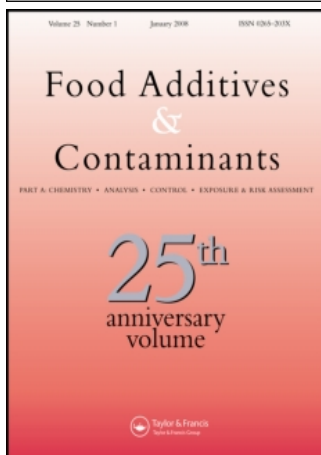


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Design and implementation of an integrated management system for ochratoxin A in the coffee production chain

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Abstract

Coffee is an important export product of Ecuador. Producers are challenged by the implementation of regulatory limits for ochratoxin A. Ecuador has four coffee production areas and the potential for mycotoxin contamination varies due to different environmental conditions and cultural differences in harvesting, storage, processing and commercialization. The major contributors to contamination are the lack of selection during harvesting, delays in drying or rewetting, the lack of proper drying and storage conditions, the mixing of products with different levels of moisture, and the potential for cross-contamination. The long commercialization chain involves different intermediaries that use foreign materials to increase the weight of the product without consideration of quality. An integrated mycotoxin management system using the Hazard Analysis Critical Control Point Systems (HACCP) principles was developed to prevent mycotoxin contamination at each stage of production. Critical control points were developed based on the resources available at the different stages of the production chain. Training programmes helped increase awareness about the impact of contamination, but failed to transform knowledge into improved practices. Thus, different demonstrative models specific for each productive region at all production levels were developed to show the application of prevention mechanisms using limited resources and to demonstrate the increased commercial value of coffee produced using good practices throughout the chain so producers have a better disposition to adopt improved practices. Preliminary results show that coffee managed using the models had a better quality, a lower contamination, a higher yield and better commercial value. The use of local resources and low-cost technology was important in demonstrating the practical approach.

Keywords: *Ochratoxin A, coffee, hazard analysis critical control point systems (HACCP), integrated mycotoxin management*

Introduction

Mould infestation of susceptible agricultural products such as cereal grains, nuts and fruits is common in food supplies worldwide. Mould growth can result in reduced crop yields, losses during storage and mycotoxin contamination. Some mycotoxins such as ochratoxin A (OTA) have been recognized as contaminants of concern from a food safety perspective. OTA is produced by mould from the *Penicillium* and *Aspergillus* genera particularly by *P. verrucosum*, *A. ochraceus* and *A. carbonarius*. Of these species, *A. ochraceus* grows at moderate temperatures and at water activity above 0.8 and

may infect coffee beans producing OTA during drying (Food and Agricultural Organization (FAO) 2006). Contamination may also occur during storage and transportation if coffee is exposed to humid conditions. OTA is a known nephrotoxin, carcinogen and genotoxic agent (Joint Expert Committee on Food Additives (JECFA) 2001). Although coffee is processed at high temperatures during roasting, mycotoxins such as OTA, and to a lesser extent aflatoxin, are known to survive roasting and remain as a potential hazard. Several studies have reported OTA data for raw and roasted coffee since 1980, and occurrence continues to be reported from different regions of the world (Levi 1980,

Tsubouchi et al. 1987; Studer-Rhor et al. 1995; Nakajima et al. 1997). Worldwide contamination trends may be hard to establish since many analyses come from European customs offices, therefore restricting some contamination information to coffee exported to the European Union.

Coffee is one of Ecuador's major agricultural export products and together with bananas, cocoa beans and flowers represents the majority of the income from agricultural exports. It is estimated that in 2005 Ecuador had at least 200,000 hectares destined for coffee production. This activity represents the major source of income for approximately 130,000 families that have regrettably suffered with the different commercial crises that have affected international coffee trade. These estimates do not consider the number of jobs generated by the industrialization and commercialization of coffee beans. According to the Ecuadorian Institute of Statistics, approximately 8% of the population depends directly or indirectly on coffee production (Instituto Nacional de Estadística y Censos (INEC) 2005).

Ecuador is one of the 14 coffee producer countries that, due to its geographical location and conditions, produces both arabica (*Coffea arabica*) and robusta (*Coffea canephora*) coffee. Coffee is produced throughout the country in 20 of the 22 provinces and can be generally located in four different distinct regions (INEC 2005): Coast, Andes, Amazon, and Islands, with the majority of production concentrated in the Coast region where Arabica is produced predominantly. Each production region has different challenges due to the environmental conditions, type of production, processing and commercial routes.

