BALOTA; CHAVES, 2011). However, one of the main challenges for the use of green manure intercropped with coffee is to establish adequate management for both species and to synchronize the availability of nutrients from green manure to coffee demand (ARAÚJO, 2015).

Brachiaria *decumbens* (*Brachiaria decumbens*) has been planted in the coffee line and also favors nutrient cycling, access to N of the soil outside the range of the coffee roots, gradual release of N, soil porosity (PEDROSA, 2013; PEDROSA et al., 2014; ROCHA, 2014) and increases up to 18% the amount of available water in the soil (FAVARIN et al., 2010).

The conilon coffee post-harvesting is another important factor that affects the economic dimension of sustainability and influences the trading market maintenance, especially for buyers who are more demanding in relation to the intrinsic and extrinsic factors of coffee, such as the quality of the beverage and the grains size. The cultivars Centenária, Diamante and Jequitibá were launched aiming at this market.

The coffee drying stage, in the post-harvesting processing, has been extremely important in this competitive market where it is demanded. Aiming at environmental conservation and the system redesign, it is important to use more natural methods, with the use of solar energy to perform this drying stage, either in farmyards, greenhouses or other alternatives that reduce the intensive use of mechanics dryers, which demand great energy input. When the use of mechanical dryers is necessary, care must be taken to use indirect fire to dry the grain mass. In this sense, it is necessary to develop a technological matrix that allows the production of coffee with a higher productivity level and premium quality and incorporates the other sustainability dimensions.

6 SUSTAINABLE COFFEE PROGRAM

The Sustainable Coffee Program (SCP, 2015) is a global pre-competitive public-private initiative and involves partners from the coffee industry and trade, local governments, NGOs, and coffee sector credentials/verification organizations. Its goal is to contribute to sustainable production and product purchase practices scale through alignment of *stakeholder* investments in producer support programs. These aim to improve coffee growers' living standards, reduce environmental impacts, mitigate the climate change and biodiversity loss effects, make them more resilient in the ever-changing market, and expand sustainable coffee volumes to meet the demand.

This initiative came from the IDH (2014) (Dutch acronym for Sustainable Trade Initiative), an international organization that operates in 18 production chains, such as cotton, cocoa, tea, timber and soy, besides coffee. Its resources are public-private, and the public sector counts on contributions from the governments of Denmark, the Netherlands and Switzerland. It acts in Brazil, Colombia, Ethiopia, Indonesia, Peru, Uganda and Vietnam. In Brazil, it has the coordination of P&A and as international private partners four of the world's largest coffee roasters: D. E. Master Blenders 1753, Mondeléz, Nestlé and Tchibo, as well as the European Coffee Federation and the international organization Hivos. Together they set the global goal of increasing sustainable coffee production from 18% to 40% and coffee trading from 8% to 25% in the period that comprises 2010-2016.

PCS seeks to catalyze energy from the Brazilian coffee sector to produce more sustainable and expand Brazilian exports of these coffees. Through work developed with national and international credentials/verification organizations, it will help reduce the production environmental impact and create more sustainable coffee supply. However, the information level on sustainable agricultural practices among coffee producers is still insufficient, especially in family farming.

On the other hand, many producers aligned with sustainability practices are unable to export their production as sustainable because they are not verified/certified according to an international sustainability standard. So, it is noted that for these coffees to be appreciated in the international market, it is necessary that they are recognized through some form of credentials/verification. Therefore, unlocking larger volumes of sustainable coffee produced in Brazil is crucial to transform the world coffee market. Still, it turns out that coffee growers are vulnerable to climate change and also face difficulties accessing financial services that might help them become more sustainable.

Although sustainable coffee production has grown considerably over the period 2010-2013, there is a significant difference between the produced and traded amount of verified/certified coffee (Figures 2 and 3). Besides the obvious difference between supply and demand, there are other factors that explain such discrepancy. The demand for green coffee depends on several quality attributes, including flavor and origin and it is not all the coffees that meet these buyers' criteria. Therefore, to meet the demand, it is essential to have a wide range of qualities and origins to offer. Also, there is data overlap when the same coffee has more than one certification. This is a critical element in evaluating the verified/certified coffee entry in the market and this may lead to overestimation of the total available volume (PANHUYSEN; PIERROT, 2014).

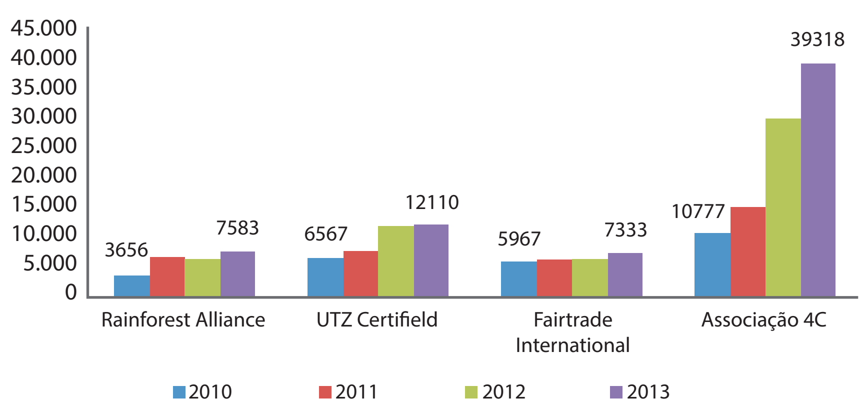

Figure 2. Verified/certified coffee production, 2010 to 2013 (thousand bags).
Source: Organized by P&A (2015).

