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Traceability Manual: Traceability in the Green Coffee Supply Chain



UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

Traceability Manual:
Traceability in the Green Coffee
Supply Chain



UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna, 2013

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Publishing production: English, Publishing and Library Section, United Nations Office at Vienna.

Acknowledgements

UNIDO would like to express its deepest appreciation to the Swiss State Secretariat for Economic Affairs (SECO)* who has provided funds to implement the UNIDO project US/VIE/o8/oo4 “Post WTO Accession Support to Viet Nam—TBT/SPS Compliance Capacity Development Related to Key Export Sectors”, under which the *Traceability Manual—Traceability in Green Coffee Supply Chain* has been prepared and published.

UNIDO would like to thank Dr. Chris Knight, the Project’s International Expert, for his valuable and significant contribution to prepare the *Traceability Manual—Traceability in Green Coffee Supply Chain*.

UNIDO also gratefully acknowledges the cooperation of the following coffee companies in Viet Nam that have provided access to their organizations for the Project’s experts to evaluate and comment on their traceability systems:

Buon Ho Coffee Company; IASAO Coffee Company; Nam Nguyet Coffee Company Ltd; Duc Lap Coffee Company; 49 Coffee Company; 721 Coffee Company; Atlantic Commodities Viet Nam Ltd (ACOM); Buon Ma Thuot Thai Hoa Joint Stock Company; and Daklak 2/9 Import-Export Company Ltd.

*SECO is the federal government’s centre of expertise for all core issues relating to economic policy. Its aim is to ensure sustainable economic growth by putting in place the necessary regulatory and economic policy conditions. Among other things, SECO is responsible for the implementation of the foreign economic policy of the Swiss Government. This policy consists of three pillars: *a)* strengthening of the internal market, *b)* providing market access to foreign market and *c)* inclusion of developing countries into the global market. The latter is the basis for the activities supported in the frame of economic development cooperation. For further information please visit www.seco.admin.ch

Foreword

The *Traceability Manual: Traceability in the Green Coffee Supply Chain* has been prepared as one of the outputs of the UNIDO Project US/VIE/08/004, “Post WTO Accession Support to Viet Nam—TBT/SPS Compliance Capacity Development Related to Key Export Sectors”. The objectives of this project, funded by the Swiss State Secretariat for Economic Affairs (SECO), and conducted over the period July 2008–December 2012, include various activities designed to assist Vietnamese Institutions and exporters meet the demands of foreign markets, including compliance with relevant standards for product quality and hygiene as well as technical regulations in those markets.

The export of agricultural products plays an important role in the Vietnamese economy, remaining as a major component of the country’s goals for economic growth and poverty reduction. Some exporters, however, may be confronted with significant obstacles arising from the requirements of the European Union (EU) food safety regulations.

Consumers worldwide now have access to a wider variety of high quality and quantity of foods than ever before. Other developments in the food trade include a substantial increase in the number of countries engaged in food production and export as well as the internationalization of dietary habits and food tastes. With food being often transported over long distances, the fundamental condition is that food should remain safe and free of adulteration along the supply chain. To ensure consumer safety, the Codex Alimentarius Commission established the Hazard Analysis and Critical Control Points (HACCP) approach as a benchmark in the international food trade. Recently, the International Organization for Standardization (ISO) published the ISO 22000 standard that further defines the requirements of a food management system covering all organizations in the entire food chain.

Clause 7.9 of ISO 22000 requires food producers to establish and maintain a traceability system, which, amongst other purposes, can assist proper recall of products that are not safe. For this UNIDO project, the green coffee sector was chosen as a significant Vietnamese export sector where it would add value to the quality of the supply chain if there was increased awareness of the importance of food traceability in the sector as well as practical advice on how to analyze and improve traceability systems amongst coffee producers.