Coffee production in Ecuador is a family activity done in small farms where primary production is not technified and demands a lot of labour. Lack of productivity and low yields are common problems for most producers. Since the international coffee price crisis that started in 1998 and worsened during 1999, coffee producers have faced serious problems and have struggled to maintain production. In many cases, the commercial price did not cover production costs leading to the loss of income and eventual crop replacement. Although efforts have been made internationally to stabilize prices, producers are still plagued with challenges that are now increased by the new OTA limits established by several countries. Table I presents some of the major strengths, weaknesses and risk factors for OTA contamination in Ecuador.

Ecuador exports mainly soluble coffee from domestic or imported coffee beans. Since the major market for Ecuadorian coffee are countries in the European Union with implemented regulations (Table II), the National Coffee Exporter's

Association (ANECAFE) tried to address mycotoxin contamination by participating in the global project 'Enhancement of Coffee Quality through the Prevention of Mould Formation' (GCP/INT/743/CFC) financed by the Common Fund for Basic Products of the United Nations Food and Agriculture Organization (FAO) (ANECAFE, Statistics for coffee exports from Ecuador, personal communication, 2006).

In 1999, a processed coffee shipment from Ecuador was denied entrance to France due to contamination with OTA at levels of 21.1 and 13.8 $\mu\text{g kg}^{-1}$. Subsequent analysis done in 2002 showed there was OTA contamination ranging from 0.6 to 104.1 $\mu\text{g kg}^{-1}$, with an average contamination of 14.95 $\mu\text{g kg}^{-1}$. Curiously, coffee beans reported as being very damaged by the coffee berry borer (*Hypothenemus hampei*) and visibly mouldy were not highly contaminated (FAO 2004).

During 2003, fourteen field technicians participated in an international training workshop on good agricultural practices (GAP) and Hazard Analysis Critical Control Point Systems (HACCP) for mycotoxin prevention and control sponsored by the FAO. However, due to the detection of mycotoxin contamination, in particular OTA, and the importance of coffee production in the country, Ecuador requested additional technical support from the FAO. This technical cooperation project (FAO 2004) was developed in coordination with the Ecuador Ministry of Agriculture (MAG), ANECAFE and the FAO. The main objective was to develop national awareness in relation to contamination issues due to mould contamination and mycotoxin formation and the impact on food safety. Specific objectives included training on prevention and control strategies at different levels of the coffee production chain, strengthening of the national analytical capabilities, development of communication tools, and development of a concerted National Action Plan to ensure long-term improvement of the safety and quality of coffee from Ecuador.

Integrated mycotoxin management systems

In order to establish clear strategies for this project it was important to know the conditions by which coffee is produced, processed, stored and transported in the country. In general, it was determined that there were four distinct coffee production areas with very different systems due to the type of coffee produced and the environmental and market conditions:

- The Coast is the area with the highest production of arabica coffee. Harvesting is conducted during the dry season so

Table I. Major weaknesses, strengths and risk factors for contamination with ochratoxin A (OTA).

Weaknesses in the coffee production chain of Ecuador	Strengths in the coffee production chain of Ecuador	Major risk factors for contamination with OTA
Lack of education	Existence of a national organization Consejo Cafetalero Nacional (COFENAC) that provides technical support throughout the coffee production chain	Lack of awareness of the problem
Lack of awareness of contamination issues	Production of both species, robusta and arabica	Ideal environmental conditions for mould proliferation
Low productivity and yield	Good industry capability	General lack of sanitary conditions for coffee production
Decrease of cultivated areas	Existence of updated technical norms	Presence of pests such as the coffee borer (<i>Hypothenemus hampei</i>)
Lack of a producer organization	Flourishing of a new industry of specialty coffees with access to higher value markets	Lack of selective harvesting
Lack of a commercial organization	Availability of a laboratory equipped to perform ochratoxin analyses	Harvested beans mixed with dirt, fallen beans, rocks and other contamination vectors
Lack of access to financial resources		Storage of freshly harvested beans under inadequate conditions for over 8 h
Lack of insurance for agriculture		Lack of infrastructure for wet processing
Low income for producers		Lack of adequate infrastructure for drying
Increase of production costs and decrease of competitiveness		Product blending with products of different moisture content
Lack of technification		Lack of adequate storage infrastructure
Lack of communication throughout the coffee production chain		Storage for long periods of time
Low production of washed coffee		Storage with other grains
Lack of incentives to improve quality		Lack of adequate transportation conditions
Disorganization throughout the commercial chain		Extremely long commercial chain with several intermediaries
Decrease of exports		Lack of bean sorting and selection
Low domestic consumption of coffee		Lack of maintenance and clearing of processing equipment
Lack of enforcement of existent regulations		Cross contamination with peeling operations
Purchasing of coffee without consideration of quality issues		