The world's top ten coffee roasters have developed strategic alliances with a number of international standards (such as 4C, Rainforest Alliance and UTZ Certified) or have created their own standards (such as C.A.F.E. Practices, Starbucks, and Nespresso's AAA) as part of their global corporate strategies for coffees acquisition (Figure 4).

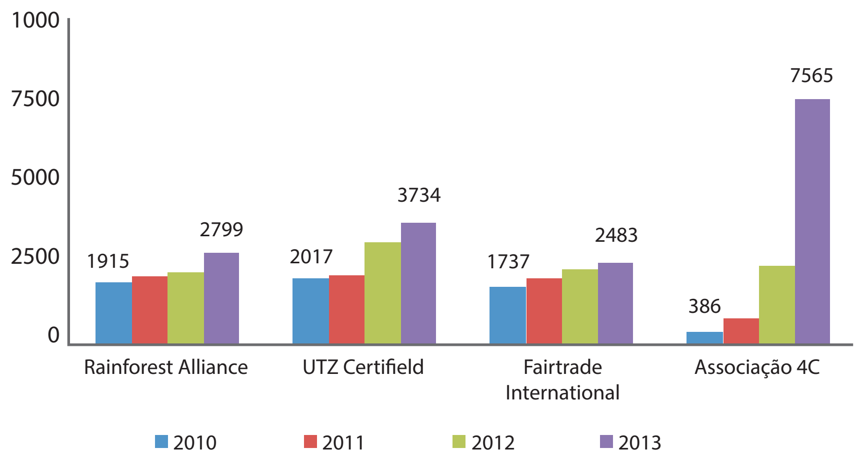

Figure 3. Verified/certified coffee trading, 2010 to 2013 (thousand bags).

Source: Organized by P&A (2015).

6.1 ARABICA AND CONILON COFFEES IN THE SUSTAINABILITY MARKET

Using the data from four large credentials/verification organizations (Figure 5), it is observed that in 2013, with the exception of the 4C verification association, the amount of certified conilon coffee did not exceed 1% of the total marketed (arabica + conilon). This demonstrates the lag of the sustainability introduction and its standards (credentials/verification) in the producing areas of robusta coffee. Given the high and growing proportion of conilon in the Brazilian coffee production, the low entry of the main sustainability standards in conilon evidences that there are opportunities for Brazilian coffee growers to incorporate sustainable practices that will bring countless benefits to the entire production chain, besides add value to their production.

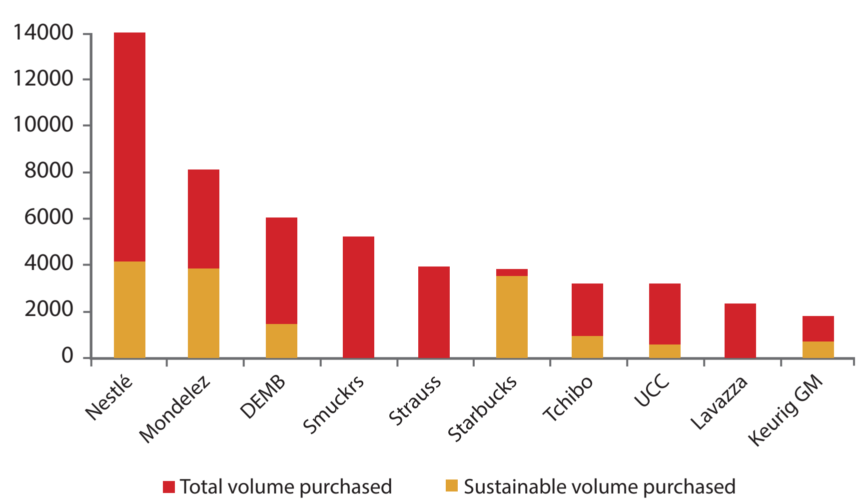

Figure 4. Coffee volume bought by the main roasters in 2013 (thousand bags).

Source: Organized by P&A (2015).

6.2 BRAZIL: A CASE STUDY FOR THE SUSTAINABLE COFFEE PRODUCTION

Although Brazil is among the major exporters of verified/certified coffees, regulations on sustainability standards and compliance costs can be two bottlenecks that affect its future growth. The strict Brazilian laws go beyond the minimum criteria demanded by most international standards. This often makes it difficult and expensive for low-income producers to make the necessary investments to comply with this legislation. As most international *standards* provide for the adoption of national laws, even if more than accepted by the *standard* itself in other countries, farms that do not comply with local laws can not be verified/certified.