The project undertook a number of activities to provide such assistance which included:

1. In November 2009, the project’s international food traceability expert conducted training courses on analysis and development of traceability systems in Dak Lak (25 participants) and Ho Chi Minh City (47 participants) to prepare local consultants to conduct initial analysis and development of food traceability systems in the coffee producers sector.
2. Training included on-site evaluation of the traceability systems at seven coffee producers with the trainer acting as mentor to the trainees.
3. UNIDO sent a study group from Viet Nam to Egypt to conduct specialized training in food traceability at the E-Trace centre.
4. The project’s international expert prepared a protocol for use in development of traceability systems in nine coffee producers as well as a code of good practice for such traceability systems in the coffee sector.
5. The project commissioned a national expert to conduct a detailed analysis of the traceability systems of nine coffee producers which volunteered to cooperate with the project. The national

expert also provided each of the nine producers with written reports on the results of these analyses and provided recommendations, where needed, to improve the systems in some producers.

6. The project also provided detailed training on best practice in development of technical regulations and these included inputs to two Vietnamese technical regulations relevant to coffee production and quality.

The results of the above activities, (which provided a very good case-study basis for evaluating the current standards of traceability systems in coffee producers in Viet Nam), were used to prepare this *Manual*. The *Manual* was prepared by the project's international expert, Dr. Chris Knight, and UNIDO acknowledges with thanks his valuable contributions. UNIDO also gratefully acknowledges the cooperation of the following coffee companies in Viet Nam, which provided access to their organizations for the project's experts to evaluate and comment on their traceability systems:

Buon Ho Coffee Company; IASAO Coffee Company; Nam Nguyet Coffee Company Ltd; Duc Lap Coffee Company; 49 Coffee Company; 721 Coffee Company; Atlantic Commodities Viet Nam Ltd (ACOM); Buon Ma Thuot Thai Hoa Joint Stock Company; and Daklak 2/9 Import-Export Company Ltd.

UNIDO hopes that coffee producers in Viet Nam will find this *Manual* of value in evaluating their organizations' food traceability systems and in taking any improvement actions which will assist both production of safe and quality products as well as acceptance of their products' value in both foreign markets and for consumers in Viet Nam.

Dr T. Miyake
UNIDO Project Manager (US/VIE/o8/oo4)
Vienna, December 2012

Preface

Traceability systems are an integral part of food safety management in many countries, including the European Union and Viet Nam, and a legal requirement for food business operations. Traceability is also an important compliance criteria in many standards adopted at all stages of the food supply chain, farm to market, including international standards such as ISO 22000 and private voluntary standards such as GlobalGAP on farm and standards for food producers (traders, processors, etc.) such as the BRC Global Standard Food and International Food Standard.

In addition to meeting legal and market place requirements traceability can also be said to have a number of roles (or benefits) within a food business operation:

- To document the history of the product and/or locate a product in the food and feed chain.
- To help support claims about the products and provide information to customers, e.g. to authenticate origin and assurance claims.
- To assist with the search of the cause of non-conformity and to withdraw and/or recall products if necessary, i.e. to implement corrective actions in order to regain control of the process and deal with any non-conforming product.
- To assist in process control and management, e.g. in stock control, quality control and provide information to who needs to know (regulators and customers).

In general legislation focuses on the “one step back/one step forward” approach or external traceability, whereas international and private voluntary standards also include internal or process traceability. However, none is prescriptive in the way traceability is to be achieved. This presents a number of challenges and it is against this background that this document has been developed.

The guidance given in this document has been developed as part of the UNIDO project Post WTO Accession Support to Viet Nam—TBT/SPS Compliance Capacity Development Related to Key Export Sectors (US/VIE/o8/004). One aim of which was the preparation of a model food traceability manual to assist producers more generally to comply with relevant international standards including compliance with EU Regulation of Food Law (EC) 178/2002.

The text of the document has been illustrated by the use of examples, and specifically case studies in the green coffee supply chain. However, the approach to establishing a traceability system illustrated is equally applicable to other key export sectors.

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Introduction

A. What is traceability?

Traceability is a widely used term, and a broad concept, for which there are many definitions and applications. In practical terms it is about meeting legal requirements and marketplace demands and expectations, as well as implementing internal quality management objectives and improving business performance.

There is no single universally acceptable system of traceability; it depends on many factors including the objective, e.g. assurance of food safety, product quality attribute or product identity, the nature of the product and type of production operation. Although legal requirements and adopted international standards and private voluntary standards often require traceability systems, none is prescriptive in the way traceability is achieved. It is up to the operator to define the scope of the traceability system and how it is to be achieved based on their particular needs. These issues highlight the practical difficulties in establishing and implementing a traceability system in a food business operation such as a farmer, trader or processor of green coffee.