Table II. Regulatory requirements and coffee exports from Ecuador by volume and value (US\$), 2005.

	Regulatory requirements			Exports from Ecuador	
	Green coffee beans (ppb)*	Roasted and ground coffee (ppb)*	Soluble coffee (ppb)*	Volume of soluble coffee exported from Ecuador (number of 60-kg bags, 2005)	Value of soluble coffee exported from Ecuador (US\$ thousands, 2005)
European Union (general)	n.d.	5	10	458,638.08	45,039.13
<i>Countries with individual regulations</i>					
Germany**	n.d.	5	10	125,744.67	10,331.01
Czech Republic**	10	5	10	11,700.00	1123.50
Netherlands**		5	10	5427.50	424.30
Spain**	8	5	10	915.64	68.92
Finland**	5	5	10	587.17	60.98
Italy**	8	5	10	390.00	53.60
Greece**	20	5	10	–	–
Hungary**	15	5	10	–	–
Portugal**	8	5	10	–	–
Switzerland	5	5	5	–	–

Sources: FAO, ANECAFE.

Notes: *Limits were updated to November 2004. The status for the limits differs by country. Some are included in the regulations and others are norms, customs instructions or inspection guidelines.

**Limits of roasted and ground coffee and soluble coffee for European Union members have been expressed as the European Union general limit.

environmental conditions do not usually play a major role in the drying process and contamination issues may be prevented with improved practices.

- The Amazon produces mostly robusta coffee and faces high relative humidity and rainy conditions during harvesting, thus drying operations are extremely difficult. In addition, transportation is challenging since coffee for exportation to the European Union is transported by land and will take several hours on roads with different conditions going through diverse environmental extremes.
- Coffee in the Andes is produced by small producers, many of which are now organized in cooperatives. Although the use of washing is still not widespread, producers in this region are slowly transforming to this method of processing. In general, there are dry conditions during harvesting which facilitate drying operations. However, many producers that wash coffee do not dry it immediately and usually transport it as wet parchment. Many producers in the Andes region have turned to the specialty coffee market and are participating in organic and fair trade certification programmes. Since they are more organized and have been able to penetrate some specialty markets successfully, producer awareness is better. Contamination may be prevented with improved practices during wet processing and storage.

- The Galapagos Islands produce mainly specialty organic coffee. There is one major producer that has access to top-of-the-line organic technology and only uses wet processing. However, dry parchment coffee is then transported by sea to the mainland for further processing such as sorting, grading, polishing, blending, roasting and grinding. This transportation operation may again increase the risk of contamination. In addition, processing facilities also polish and blend coffee from the mainland, so cross-contamination is also a possibility. Increased awareness and improved storage, transportation and processing practices may help prevent and control contamination of coffee from the islands.

Throughout the country, with the exception of producers with special certifications, coffee may be sold to a number of different intermediaries who will in turn blend it with coffee from other producers. Sometimes water, dirt or rocks are added to increase weight and get more money during commercialization. Coffee with different levels of moisture is usually blended and stored without any further precaution and in some cases storage conditions are less than ideal. In many cases, coffee is stored piled directly on the ground and mixed with other commodities with different levels of moisture such as cocoa beans, corn, peanuts and peppercorns.