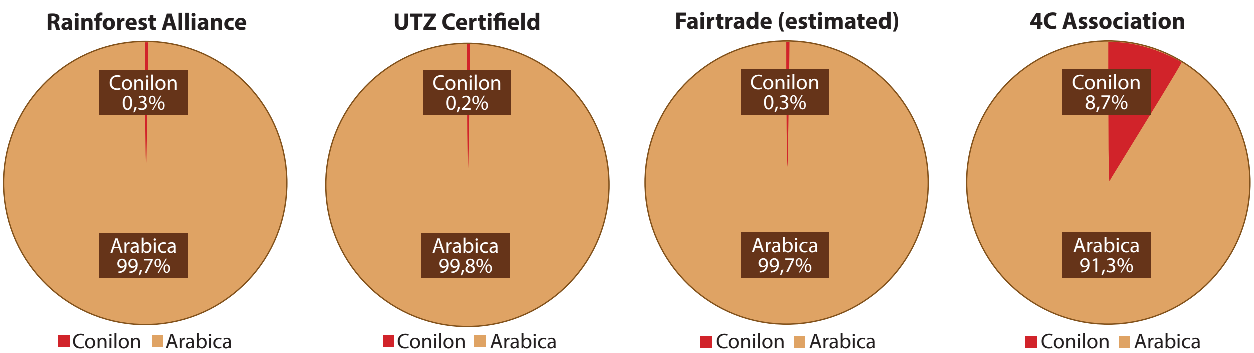

Figure 5. Verified/certified arabica and conilon coffee proportion in Brazil by the main sustainability standards.

Source: Organized by P&A (2015).

Verification/certification is economically viable for larger farms and cooperatives. However, the cost is too high for low-income producers to seek it independently. Group schemes could reduce costs, but coffee growers would in certain cases have less flexibility to switch between exporters and other partners, who are the ones that usually organize groups.

In this context, the PCS explores ways to facilitate and expand the access of these producers to training in sustainable practices by the use of the existing rural extension structure and technical assistance in the country. It also uses the means of disseminating existing programs and tools that may collaborate with the producer for this purpose, in case of the disclosure of credit lines for investments in sustainability.

Producers who invest in sustainability are more profitable, since good farming practices increase productivity, quality, and improve business management. The introduction of new technologies generates efficiency in harvesting, processing and other activities in the property. A correlation was observed between the increase in productivity and the reduction in production costs, which directly impacted the increase in profitability in a sample of Brazilian coffee growers (Figure 6).

6.3 ACTIONS OF THE SUSTAINABLE COFFEE PROGRAM

PCS has been operating in Brazil since 2012, through several projects with specific scopes and fixed deadlines. All projects are aligned with the overall strategy of this program to promote sustainability in the coffee chain. However, they are adapted to the Brazilian reality and focus on the small and medium product production. In that sense, in 2013, one of the projects was dedicated to make a massive and all-encompassing effort to inform coffee producers about the ban on Endosulfan, used to combat coffee borer and would take effect from the middle of that year. This action also worked to touch the sector leaders, who took initiatives to accelerate the registration of substitute products in order to ensure that coffee was produced using safe and legally authorized agrochemicals.

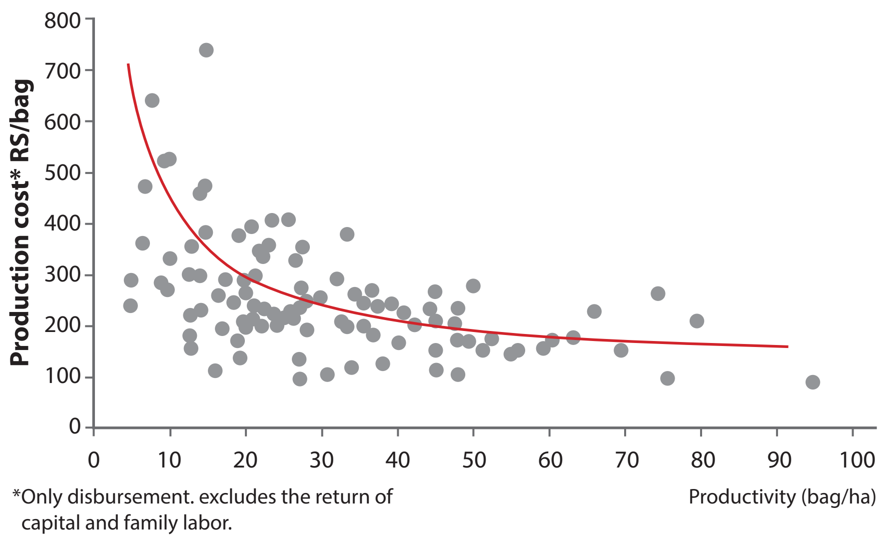

Figure 6. Correlation between productivity and coffee production cost.

Source: IDH (2014).

Other projects were developed in 2013-2014 to facilitate the training on sustainable production in a coordinated manner with local organizations and ongoing initiatives. Also, information was systematized on financing programs that could help coffee growers to make their production systems sustainable and selected 20 credit lines with funds of over R$ 50 billion. This information is summarized in both print and digital versions in the "Practical Guide to Access Credit Lines for Promoting Coffee Growers' Sustainability," distributed to more than 39 thousand coffee growers. It informs the existing options and with advantageous conditions of access to credit to finance the necessary investment in rural properties adequacy.