Traceability identifies the path from which a product has originated and to whom it has been supplied, and consists of an inter-linking chain of records between steps in a process operation and/or between different stages in a supply chain. Traceability systems have three basic components:

- Supplier traceability, which enables the source of materials used or handled to be identified (the previous point in the supply chain).
- Process traceability, which enables the identity of raw materials and process or handling records for each lot.
- Customer traceability, which enables to whom product has been supplied to be identified (the next point in the supply chain).

Linked to these basic components of traceability are efficient record keeping and the ability to provide relevant information on request. There are two categories of information relating to traceability:

- External traceability, which relates to product information that an operation receives from suppliers or provides to customers; and
- Internal traceability, which relates to the processing history within an operation.

Most operations within the supply chain cannot readily create traceability throughout the whole supply chain, but each has a role to play in collecting and storing information about raw materials, products and processes under their control.

Traceability is a management tool; it does not make food safe or identify product in its self. Traceability does, however, give the assurance of food safety or identity and allows action to be taken if the product is found to be non-conforming in terms of safety or identity. This *Manual* outlines the general principles and basic system requirements for the design and implementation of a traceability system, with special reference to the green coffee supply chain in Viet Nam.

B. Traceability and legislation

Traceability has a legal framework in many countries including the European Union and Viet Nam. In the EU food law food business operators must be able:

- To identify from whom and to whom product has been supplied.
- To have systems and procedures in place that allow for this information to be made available to competent authorities upon their request.

This requirement relies on the one step back/one step forward approach, i.e. external traceability (see figure 1), and implies that food business operators must be able to:

- Identify from whom product materials has been received (the previous point in the chain);
- Identify the businesses to whom they have supplied products (the next point in the supply chain); and
- Make the information available to the Competent Authorities in a timely manner.

In Viet Nam the Ministry of Agriculture and Rural Development (MARD) “guide to traceability, recall and handling of unsafe agroforestry food products” (Circular No. 74/2011/TT-BNNPTNT) specifies that:

- A food business operator (FBO) must have in place a traceability system with principle of one step back/one step forward to ensure the ability to identify and follow an entity at a specific stage in the chain of production and trading;
- Through traceability systems, the FBO shall have information recorded on suppliers of raw material and recipients of its final products during its operation;
- After each stage of production, a product must be labelled or identified in an appropriate manner to facilitate traceability;

Traceability is defined as “the ability to trace and follow the movement of a food through specified stage(s) of production and trading”. In addition the one step back/one step forward principle means “the responsibility of a FBO to document information to identify producer and/or trader of previous and next stages of the chain of production and trading of an agroforestry food product”.

The requirement for traceability in the food supply chain in Viet Nam is therefore similar to that in the EU in that FBOs are required:

- To be able to identify from whom materials have been acquired (the one step back) and to whom products are supplied (the one step forward); and
- To have systems and procedures in place that allow for this information to be made available upon request.

One point of difference however is that in Viet Nam FBOs must set up a procedure for recall of their unsafe outbound lots in compliance with requirements as stated in circular 74. This is not a specific requirement of EU regulation but is implied in that the objective of the traceability requirements is to be able to assist in targeted and accurate withdrawal of product or recall of product from the supply chain. Recall procedures are however a specific requirement of most private voluntary standards.

The EU and Vietnamese legal requirements do not include internal traceability (see figure 1), i.e. the matching up of all inputs to outputs, which is a feature of international and private voluntary standards. Nor are there any requirements for records to be kept identifying how lots are split and combined within an operation to create new products or lots.

The EU and Vietnamese legal requirements apply to any FBO that trades in food at all stages of the food chain from farm to market including importers. The requirements do not extend to food business operators outside the EU or Viet Nam.

As a general rule the one step back/one step forward (i.e. external traceability) approach is a general principle that is applied in food legislation in many countries. It is also a recommendation of Codex. For example, where traceability/product tracing is a tool within a food inspection and certification system, this should be able to identify at any specified stage of the food chain from where the food came (the one step back) and to where the food went (the one step forward). Codex defines traceability/product tracing in this context as “the ability to follow the movement of food through specified stages of production, processing and distribution”.