Although each region presents a unique challenge, a general HACCP model was developed to represent the major steps in coffee production. Obviously, the

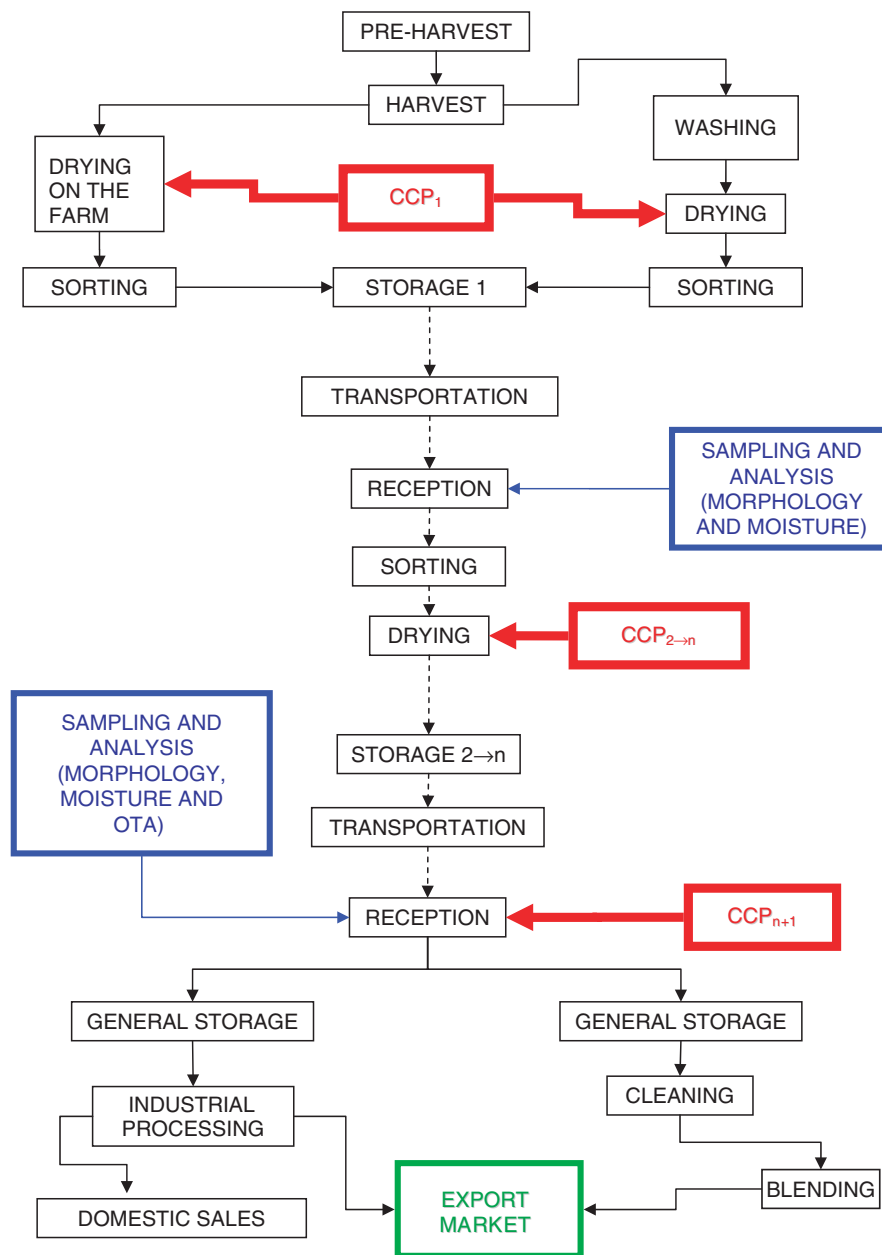


Figure 1. General flow chart for coffee production in Ecuador showing potential critical control points (CCPs).

flow diagram may be quite fragmented because different players will be involved. In addition, the storage, reception, and transportation phases may occur more than once due to the very long commercial chain involving many intermediaries. Figure 1 shows a general flow diagram with proposed critical control points, and Table III shows a summary of the critical control points (CCP). It is important to point out that critical limits were established according to the international guidelines emanating from the FAO Global Project (FAO 2006). This is obviously, a modified version of a HACCP plan since some steps had to be adapted to obtain an integrated management approach. In other words, CCPs may not follow the formal

definition because none minimize the risk associated with OTA in a single step; however, correct application of these controls in conjunction with the use of good practices throughout the production chain should prevent and control mould contamination at each stage of production. In addition, some of the monitoring operations are qualitative since they are adapted to the resources available at each stage of production.

Training

The ‘Train the Trainer’ approach was used to teach GAP and HACCP for mycotoxin management.

