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Enhancement of coffee quality through the prevention of mould formation

Final Technical Report (Executive Summary)

Background

1. This document contains extracts from the Final Technical Report of the project "Enhancement of coffee quality through the prevention of mould formation", including Part A: Introduction to project approaches and objectives, and Part B: Executive Summary. The report has been submitted by the Project Executing Agency, the Food and Agriculture Organization of the United Nations.

2. The full report (including the Final Management Report and all Annexes) will be distributed on CD-Rom together with a copy of the CD-Rom training tool "Good Hygiene Practices along the coffee chain" at the 96th Session of the Council from 25 to 29 September 2006.

Action

The Council is requested to take note of this report.

Enhancement of Coffee Quality through the Prevention of Mould Formation

This project was funded with grants from the Common Fund for Commodities and the Government of the Netherlands, and support from the European coffee industry.

It was implemented under the supervision of the International Coffee Organization, and executed on behalf of the above by the Food Quality and Standards Service of the Food and Agriculture Organization of the United Nations.

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Project Summary

Project Title:	Enhancement of Coffee Quality through the Prevention of Mould Formation
Project Descriptor:	CFC/ICO/06 and GCP/INT/743/CFC
Project Executing Agency (PEA):	Food Quality and Standards Service, Food and Agriculture Organization (FAO)
Location:	Brazil, Colombia, Côte d'Ivoire, India, Indonesia, Kenya, Uganda, CIRAD (Montpellier), University of Surrey (UK) Ecuador (Project CFC/ICO/25FT)
Starting Date:	13th September 2000 (Disbursement of Authorised Allocation by CFC)
Completion Date:	October 31st 2005 (CFC Funds)[1] October 31st 2005 (Dutch Govt. Funds)[2]
Total Project Cost:	US$6,242,000
CFC Financing (Grant):	US$2,526,000 (under CFC/ICO/02), and US$60,000 (under CFC/ICO/25FT)
Co-financing (Grant):	European coffee industry (ISIC) - US$367,000 Dutch Government - US$1,500,000
Counterpart Contributions:	CIRAD - US$200,000 EMBRAPA (Brazil), Cenicafé (Colombia), CNRA (Côte d'Ivoire), CBI (India), ICCRI (Indonesia), CRF (Kenya), UCDA (Uganda) US$227,000 each (US$1,589,000 total)

[1] CFC funds available for disbursement until 31st May 2006.
[2] Dutch Govt. funds available for disbursement until 31st March 2006.

Part A

Introduction to Project Approaches and Objectives

Sorting fresh cherries, Indonesia

Part A
Introduction to Project Approach and Objectives

1.1 Background

Coffee growing and trade have exceptional importance in the economies of many countries, which are largely dependent upon this commodity for their export earnings, and thus for their social and economic development.

During the late 1990s, several reports on the occurrence of ochratoxin A (OTA) in coffee samples from different origins raised concerns among consumer representatives and national food safety authorities about the health risks to coffee consumers. The reports also indicated that neither roasting nor extraction could completely eliminate the toxin.

These findings led the European Union (EU) authorities in Brussels to consider including coffee among those agricultural commodities for which maximum limits for OTA would be set. Coffee producers, processors and distributors were also concerned about the possible negative consequences of this contamination on the coffee industry and the potentially disruptive impact of maximum OTA limits on international trade. The Codex Committee on Food Additives and Contaminants (CCFAC) emphasised the importance of a risk-based approach to preventing OTA contamination at all stages of the coffee chain through application of good hygiene practices.

An initial response to this problem came from the European Coffee Federation which commissioned a '*Pilot Study on the Prevention of Mould Formation in Coffee*' in 1997. Several coffee producing countries, through the International Coffee Organization (ICO) and the Common Fund for Commodities (CFC), requested the Food and Agriculture Organization of the United Nations' (FAO) assistance in developing and implementing a project to deal comprehensively with the issue of preventing mould growth and OTA contamination in coffee.

The project, '*Enhancement of Coffee Quality through the Prevention of Mould Formation*' became operational in 2000, and activities commenced in 2001. The project, with a total budget of US$6,242,000, was supported by funding from the Common Fund for Commodities (US$2,586,000), the Government of the Netherlands (US$1,500,000) and the Institute for Scientific Information on Coffee (US$367,000), as well as in-kind contributions from project counterpart institutions (totalling US$1,589,000).