The project on climate change and its effects on coffee cultivation, conducted in 2013, culminated in a *workshop* to exchange experiences and knowledge among Brazilian researchers. Besides that, PCS contributes to the progress and diffusion of the Coffee & Climate Initiative, a global project that aims to directly support coffee producers in the adoption of agricultural practices that promote the climate resilience of the crop.

6.3.1 The Coffee Sustainability Curriculum (CSC)

The program contributes to the creation of a national coalition of extension services and the Coffee Sustainability Curriculum (CSC) implementation, a document based on the PI-Café national standard (Integrated Coffee Production, published as Normative Instruction No. 49, of September 24th, 2013).

The CSC was elaborated by several institutions in a long participatory process that culminated with its official launch, held in March 2015, at Incaper in Vitória, Espírito Santo. The rural extension services of the main coffee producing states (Incaper, Emater-MG, Cati-SP, Emater-PR and Emater-RO), as well as coffee chain institutions and entities, and verification and certification systems.

The CSC gathers the sustainability content to be implanted in the producer properties in order to improve its economic, environmental and social sustainability. This document unified, in a simplified way, the language and several existing sustainability content which was organized to assist the technician and the producer action, pointing out the most urgent actions ("Forbidden"), going to the "Priorities" and concluding with the "Recommended" in the continuous improvement process.

CSC is not intended to be a certification system. However, it seeks to be a common reference of content for the guidance of extension workers and rural producers in the search for long term agricultural sustainability. This action will reduce the impacts (social, environmental and productive) caused throughout the process, increasing productivity, reducing production costs and adjusting to the market that demands coffee produced according to sustainable parameters. When applied in the field, it prepares the producer to obtain the existing verification/certifications, in case he wants it.

Continuing this process, PCS has developed an "Implementation Guide" of the CSC, which details how to accomplish each of the items to facilitate its implementation in the field. In addition, PCS is implementing training programs in the CSC, aimed at multiplier technicians who can replicate the content to other multipliers and producers in a continuous training process. Several other actions disseminate the CSC in regional partnerships with extension services and other institutions so that small coffee growers in Brazil can become more sustainable and with a better quality of life.

One of the main bottlenecks of technical assistance and rural extension in all the producing states is the limitation of financial resources for the hiring of new technicians to serve a larger number of rural producers. At the same time, the improvement of the rural producer who receives quality technical assistance is unquestionable. The Program, in partnership with the Hanns Neumann Foundation of Brazil and with the rural extension services of the producing states, develops studies of effective models of collective technical assistance. The numerous and relevant successful experiences that the extension services accumulate in several Brazilian regions will be published in a common and replicable methodology of collective technical assistance that allows reaching more producers with the current availability of technicians.

In the following, it is presented the full text of the **Coffee Sustainability Curriculum (CSC)**: Sustainable Coffee Program- Coffee Sustainability Curriculum. The CSC is a collective elaboration document with the main participation of the rural extension services (Emater-MG, Incaper-ES, Cati-SP and Emater-PR) of the main coffee producing states of Brazil, representatives of industry, class entities, institutes and certification bodies. The CSC was based on the Integrated Production of Coffee (PI-Coffee, Normative Ruling 49, of September 24, 2013), in view of its national and public character and this document quality.

The CSC is the selection of the central and essential themes for the performance in sustainability of both the producer and the extensionist. Thus, it is a common reference for the application of sustainability in coffee properties. By unifying the language, it strengthens the actions and accelerates the entry process into sustainability, especially for low and middle income coffee producers. The CSC content was also built to be the base for the properties preparation to later access to internationally recognized verification/certification systems and new markets, if this is the producer's will.

The CSC content, presented below, indicates in a practical way "what" to do to make coffee property sustainable[3]. Its content has been divided into three categories with increasing priority order of appropriateness (Forbidden, Priority and Recommended). It is recommended that the producer initially seeks to comply with the "Forbidden" items, then go to the "Priorities" and finally the "Recommendations" in the continuous improvement process (Table 5).

Table 5. Sustainable Coffee Program: Coffee Sustainability Curriculum (CSC) and forbidden, recommended and priority actions

(to be continued)

Thematic areas	Priorities	Recommended	Forbidden
1 Property Management			
1.1 Management	1.1.1 Property must have identification of the areas use through one of the following items: sketch, map, ground plan, aerial photo or satellite image. The areas of production, conservation, PPAs, RLs, areas of residual treatments, recycling, water bodies and other areas should be identified. Production plots are identified and related to the application records. 1.1.2 Maintaining the employees registration updated, through a registration form with personal data, occupation and training information. 1.1.3 Developing notions of the main items that make up and impact the average production cost of the region according to the production system.	1.1.4 Calculating the coffee producing cost annually (even if it is simplified- average cost obtained by summing the expenses divided by the number of bags produced, as well as the total revenue). 1.1.5 Controlling the productivity per plot and comparing the moving average (2 and 4 years) for evaluation. Go through market training, production costs, price formation and operation in future markets.	
1.2 Technical responsibility		1.2.1 Receiving technical assistance from a qualified professional (may be a technician from the extension, cooperative, association, institute, private company or similar service).	