Table III. Summary of Hazard Analysis Critical Control Point Systems (HACCP) Critical Control Points (CCPs).

Critical control points	Hazard(s)	Critical limits	Where	Monitoring				Corrective actions	Verification	Records
				How	How often	Who	How			
CCP ₁ Drying on the farm or drying after wet processing	Biological: presence of toxigenic moulds Chemical: contamination with ochratoxin	Moisture <15% Depth of drying bed <4 cm	Patios, tents or dryers	Qualitative (supervisor uses traditional sensory methods such as biting onto the bean or cracking it to hear to a characteristic sound)	Every 4–8 h depending on the drying system	Farmer, supervisor or operator	Use of mechanical dryers or redistribution of coffee beds on patios to obtain the desired depth	Use of a moisture analyser	Lot records and moisture reports	
CCP _{2→n} Drying before storage	Biological: presence of toxigenic moulds Chemical: contamination with ochratoxin	Moisture ≤12% Depth of drying bed <4 cm Mechanical dryer settings	Patios, tents or dryers	Qualitative (supervisor uses traditional sensory methods such as biting onto the bean or cracking it to hear to a characteristic sound)	Every 4–8 h depending on the drying system	Farmer, supervisor or operator	Product segregation	OTA analysis	Lot records, moisture reports and OTA analysis	
CCP _{n+1} Reception at the processing facility	Biological, chemical: damaged coffee or contamination with OTA	Percentage defects according to the Ecuadorian technical norm number nte.inen 285 OTA <6 ppb	Reception area Laboratory	Laboratory analysis	Each lot	Buyer/receiving supervisor	Rejection or segregation if the per cent defects is more than allowed or OTA is over the limit	Laboratory analysis of the finished product (in-house or official laboratory)	Documentation for reception - Laboratory records for each lot	

A total of 57 field technicians were trained as trainers in two different workshops. These trainers in turn taught 442 regional workshops that reached 4213 people in all coffee production areas. In addition, three good manufacturing practices (GMP) and HACCP workshops were taught to industry personnel with a total participation of 94 people. These workshops left a good base of personnel trained on the basic methods for prevention and control. However, the question remained on how to transform this knowledge into a practical approach since most producers did not understand the contamination issues and did not feel this was a problem to which they were directly related. In addition, producers felt that additional controls were a burden for their already aggravated commercial systems. A common question during the workshops was as follows. 'If I do this, how much will the international price increase and how much more money will I make?' Obviously, these were not answers that could be obtained through the framework of the project. So, although training had a good outcome, its impact was questionable except for the increased awareness that was accomplished. A different approach was needed to encourage producers to adopt controls.

Development of demonstrative models

Since producers perceived controls as an economic burden to their system without increased price, it was decided to create demonstrative models. Different models were designed according to the environmental conditions for each region. The objective was to demonstrate that regardless of the international price for coffee, the use of good practices throughout the chain would help them increase the yield, quality and marketability of their products increasing value rather than price. These model systems were created using a volunteer producer, merchant or organization that was perceived as a community leader, had awareness of the impact of contamination on the country in general and their commercial infrastructure in particular and was willing to lend his warehouse, drying patio or processing facility.

Selective harvesting was encouraged by selecting volunteer producers that would harvest only mature berries and discard over-mature or dropped berries. Green berries were saved until maturation. This expanded the commercial cycle and some producers were able to save berries and sell them at the peak of pricing instead of the low prices experienced at the peak of the harvesting season. The intent was to have these producers share their experiences through personal communication.

Unfortunately, it will take several harvesting cycles to obtain reliable information, but at this point this demonstrative mechanism has been seeded for future reference.

A model warehouse was created in the Coast region. A warehouse building was already available; however, common storage practices included mixing of products with different moisture levels or different commodities. Products of extremely different qualities were also mixed in the warehouse. Therefore, if the producer had originally harvested high-quality beans that could have achieved a higher price in the market, by the time it arrived at the warehouse, it had lost its additional value due to blending with products of questionable quality. Thus, the resulting product had low quality and low value and had already lost a potential higher market price. Also, walls on the warehouse had evident mould growth and products were blended with leftovers from the previous harvest. Blended beans stored directly on the floor had such mould contamination that they were white and had high temperatures. Obviously, in addition to losing quality and increasing potential for contamination, the evident contamination is directly related to product yield and, therefore, decreased material to commercialize further.