FAO was given the responsibility for executing the project and ICO was named as the Supervisory Body. The producing countries directly involved in the project were Brazil, Colombia, Côte d'Ivoire, India, Indonesia, Kenya and Uganda covering all major coffee producing regions. Numerous other coffee-producing countries were also involved in training activities to varying degrees during the course of the project.

1.2 Objectives

The stated overall objective of this project was:

> '...to enhance the quality of coffee thereby impacting positively on the earnings of producers; and to improve production volumes of good quality coffee in producing nations. The improved quality would minimise potential health risk to consumers.'

The principle focus of the project was to prevent disruption in the coffee trade through effective management of OTA contamination of coffee. The main elements of an overall strategy for managing risks of OTA contamination include:

- Improving practices in all aspects of production and handling, based on a sound understanding of where the most important problems lie, so as to minimise contamination;
- Establishing and enforcing appropriate regulations at national and international levels;
- Monitoring of OTA contamination in coffee.

The project therefore sought to enable coffee-producing countries to develop and implement national programmes for the prevention/reduction of mould contamination in coffee that cover the above-listed elements. The specific objectives of the project were:

- Increasing awareness of the need to prevent mould contamination in coffee among decision-makers within the coffee sector;
- Achieving a better understanding of the mechanisms of mould formation and OTA production in green coffee and of the factors affecting them;
- Developing the necessary tools to support effective management of food safety hazards in coffee;
- Building the capacity of operators at all stages of the coffee chain to implement good practices;
- Enabling policy-makers in the producing countries to participate effectively in international deliberations on food safety measures relevant to the coffee sector;
- Strengthening the ability of the main coffee institutions in the producing countries to provide technical support on food hygiene issues related to all aspects of the coffee sector.

1.3 Approach

Achieving the project's objectives required a range of activities that were well coordinated, given the interlinkages among several of them, and also carefully timed in relation to the coffee seasons in each of the participating countries.

Activities were planned and implemented with the full participation of the collaborating national institutions who were responsible for the day-to-day supervision and management of project work at national level.

Situation assessment: The starting phase of the project focused on assessment of coffee production and handling practices in the seven core participating countries so as to inform the planning of training to be provided under the project on hygiene in the coffee chain, and to support planning of field trials and surveys such that they addressed the most important questions related to OTA in coffee.

Within each country, broad stakeholder participation from the public and private sectors was encouraged to facilitate collaboration and consensus among all key partners in implementing national programmes for OTA prevention and quality improvement in coffee.

Field trials: Field trials were designed to investigate the effect of selected processing and production factors on growth of OTA-producers and accumulation of OTA. Many of the trials aimed at developing guidance for improving existing practices in coffee-growing regions. In other cases, the trials examined the feasibility of transferring technologies from one region to another.

Training in good hygiene practices along the coffee chain: Training of Trainers' (ToT) courses on food hygiene principles and their application to coffee handling were the key element of the project strategy for reducing mould contamination by improving handling practices by all operators along the chain. The groups of trainers thus formed at national level were responsible for the development of training and communication programmes to reach all stakeholders. The project also provided guidance and financial support to initiating implementation of national programmes.

Guidelines for reducing mould contamination: An important activity within the project was the drafting of '*Guidelines for the Prevention of Mould Formation in Coffee*' (see Part D). Findings from the field assessments and field trials informed the drafting of these guidelines. They are seen as an important tool for promoting Good Hygiene Practices in all coffee producing countries.

Capacity building at collaborating coffee institutes: A range of activities for building the capacities of collaborating institutions to effectively handle food safety and hygiene issues affecting the coffee sector. These included:

- Direct training on a number of food hygiene issues relevant to the coffee sector;
- Support for strengthening capacities to develop and implement successful national training and communication programmes on coffee safety and quality;
- Training in OTA analysis and provision of equipment for carrying out this work;
- Training in mycological analysis and support for improving facilities for this work.

Socio-economic studies/market chain surveys: The project recognised the importance of ensuring the proposed improvements to practice or to technologies used are feasible in the context in which they are expected to be applied. This required the conduct of targeted studies to assess the feasibility of programmes or policies under consideration by the collaborating institutions to promote mould prevention and quality improvement.