[3]"How to do" will be detailed in the complementary document: Implementation Guide of CSC.

(continuation)

Thematic areas	Priorities	Recommended	Forbidden
1.3 Risk analysis		1.3.1 Elaborating a property analysis by identifying existing and potential risks to the environmental and social impacts (including climate change), social and productive of the unit and its surroundings, as well as action steps to minimize them. Including in the analysis the risk of fire with proximity between areas of greater risk and preventive and emergency actions planned.	
1.4 Compliance with legislation	1.4.1 For all the points included in this CSC, compliance with relevant and current legislation must always be considered.		
1.5 Information and traceability record	1.5.1 Keeping the minimum record with information on varieties used, number of plants, purchased and applied inputs (place and date) and products sold. 1.5.2 Keeping information on the coffee batches produced and the steps taken in the harvesting and post-harvesting processing updated, identifying it from the original site to its destination after trading.	1.5.3 Keeping field notebooks with information on pest monitoring, use of inputs, irrigation water and all activities carried out for crop management. Recording the procedure, date, dose, quantity, executor and location (eg plot). 1.5.4 Adopting a batch identification system that allows to recognize the property and the plot where the coffee was produced, with information about the product type: sweeping, cherry, cloth picking or with machine, humidity, type, beverage. 1.5.5 Practicing Good Trading Practices and maintaining samples of green coffee representative batches for at least one year for analysis in case of complaints.	
1.6 Continuous improvement	1.6.1 Promoting the concept of property continuous improvement. Carrying out, annually, a self-evaluation of compliance with the content of this CSC, trying to solve the pending issues, prioritizing the most important: forbidden items must be solved urgently, followed by priority and then recommended.		

(continuation)

Thematic areas	Priorities	Recommended	Forbidden
2 Environmental Management			
2.1 Environmental planning	2.1.1 Identifying possible sources of pollution generated on the property, such as liquid effluents, solid and gaseous residuals. Planning and carrying out appropriate treatment and disposal, avoiding the impacts they may cause on or off property (after residue disposal or destination). 2.1.2 Identifying the degraded areas within the property. Planning and performing its recovery.		
2.2 Plant coverage and biodiversity	2.2.1 Preserving and recovering protected areas (PPAs, RLs and other conservation areas), identifying them in the field, aiming to promote biological control, natural balance and water conservation, in accordance with current environmental legislation.	2.2.2 Keeping fire protection actions. 2.2.3 Considering the existence and expansion of internal ecological corridors and connected to neighbors as a way to increase the biological balance.	2.2.4 Growing coffee in areas of environmental protection, permanent preservation or in areas of illegal deforestation, respecting the current Brazilian Forest Code and its exceptions (when applicable).
2.3 Solid residues (waste, polluting and non-polluting residues)	2.3.1 Collecting garbage generated on the property and disposing it properly.	2.3.2 Disposing the recyclable residues for recycling. 2.3.3 Treating organic wastes from coffee and other organic waste using them for recycling and the production system optimization (soil coverage, fertilizers or energy sources). 2.3.4 Minimizing the polluting waste production.	2.3.5Performing waste or residue incineration.
2.4 Polluting liquid effluents	2.4.1 Taking measures to ensure that all liquid effluents, including domestic sewage, have proper parameters before being disposed of in the environment.		2.4.2 Releasing the polluting liquid effluents including domestic sewage into bodies of water or the environment, without proper treatment.
2.5 Power Consumption		2.5.1 Identifying the sources of energy use aiming at their reduction as well as the replacement of the energy produced by fossil fuel. Relating the amount of energy used per bag of coffee produced. Creating goals and measures to reduce energy consumption. 2.5.2 Recording the monthly energy consumption including electricity. Setting reduction target.	2.5.3 Using illegal firewood from PPAs and RLs.

(continuation)

Thematic areas	Priorities	Recommended	Forbidden
2.6 Agrochemicals Handling	2.6.1 Having a suitable place for the handling of agrochemicals, syrups and the accomplishment of the packaging triple washing (or under pressure). 2.6.2 Properly store (safe, isolated and identified) the empty agrochemical containers, washed and perforated, until their correct return. Saving the packages proof of return. 2.6.3 Having an appropriate place for the washing of atomizers with a correct destination for the washing waste.		2.6.4 Using agrochemical packaging for any other purpose.
2.7 Agrochemicals storage	2.7.1 Keeping agrochemicals without adequate storage conditions, with hazard and risk identification, in a closed, ventilated, restricted access environment (in compliance with the legislation). 2.7.2 Agrochemical storage sites must have a leakage containment system. 2.7.3 Agrochemical deposits must respect the recommended distances from sources, residences and roads.		
2.8 Fauna and flora			2.8.1 Performing illegal hunting, capture, dealing and fishing of wild animals and plants.
3 Propagation Material (seeds, seedlings and cuttings)			
3.1 Choosing the cultivar		3.1.1 In new plantations, adopt adapted cultivars, according to the soil characteristics and property microclimates. 3.1.2 Using cultivars registered on Mapa and give preference to those resistant or tolerant to pests, diseases and drought.	3.1.3 Using propagating material of unknown origin (which does not originate from legally authorized materials).
3.2 Seeds, seedlings and cuttings	3.2.1 Acquiring seeds, cuttings or seedlings from producers or nurseries duly authorized (updated registration), requesting and keeping the sanitary certificate and purchase invoices.		
4 Coffee Plantations Location and Deployment			
4.1 Coffee plantation location	4.1.1 In the formation of coffee plantations, observe soil and climate conditions (edaphoclimatic) and comply with environmental legislation and the Economic Ecological Zoning - EEZ, when applicable.	4.1.2 Identifying the property soil types so that the planning is efficient.	