C. Traceability and international standards

Traceability may be managed as part of a formal business management system, for example the international series of standards for Quality System Management (the ISO 9000 series). ISO 9001:2008 specifies management system attributes including in the section on production and service provisions requirements for identification and traceability and preservation of product. This states that where appropriate, the organization shall identify product by suitable means throughout product realization and, where traceability is a requirement, the organization shall control the unique identification of the product and maintain records.

Traceability is also a constituent part of the ISO 22000 standard (food safety management systems—requirements for any organization in the food chain). ISO 22000:2005 specifies requirements for a food safety management system where an organization in the food chain needs to demonstrate its ability to control food safety hazards in order to ensure that food is safe at the time of human consumption. It is applicable to all organizations, which are involved in any aspect of the food chain. There is a specific requirement for traceability, which covers the establishment and application of a traceability system that enables the identification of product lots and their relation to batches of raw materials, processing and delivery records. This implies a combination of the “one up/one down” approach (external traceability) plus internal traceability (figure 1).

Traceability systems attributes are also specified in ISO 22005:2007, which outlines the principles and specifies the basic requirements for the design and implementation of a food and feed traceability system. As such it covers the management system attributes of a traceability system. As with ISO 9001 and ISO 22000 it does not specify how traceability is to be achieved. It does however imply that traceability should include external and internal traceability plus appropriate record keeping.

D. Traceability and private voluntary standards

There are many private standards which apply to specific sectors in the food chain or product types. Most, if not all, have provisions relating to product identity and traceability.

The GlobalGAP standard which is applied to the primary production sector (crops, livestock and aquaculture) has control points relating to traceability. For example the Crops Base module requires that “GlobalGAP registered product is traceable back to and be able to be traced from the registered farm ...where it has been grown”. The associated compliance criteria also states that “registered product is traced back to ...tracked forward to the immediate customer... harvest information must link a batch to the production records...produce handling must also be covered if applicable”. Similar provisions are also required for animal and aquaculture production but taking account of specific additional provisions in relation to identity, etc.

There are also standards that are adopted by food and feed business operations including processing and manufacturing. The BRC Global Standard for Food Safety for example requires that “the company shall have a system in place to identify and trace product lots and follow through all raw materials, all stages of processing and the distribution of the finished product to the customer in a timely manner”.

Similarly, the International Food Standard (Standard for Auditing retailer (and Wholesaler) Branded Food Products) requires that “the organization shall establish a traceability system, which enables the identification of product lots and their relation to batches of raw materials, primary and consumer unit packaging materials, processing and distribution”.

The Global Food Safety Initiative (GFSI) benchmarks existing food standards against food safety criteria. Benchmarking is a procedure by which a food safety-related scheme is compared to the GFSI Guidance Documents such that benchmarked schemes have a common foundation of requirements, including traceability. The requirements for traceability differ for specific sectors of the food chain and reflect the nature of the product type and production operation. In general the requirements focus on the identity and traceability of the material source (one stage back), throughout all production processes, on to internal and external warehousing and the customer (one stage forward), that is internal and/or external traceability.

Similarly the GFSI Global Markets Programme Primary Production specifies that “a traceability system shall be implemented to identify the produce at any stage of production harvesting and distribution”... and that ...“records shall be kept to trace one step back and one step forward in the supply chain”.