1.4 Explanation of Report Structure

Part C of this report, immediately following the Executive Summary, discusses the field trials that were conducted under the project. This part of the report is sub-divided into twelve Sections. Each of the first eleven of these Sections deal with a group of related experimental trials. The first page or two of each of these Sections explains the reasons for which the trials were conducted and then summarises the main findings and relevance of these. For most readers this will be a sufficient overview of the field trials. The remainder of each of the sections provides a more detailed technical discussion of the trial results.

Section 12 outlines the overall conclusions of all of the trials and indicates areas where further work could contribute to a clearer understanding of OTA accumulation in coffee.

Where it was considered useful, further information related to the trials is provided in the Annexes, all of which are available on the CD-Rom included with this report.

Part D of the report contains the '*Guidelines for the Prevention of Mould Formation in Coffee*' which have been informed by the findings of the experimental work discussed in Part C.

Part E presents an overview of the socio-economic studies and market chain surveys conducted during the project, highlighting their relevance to the process of planning national programmes for mould prevention and coffee quality improvement. Full reports of the studies and surveys that were commissioned under the project and discussed in this part of the report are also provided as Annexes on the enclosed CD-Rom.

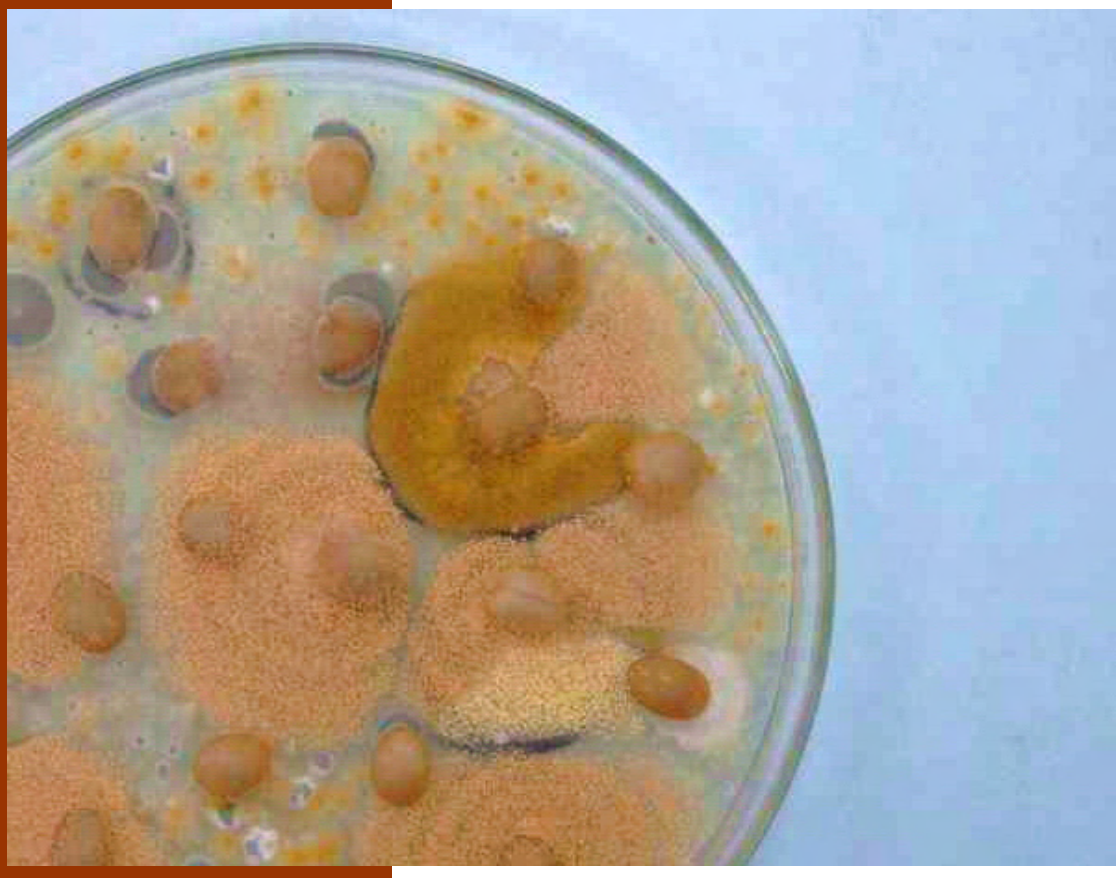
Part F reports on the capacity building and training activities carried out under the project covering food hygiene, OTA analysis and mycological analysis.