(continuation)

Thematic areas	Priorities	Recommended	Forbidden
4.2 Plots Identification	4.2.1 Identifying the plots for recording information indicating cultivar, planting date, crop dealings, plot number and area, number of plants and spacing for traceability purposes.		
4.3 New plantings	4.3.1 Carrying out the coffee planting for the soil conservation, planting fertilization and coverage based on soil analysis.		
5 Soil Fertility and Coffee Nutrition			
5.1 Soil fertility evaluation	5.1.1 Performing soil analysis, preferably once a year and at most every 2 years using laboratories that participate in proficiency tests. 5.1.2 Establishing soil fertilization and correction program according to technical recommendation based on soil analysis.	5.1.3 Performing one leaf analysis per year.	
5.2 Correctives and fertilizers choice	5.2.1 Use correctives and fertilizers registered on the Mapa, which meet the needs of each plot.	5.2.2 Use organic matter as a source of nutrients (coffee straw, organic compound, manure, etc.) When using organic sources, consider the nutrients contained in fertilization calculations.	5.2.3 Use nutrients sources of industrial origin or urban waste with high contents of heavy metals above that allowed by current legislation. For fertilizers and limestone, request manufacturer's analysis.
5.3 Fertilizers storage	5.3.1 Store fertilizers safely and in accordance with legislation to prevent the environment contamination.		
6 Soil, Vegetation Cover and Coffee Management			
6.1 Soil conservation	6.1.1 Adopt soil conservation techniques in planting and crops management. 6.1.2 Protect the internal roads of the property from erosion. 6.1.3 Identify the degraded areas within the property. Plan and perform its recovery. Control erosion and water runoff through a set of soil conservation practices.		
6.2 Soil cover	6.2.1 Keep the soil, between the coffee plantation lines, covered with live or dead vegetation.	6.2.2 Handle the soil cover of the coffee plantation, preferably and when possible, using mechanical methods. 6.2.3 Perform the mowing of the weed between coffee lines in alternating streets, as well as keep cover (where possible) in carriers or around the plots, as a way to maintain green cover and *habitat* for natural enemies and insects.	

(continuation)

Thematic areas	Priorities	Recommended	Forbidden
6.3 Weed Management		6.3.1 The use of the Weed Management and green manure in the coffee plantation formation and conduction, either for windbreaks or for improving the physical, chemical and biological conditions of the soil and increasing the organic matter content. Minimize the use of herbicides and, when necessary, associate it alternately with mechanical control practices.	
6.4 Mitigating the drought effects		6.4.1 Use techniques that favor root system deepening, increase in organic matter content and decrease of water loss in the system as a way to increase plant resistance and mitigate the drought effects. Consider partial shading and use of windbreaks.	
7 Water Use and Irrigation			
7.1 Water use	7.1.1 Register and use water in the different stages of coffee production in compliance with the legislation and granting, when applicable.	7.1.2 Consider the use of rainwater collection systems, whether for irrigation and/or general use of the property. 7.1.3 Periodically perform microbiological and chemical analysis (including pollutants) of irrigation water and post-harvesting use.	
7.2 Need for irrigation	7.2.1 Elaborate technical project for the implementation of irrigation. 7.2.2 Require granting or granting dispensation in compliance with current legislation. Carry out a management plan according to the technical recommendation. 7.2.3 Manage the amount of irrigation water according to the climate data on water in the soil, the granting and the demand of the coffee crop, recording in field notebooks or similar device dates, irrigation volume and respective climate data.	7.2.4 Use techniques to evaluate water storage capacity, such as water retention curves for each type of soil on the property. Consider other precise techniques to ensure that the volume of water used and the length of application do not produce waste or excessive application. 7.2.5 Perform water distribution uniformity tests and regular the system maintenance.	
7.3 Fertigation		7.3.1 In addition to water control, record application dates, type, amount of fertilizer applied and field.	
7.4 Quimigation		7.4.1 Use authorized agrochemicals for application via irrigation water following technical recommendation.	