The walls of the model warehouse were white washed as a means for inexpensive disinfection. Small cubic ($1 \times 1 \times 1$ m) containers were made of cane, a construction material that is widely available in the region and which is successfully used for building traditional houses and storage units. This material, if handled correctly, is extremely resistant to mould and other pests. Also, it is widely available so the cost of the material is not an issue and, in many cases, producers or merchants can harvest it from their own land. Since cane is cut into thin strips, finished containers had open strips that allowed for product ventilation. Additionally, the wooden frame was oversized to allow for stacking and to prevent storage immediately next to the wall. Therefore, wall spacing and spacing between containers to allow for air flow between the containers was guaranteed. These small containers were useful for product sorting, maintaining coffee of different qualities and other commodities segregated. Since, originally, the warehouse capacity depended only on the ability to pile grains on the floor, the use of containers immediately increased the warehouse capability and, thus, the merchant's ability to commercialize more products. This improved his perception of the value of good practices and generated a model storage unit that can be easily multiplied by other producers in the area.

In the Amazon region, another model warehouse was created. In addition, several artisanal drying mechanisms for small volumes were explored.

Since there is high relative humidity and constant rainfall in this area, it was essential to provide producers with accessible drying technology. Although some merchants own mechanical dryers, one of the major issues is that these dryers have a medium to large capacity (10–20 tonnes). Producers are small and a single producer is not able to harvest such large volumes at any given day. Thus, recently harvested coffee berries are stored wet for several days until enough volume is obtained to run the dryer. This process may take several days, therefore there is increased risk of contamination. The use of drying patios is not feasible due to rainfall. Traditionally, producers had tried to use tents to protect their products during drying. However, there are some design issues associated with these tents because moisture accumulates inside and during night condensate falls again onto the product. A demonstrative model for this method of drying included a tent built with a double roof that was designed to let moisture escape during the day, protect the product from rainfall and avoid nighttime condensation. Also, structures were built to raise the product off the ground and allow for air circulation. In addition, an artisanal dryer made of wood and operated with domestic gas was constructed for demonstration. This dryer can be operated with a low volume of coffee as opposed to the commercial dryers that were originally available.

This region also faces a very disorganized commercial chain. There are several formal established merchants. However, at the peak of the harvesting season, opportunistic merchants emerge and buy coffee regardless of the quality. This has a direct impact on the efforts to control contamination because producers are able to sell the worst coffee through this route. This coffee is then blended with good coffee, thus getting a final product with lower quality. To address this issue, the organization of a formal merchant association was facilitated during the project. The idea was to empower formal merchants to ensure that they would all buy coffee under the same criteria and segregate coffee of questionable quality. Through this organization, merchants can negotiate directly with exporters and avoid the chain of intermediaries that tend to blend coffee and add water and other materials to increase weight. Thus, organized merchants have a better chance of obtaining better value and avoiding contamination.

In the Andes region the use of small drying patios to dry wet parchment coffee before transportation was promoted. In addition, the warehouse of one of the major cooperatives was improved as a demonstrative model for good storage practices.

In order to obtain long-term success, producers will have to imitate these models and multiply the efforts. However, one of the major challenges will be their ability to obtain the financial resources needed to improve their production, storage and processing infrastructure. During the project, negotiations were initiated with the Ministry of Agriculture to obtain long-term soft credits of US\$300–1000/producer or merchant for individuals who had participated in the training programmes. These funds will be used to establish adequate drying patios or, in the case of the Amazon area, drying tents or artisanal dryers as well as improving storage conditions. In the Andes region funds will be used to buy small depulpers and establish adequate drying patios to produce washed arabica coffee through wet processing. It will take several harvest cycles to determine if producers requested the funds and the result of their investments with the subsequent impact on mycotoxin contamination.