Part G shows how the training and capacity building discussed in Part F, and the studies and surveys outlined in Part E, should be utilised by the concerned national institutions to achieve improved management of hygiene and quality in the coffee chain. It also outlines the main findings of reviews of national systems of coffee quality and safety control that were conducted in three of the participating countries providing recommendations for improving these systems.

Part H states the overall project conclusions and recommendations.

In addition to this Final Technical report, the Project Executing Agency has also prepared a Final Management report. A copy of this report is also included on the enclosed CD-Rom.

Part B Executive Summary



Colonies of *Aspergillus ochraceus* and other *Aspergillus* spp. cultured in a petri dish

Part B
Executive Summary

1.1 Background

Coffee production has exceptional importance in the economies of many sub-tropical countries, some of which are dependent upon trade in this commodity for their export earnings. Over 90% of global coffee production takes place in the South, and it is estimated to directly involve over 25 million families worldwide.

In the late 1990s reports emerged concerning the occurrence of a mycotoxin, ochratoxin A (OTA), in coffee from various origins. This raised concern amongst consumer representatives and national food safety authorities over the potential health implications of drinking coffee, and among coffee-producers, processors and distributors over the possible negative consequences of OTA contamination in coffee on trade.

This situation led a number of coffee-producing countries to request the Food and Agriculture Organization of the United Nations' (FAO) assistance in developing and implementing a 'global' project to address prevention of mould growth and OTA contamination in coffee.

The resulting US$6.2m global project ('*Enhancement of Coffee Quality through the Prevention of Mould Formation*'), supervised by the International Coffee Organization (ICO) and funded by the Common Fund for Commodities (CFC), the Government of the Netherlands and the coffee industry, was implemented between 2000 and 2005.

The project focused on building the capacity of coffee producing countries to develop and implement national programmes for the prevention/reduction of mould contamination in coffee through field investigations and training in relevant disciplines. Seven major coffee-producing countries were directly involved in the project: Brazil, Colombia, Côte d'Ivoire, India, Indonesia, Kenya and Uganda, covering all major coffee-producing regions, and commercially traded varieties.

1.2 Field Trials

The basic requirements for OTA contamination of coffee are known and were known before the start of this project: there must be an active population of OTA-producers and adequate time at a water activity (A_w) level that permits the accumulation of OTA.

The aim of the field trials carried out under the project was to better characterise the conditions that lead to OTA contamination of coffee so that acceptable process controls could be more clearly defined and points of greatest risk along the coffee chain identified.

These trials contributed both to an improved understanding of mould and OTA contamination of coffee, and were also an essential input to developing science-based

recommendations on measures for improving coffee hygiene that are commensurate with the food safety risks involved through all stages of coffee production, handling and processing. Conclusions from the field trials are summarised in Part C, Section 12 of this report, and are not further synthesised in this Executive Summary.

However, it should be noted that some issues require further attention to improve risk-based approaches to preventing OTA contamination of coffee. National bodies or, where possible, collaborative action by groups of producer countries, need to prioritise and act to tackle the outstanding issues in continuing the process that the project initiated.

Findings from field trials under the project point to the following two issues as priority areas for investigation:

- Improving our understanding of the accumulation of OTA in coffee beans during primary production, and
- The association of certain coffee bean defects with OTA contamination.

1.2.1 OTA contamination of coffee during primary production

No correlation of OTA-producing fungi or general mycological load to any horticultural practice could be discerned by surveys undertaken under the project. However, given the finding that OTA contamination in the field is much more common than previously thought, it could be important to design further surveys targeting this aspect.

Aspergillus ochraceus is not uniformly distributed throughout coffee production areas, and there is evidence of greater activity in certain regions. However, there must be some uncertainty about apparent regional distribution patterns, not least because of the question of stability of such patterns from season to season.

Experiments carried out under the project showed that exposure of coffee flowers to spores of *A. ochraceus*, leads to bean infection. Even though this does not amount to proof that the observed field infection of coffee seeds is established via this route, the hypothesis merits further consideration.

Niger group aspergilli are commonly found in stem tissue, fresh beans and fruit. Infection by this group is almost universal in samples of robusta coffee, whether wet- or dry-processed and commonly reaches 100% infection during drying. Most niger group aspergilli in robusta coffee are *A. niger*, *sensu strictu*, and very few isolates of this species produce OTA. It may be that the ubiquity of this organism overcomes the rareness of its ability to produce OTA giving it a more important role in OTA contamination of coffee than previously thought. This needs to be better understood.