(continuation)

Thematic areas	Priorities	Recommended	Forbidden
8 Integrated Coffee Protection			
8.1 Diagnosis of diseases and pests	8.1.1 Monitor coffee plots, their diseases and pests by establishing strategies to prevent pests and disease-causing pathogens from reaching the level of economic damage.	8.1.2 Monitor coffee plots by evaluating the incidence of pests and diseases and recording occurrences in field notebooks or other devices, highlighting cases where the control limit has been reached. 8.1.3 Monitor and consider existing data such as warning systems, weather information, etc. in decision-making. which warn of favorable conditions for the occurrence of pests and diseases.	
8.2 Pests and diseases management and control	8.2.1 For the pests and diseases control, prioritize the use of physical, mechanical, cultural and biological controls and use as little as possible the application of agrochemicals.	8.2.2 In the case of interest in exporting coffee, verify that the country may have a restriction on some agrochemical legally allowed in Brazil and, in that case, the referred product should be avoided. 8.2.3 Establish strategies to prevent disease causing insects-pests and pathogens from becoming resistant to agrochemicals. 8.2.4 Use windbreaks or partial shading of coffee plantations as a method of cultural control and decrease of water loss.	8.2.5 Use agrochemicals without registration for coffee in Brazil.
8.3 Agrochemicals application	8.3.1 Use only agrochemicals indicated by agronomic prescriptions. 8.3.2 The applicator shall undergo agrochemical application training (and keep supporting document). 8.3.3 Control the periods of used products replacement and shortage. 8.3.4 Wash Personal Protection Equipment (PPE) in a suitable place.	8.3.5 Prioritize, whenever possible, the use of lower toxicity (human and environmental) products available.	8.3.6 Agrochemicals application by people who have not received training. 8.3.7 Agrochemicals handling and application without PPE.
8.4 Agrochemical application machinery	8.4.1 Carry out annually preventive maintenance of agrochemical application equipment. 8.4.2 Keep spraying equipment adjusted in order to apply the recommended dose, cause the least drift of agrochemicals and direct the applications to better achieve the pest or disease.		

(continuation)

Thematic areas	Priorities	Recommended	Forbidden
9 Harvesting			
9.1 Care in harvesting		9.1.1 Separate sweeping coffee from coffee harvested by machine, cloth or similar device. 9.1.2 Process the coffee and take it to the farmyard, preferably, on the same day of the harvesting.	
9.2 Hygiene and contamination prevention		9.2.1 Keep containers, tools, equipment and vehicles clean to avoid coffee contamination. 9.2.2 Minimize the contact of the coffee harvested in the tree with potential sources of contamination by fungi that produce ochratoxin.	
9.3 Harvested coffee measurement		9.3.1 Calibrate the volumetric devices used in the harvesting to estimate the yield.	
9.4 Prevention from ochratoxins		9.4.1 Take measures including training and awareness to prevent mold and moisture in coffee.	
10 Post Harvesting			
10.1 Pre Wet Processing		10.1.1 Minimize the consumption of water used in the equipment employed in the coffee processing. 10.1.2 Reuse water from pre wet processing. Recycle in the case of peeled/pulping system. 10.1.3 Collect, store correctly and give adequate destination to the residues (solids and liquids) of the post-harvesting processing and the water treatment, when necessary	
10.2 Micro-organisms prevention	10.2.1 Minimize coffee contact during post-harvesting operations with sources of contamination by microorganisms adopting good pre-processing practices.	10.2.2 Avoid coffee contamination making equipment and farmyards hygiene before the contact with the product. 10.2.3 Perform moisture control during the coffee drying and storage. 10.2.4 Separate batches of sweeping coffee at all stages of pre-processing.	
10.3 Coffee storage	10.3.1 Keep the facilities fresh, clean and disinfected (with legally authorized products) for coffee storage.	10.3.2 The producer shall separate the coffee types he harvests, identify them and store them in an appropriate location, away from pesticides or other materials that may contaminate or impair its characteristics.	

(continuation)

Thematic areas	Priorities	Recommended	Forbidden
11 Labour Law and Worker's Safety, Health and Welfare			
11.1 Labour Law	11.1.1 Register and remunerate workers in accordance with current legislation. Consider the specificity for family farming.		11.1.2 Illegal forms of child labor and forced labor.
11.2 Right to association, bargaining and discrimination		11.2.1 Ensure organization freedom and the right to collective bargaining.	11.2.2 Practice race, gender, religion, marital status and political affiliation discrimination.
11.3 Working periods	11.3.1 Do not exceed the working hours established by the legislation, the maximum limits of overtime per employee and paid weekly rest. Consider the specificity for family farming.		
11.4 Producer organization		11.4.1 Stimulate, facilitate and promote participation in associations, cooperatives, producer organizations and promote bargaining power, the producers' strengthening, the collective purchase and production professionalization.	
11.5 Accidents prevention	11.5.1 Identify the highest risk activities for workers, including training for specific and dangerous functions. 11.5.2 Adopt measures to reduce accidents and the unhealthiness of closed spaces.		
11.6 Workers' health	11.6.1 Submit the workers to an annual medical examination according to the current legislation considering the specificity for family farming.	11.6.2 Keep person with first aid training and Kit available at the property.	11.6.3 Washing of PPE at home or at the same place where clothes are washed.
11.7 Workshops and fuel depot	11.7.1 Workshops and fuel depot should be suitable to reduce the accidents risk and negative impacts on human health and the environment by respecting the distances between housing and legislation.		
11.8 Housing and transportation, hygiene and availability of drinking water	11.8.1 Provide proper housing conditions for workers living on the property in compliance with current legislation. 11.8.2 Provide safe transportation for workers in compliance with legal demands. 11.8.3 Provide suitable space for body hygiene and physiological needs, including for field workers. 11.8.4 Provide drinking water to workers, including field ones. 11.8.5 Provide suitable place for food, including for field workers, in compliance with current legislation.		