Strengthening of analytical capabilities

At the beginning of the project only a few of the major processing industries had analytical equipment to determine mycotoxin contamination. The official mycotoxin analytical capabilities were extremely limited. Thus, it was important to establish at least one laboratory that would be able to perform analytical services. The laboratory at the Instituto Nacional Autónomo de Investigaciones Agropecuarias, Estación Experimental Santa Catalina (INIAP) was selected due to the analytical capability already in place and its status as an official institution. The high-performance liquid chromatography (HPLC) system already available in the laboratory was equipped with a fluorescence detector. Other analytical resources needed in the laboratory were also financed by the project. Twelve laboratory technicians were trained in sampling and analysis methodology for OTA and the method for OTA analysis for green coffee beans was validated. Laboratory personnel were trained in validation methodology for other methods. In addition, the training included the use of thin-layer chromatography and rapid methods for OTA analysis. This laboratory is also preparing for ISO 17025.2005 certification. One of the major issues for this laboratory will be long-term sustainability of analytical services. Therefore, the use of the systems and methodology for other commodity analysis, i.e. cocoa beans, was promoted to increase the number of potential samples to be analysed. This laboratory will need to analyse at least 50 samples per month for sustainability. In addition, the major exporters made a commitment to send samples on a monthly basis

and promote the use of the services among the producers that work with them. Since in recent years the coffee industry has had to import green coffee beans to produce soluble coffee, this laboratory can also be used for screening contamination in imported coffee.

Communication materials

Long-term outreach and training were also considered essential for the success of the project. Therefore, brochures with basic information on OTA, GAPs and HACCP, sampling and analysis, and drying technologies were developed, printed and distributed throughout the regions where work was conducted. Posters with general information on mycotoxins and OTA were also printed and distributed. Also, two different radio spots were produced in Spanish and Quechua and were constantly aired in the coffee producing areas. A video explaining basic GAPs and the use of integrated management systems was also produced to ensure continuous training. These materials were an essential tool to raise awareness and multiply the original training efforts.

In addition, in order to increase awareness of issues related to mycotoxin contamination in the food and feed production chains, several technical presentations were made throughout the two years. These presentations involved stakeholders from industry, government and academia. Also, newspaper articles with general information on mycotoxins and the importance of prevention and control were published on several occasions.

Development of a National Action Plan

In order to ensure long-term sustainability of the project and continuation of the effort once it concluded, a concerted National Action Plan was developed. This Plan was developed with the input from the different stakeholders of the coffee production chain and established short-, medium-, and long-term strategies and recommendations to achieve the desired outcomes. Short-term strategies were addressed during the development of the FAO project. In addition, an Official National Commission integrated by all stakeholders in the coffee production chain and coordinated by the Consejo Cafetalero Nacional (National Coffee Council; COFENAC), an official government institution with national representation, was established to provide follow up and support to the Plan.

Conclusions

A continuous effort is needed in order to observe long-term results and improved safety and quality of coffee from Ecuador. However, initial project outcomes show that continuous application and follow-up of the recommendations will help prevent and control not only OTA contamination, but also other contamination issues that might have a direct impact on the safety and quality of coffee and other agricultural products in Ecuador. Table 4 shows results from random sampling and analysis of coffee during the 2006 harvest season in the areas where the project had its major activities.

Although these results are not representative of the whole country and are not statistically conclusive, they can be considered indicators of improved management. However, it will take several harvest cycles to determine not only sustainability of the improved practices, but also replication by other producers and long-term impact throughout the country.

The use of an integrated approach combining good practices and the HACCP methodology throughout the coffee production chain are essential to achieve improved safety and quality. However, more research is needed on a global basis to refine the limits established as critical control points and validate the controls.

The newly equipped laboratory will help analyse products for both domestic and export markets and provide a continuous diagnostic tool to determine mycotoxin contamination issues within the country. Finding mechanisms for the financial support of the laboratory will be essential to continue analytical services and allow for the establishment and validation of other methods. Ecuador does have current technical standards for coffee and enforcement will

Table IV. Results of random sampling and analysis of samples from different regions of Ecuador at the end of the project (not representative of the whole country).

Sample	Moisture (%)	OTA ($\mu\text{g kg}^{-1}$) (HPLC)
1	12.10	n.d.
2	12.7	0.16
3	10.7	0.12
4	11.5	0.10
5	13	0.14
6	12.20	0.15
7	12.00	0.05
8	13.00	0.08
9	13.20	0.12
10	11.00	n.d.
11	11.50	n.d.
12	12.50	0.10
13	12.40	0.17
	Average	0.18

also be important in the effort to improve quality, safety and competitiveness of the whole sector. It will take a joint effort from all players in the coffee production chain to obtain long-term success that will not only increase exports, but also improve the quality of life of the different stakeholders.

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