Other findings from the mycological surveys that could be of relevance to the question of OTA accumulation in coffee pre- and post harvest are:

- The finding of high levels of infection of *A. carbonarius*, a strong OTA-producing species of the niger group, in a few samples in certain regions. A systematic and rigorous survey to better understand the distribution of this species could be useful.

- The observation by some project collaborators that much of the ochre aspergilli that was isolated from beans proved to be the non-toxigenic species *A. melleus*, normally considered to be a fairly strict soil organism. Competition between the non-toxigenic *A. melleus* and the toxigenic *A. ochraceus* could influence OTA accumulation.

1.2.2 Defects and OTA contamination

Surveys carried out under the project documented instances where most of the OTA in the lot could be attributed to certain defect categories. This association, however, seems to be strictly related to the existence of certain conditions during processing of the coffee.

More work on this is urgently required as there are important implications for risk management measures at national and international levels. A combination of upstream surveys and investigation of OTA development in specific defects under defined situations is required to inform rational decisions about managing food safety risks associated with coffee defects.

1.3 Guidelines for the Prevention of Mould Contamination

The project developed '*Guidelines for the Prevention of Mould Formation in Coffee*' based on assessments of the coffee chain in several producing countries, expert opinion of associated risks of mould growth and mycotoxin contamination at the various stages of the chain as well as on the findings from experimental trials noted above. The guidelines are detailed in Part D of this report.

The guidelines are not intended for the direct use by every stakeholder, rather they aim to provide national authorities with concrete guidance for developing national guidelines or codes of practice specifically tuned to their respective sector given the diversity of practice in each producing country.

These guidelines, and any national guidelines or codes of practice that derive from them, will form the basis of national programmes for the reduction of OTA contamination in coffee. Implementation of national guidelines that promote modern systems of food safety management as opposed to simply informing on good and bad practice will require effective, carefully designed, and well thought out programmes of training by technical support institutions.

1.4 Training in Good Hygiene Practices along the Coffee Chain

The situation at the start of the project was a general lack of awareness of about food hygiene among professionals in the main technical institutes supporting the coffee sector. In most countries the coffee sector has evolved quite separately from the rest of the food sector and the coffee sector institutions were largely uninformed about the handling of food safety issues at national and international levels.

Training of Trainers' (ToT) courses on food hygiene principles and their application to coffee handling were a key element of the project strategy for reducing mould contamination by improving handling practices by all operators along the chain. Training involved over thirty coffee-producing countries, covering a total of over 90% of global coffee exports. Formal and informal feedback at the end of the Training of Trainers' (ToT) courses confirmed that the participants learned a lot from the courses which was directly useful in the execution of their duties.

Project countries have all reported on follow-up training activities. The nature of the follow-up activities depended very much on the existing mechanisms for training and information dissemination at each of the collaborating centres. Project funding was used in the printing of brochures and posters, targeting mainly small holder farmers, to convey simple messages about recommended improvements. However, and importantly, the absence of price incentives in much of the mainstream coffee market hinders uptake of good practices.

More elaborated guidance to several key stakeholders is still required. Support in the design of suitable quality and safety assurance programmes, and training to small-scale operators to apply them, should be provided by relevant institutions. This is not a simple job, but it is the next step that should be taken within coffee-producing countries.

1.5 CD-Rom Based Coffee Hygiene Resource Package

A CD-Rom based coffee hygiene resource tool was developed under the project to assist coffee institutes develop appropriate hygiene programmes. The tri-lingual CD-Rom (English, French and Spanish) has been widely distributed to concerned institutions in all coffee-producing countries and is also available from the project website (www.coffee-ota.org).

The guidance that it provides on training programme development will help training institutes take adequate consideration of factors influencing the 'coffee system' in planning and delivering training.

The CD-Rom will also guide trainers to redefine training objectives and training course content in relation to the new skills and approaches required for modern food safety and quality management in the sector.

1.6 Capacity for Mycological Analysis

At the start of the project, collaborating countries had varying technical capacity in the area of mycological analysis. This ranged from no research experience and no laboratory facilities, to scattered university and governmental facilities through to equipped and experienced, publicly funded, coffee research institutes working in the area of coffee mycology.