(conclusion)

Thematic areas	Priorities	Recommended	Forbidden
11.9 Access to education		11.9.1 Encourage access to education of school-age children living on the rural property.	
11.10 Qualification and family succession		11.10.1 Favor the qualification of future generations by preparing them for family succession. Promote practical and theoretical training on the subject.	

Source: P&A (2015).

Producers who achieve good compliance with this content tend to have a more sustainable production, obtaining greater profit in the short, medium and long term, since it is efficiently managed, it saves inputs, improves coffee productivity and quality and controls production costs. The great beneficiary of adopting good production practices that lead to sustainability is the rural producer and his property. The environmental impacts of the productive system are lowered, which preserves the soil and water. Other benefits include better compliance with legislation, greater occupational safety and better property organization.

7 FINAL CONSIDERATIONS

It is observed that the technological model adopted for the development of the conilon coffee cultivation in the State of Espírito Santo, in general, has been emphasizing the economic dimension. Even with the advances, the social dimension is weakened in the trading aspect, considering that the forms of coffee growers' social organization (cooperatives) interfere in less than 20% of the conilon coffee from Espírito Santo trading. In the environmental aspect, many challenges still need to be overcome, especially regarding water constraints. However, the achievement of increasing levels of sustainability presupposes reconciling all dimensions including cultural, political and ethical. Thus, it is clearly noticeable that conilon coffee cultivation continues at the first level of the transition systems, in which the optimization of the use of internal and external property resources is prioritized in order to maximize the financial return. Some initiatives for sustainable production, verification and certification, such as AAA, 4C, UTZ, RFA and CSC, support the replacement of conventional agricultural practices with more ecological ones at the second level of system transition.

The conilon coffee cultivation development in the State of Espírito Santo, whose technological contribution was historically directed to increase productivity and reduce production costs, made the activity highly economically competitive, but also dependent on external inputs, irrigation and the use of agrochemicals, with consequent social and environmental risks.

It is also observed a significant number of family farmers producing conilon coffee, exploiting the activity in less-educated areas, with water restrictions and low technological and financial resources use and showing lower productivity, mainly in the northwestern and southern regions of Espírito Santo. This has led to progressive degradation of natural resources.

As a consequence, it has been observed the abandonment of degraded land, change of agricultural exploitation and increased rural exodus.

Family farming is dependent on the economic income of the coffee industry. This is evident, especially in periods of prices fall in the international market.

More policies directed at conilon coffee cultivation in the State are necessary, with actions based on research and technical assistance to improve sustainability levels considering the environmental, social and economic aspects, as described below:

• Promoting the development of participatory research, actions and studies for the generation and adaptation of agronomic, managerial and process technologies, guided by the sustainability principles as agroforest pasture systems, conilon varieties tolerant to adverse conditions, pests and diseases and adapted to shading and intercropping with trees;

• Developing appropriate technologies for fertility management and soil and water conservation, irrigation management, wastewater and methods of spontaneous plants, pests and diseases natural control;

• Implementing Reference Units in family-based coffee farms aiming at the participatory construction and coffee growers awareness to use more sustainable farming styles;

• Developing organizational, management and rural training processes for young people, coffee cultivation workers, partners and family farmers, taking into account their cultural and social specificity, in order to ensure that productive processes in family succession, use environmentally friendly technologies, avoiding environmental damages and risks to human and animal health;

• Encouraging the consolidation of associative forms in order to strengthen collective intervention capacity, bargaining power, management and marketing processes in conilon coffee production in family agriculture;

• Increasing the social inclusion processes and strengthening citizenship through integrated actions in the education, health, rural housing and leisure areas, as well as in the compliance and adequacy of environmental and labor laws that consider the ethical, social, political, cultural, economic and environmental dimension of sustainability;

• Strengthening research and keeping actions in order to expand and consolidate conilon coffee production in the southern region of Espírito Santo under more sustainable conditions in areas suitable for cultivation and with less water restriction;

• Developing joint actions with associations, cooperatives and private initiatives of sustainability and/or production certification, such as the CSC, based on the PI-Café, aiming at the inclusion of the familiar conilon coffee growers to produce this coffee at higher sustainability levels;

• Developing, in an integrated way, the promotion and facilitation of quality improvement processes, looking for the sustainability, facilitating access to differentiated markets and adding value to the product;

• Extending funding and rural credit resources specific to initiatives, with a view to transition from the conventional system to some more sustainable styles of agriculture in family establishments;

• Promoting the marketing of coffee produced in a sustainable and integrated way among public and private initiatives and the social organizations in order to expand the differentiated markets, mainly for the green beans export.

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