The project successfully upgraded the capacity of collaborating institutes to carry out the mycological work essential for completing the field activities. This capacity building included formal training, informal one-on-one training by the international

mycological consultant, as well as financial support for modifications to working areas and provision of materials and equipment.

This enhanced capacity will ensure strengthened scientific support to coffee sectors. A handbook of mycological methods and checklists of materials and equipment required for mycological work are available to other countries interested in strengthening their mycological capacity as a means of delivering concrete guidance on quality assurance and hygiene controls to their coffee sectors.

1.7 Capacity for OTA analysis

The project focussed considerable attention and resources on building capacity at project centres for OTA analysis in coffee. Capacity building activities included provision of equipment and materials, regional and national training courses, study tours to well established laboratories working in OTA analysis, and participation of all collaborators in a series of proficiency testing rounds.

OTA analysis laboratories at all collaborating institutes are now functional utilising official methods of OTA analysis based on TLC and HPLC techniques. Proficiency testing under the project has demonstrated a growing competence among the participating laboratories.

The project emphasised the need for a system of laboratory management that allows accurate results to be reliably obtained and that promotes international acceptance of analytical results. OTA analysis data from monitoring programmes provide essential feedback on the efficacy of prevention measures, and will play a crucial role in deliberations on the need for an International Code of Practice for prevention of OTA contamination, and any future decisions on OTA limits in green coffee.

A model manual on quality assurance for OTA analysis of coffee was developed for the project by LACQSA, of the Ministry of Agriculture, Livestock and Supply in Brazil. The manual is available for use by laboratories in any coffee-producing country interested in improving their analytical services.

Finally, in order to ensure the sustainable impact of capacity building in OTA analysis budgetary provision must be made at the national level for maintenance of equipment and replacement of laboratory consumables. National laboratory staff must regularly undertake OTA analyses to maintain their expertise.

1.8 Participation in International Food Safety Decisions Concerning Coffee

The project has made key stakeholders in the coffee sector aware of the World Trade Organization (WTO) and its role in enforcing rules of international trade. Equally, project counterparts and collaborators are now aware of the importance of Codex Alimentarius texts, and on how to contribute to the formulation of national positions on Codex issues that are relevant to the coffee sector.

Ongoing discussions within Codex to decide upon the need for an international Code of Practice for the prevention of OTA contamination in coffee present an important

opportunity for coffee producing countries to influence the rules that will govern the sector.

ICO obtained observer status in Codex on 20th January 2006 (as a direct result of the awareness-raising activities carried out under this project) and is an ideal forum for developing common positions on issues affecting the coffee sector.

It is important that policy-makers in all coffee-producing countries follow developments on maximum limits being considered for contaminants and residues in coffee by WTO members, in particular the pending decision of the EU on maximum OTA limits for green coffee.

1.9 Improving the Regulatory and Policy Frameworks for Control of Coffee Quality and Safety

Market liberalization, which took place in many coffee-producing in the early 1990s, brought about a profound change in the running of the coffee sector. Many in the coffee sector view with great suspicion any form of control which is considered as being antithetical to principles of market liberalization.

This project has played an important role in ensuring that decision-makers within the coffee sector understand that food safety regulation is not a departure from free market principles but rather a necessary complement to free trade if public health is to be protected.

The project has emphasised non-regulatory measures to promote Good Hygiene Practices, but some investigations undertaken during the project have shown the need for clear regulations and the means for their enforcement. Reviews of national systems for the control of coffee quality and safety under the project revealed many weaknesses in the institutional and legal frameworks that underpin such control. These will need to be addressed, with broad stakeholder input, if national authorities intend to improve and enforce relevant regulations.

In several countries policies and programmes are under consideration or have been recently adopted to support improvement of various aspects of the performance of the national coffee sector, including coffee quality and safety improvement. The project has emphasised the need for better information on the functioning of the sector to support policy and programme development. Market chain surveys carried out under the project provide such information which should be reviewed by collaborating institutes to improve the focus of their technical support to the sector.

Targeted studies were carried out in some of the project countries to assess the feasibility of proposed 'mould prevention and quality improvement' programmes and specific recommendations made to the national authorities in the reports of these studies. The studies show that there are many common issues to be considered by coffee authorities in different countries for example, work in both Uganda and Indonesia points to the importance of well-functioning farmers' groups in achieving sustainable programmes. Guidance from the feasibility studies should be of general interest among producing countries.