E. Traceability in the food supply chain

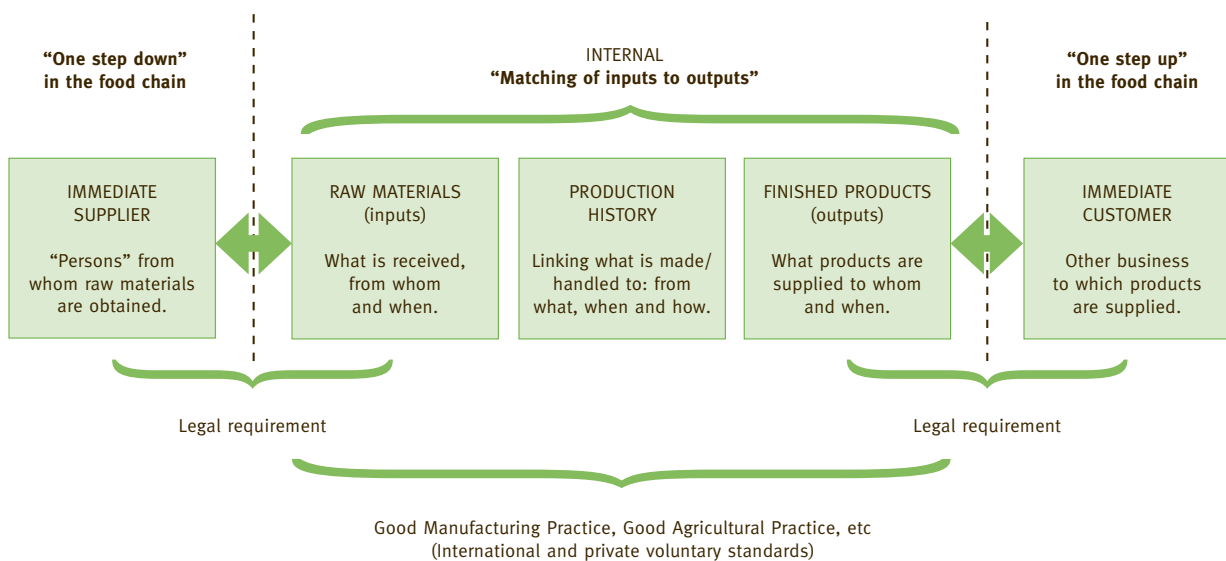
Taking all the requirements described above into account, that is as required by legislation and adopted international or private standards, then the basis of a traceability system in the food supply chain is:

- Identify and trace what is received (one step down external traceability).
- Identify and trace what is made or handled, from what, when and how (internal traceability).
- Identify and trace the delivery destination of supplied product (one step up external traceability).

This is in turn linked to efficient record keeping. Figure I provides a summary of the basic elements of a traceability system as should be applied in the food supply chain. If each stage in the supply chain, including for example food processors and distributors, whole chain traceability can be achieved, where each operation is responsible for the section of the chain under their control.

The food supply chain is a series of separate operations in sequence (farm to market), each linked by the products supplied to them from the preceding operation (the one step back or down) and the products they supply to the next operation (the one step up or forward). Each operator in the chain records information which links the separate operations with their own traceability system and provides whole chain traceability.

Figure I. Basic components of traceability in a food business operation



Source: Campden BRI Guideline No. 60.



1. How to set up a traceability system and conduct a traceability study

A. The traceability system

In Viet Nam guidance for food business operators on setting up a traceability system is given in the MARD Circular 74. This states that a traceability system includes the following:

- Scope of application;
- Procedures for encoding, identification of raw materials, semi-products, final products in whole production chain. Procedure for encoding must ensure to trace back product's data at previous production stage;
- Procedures for recording and documentation;
- Procedures for periodical verification and amendment of the system;
- Procedure for traceability (Who? What? How? When?);
- Responsibilities.

Traceability systems should therefore be underpinned by adherence to legislation and, where appropriate, to adopted international or private voluntary standards. The system approach outlined in this *Manual* is based on these general requirements but adapted to demonstrate good practice for establishing and implementing a traceability system with special reference to the green coffee supply chain. However, the principles of traceability and their application outlined in this manual are applicable to other product sectors and supply chains.

There are four basic components of a traceability system.

- Organize and plan traceability
- Implement traceability
- Ensure effective operation of traceability
- Document and record traceability

When planning a traceability system it is helpful to conduct a traceability study. A typical traceability study comprises seven stages (table 1). These stages include essential preparation activities (stages 1 to 4) and the application and maintenance of traceability (stages 5 to 7).

The terms of reference or scope of the study (stage 1) should clearly define the product, process or specific range of activities, including the product(s) the study applies to, the process the study applies to including the start and end points (and stage in the supply chain), and the specific aspect of production or condition of product that applies. In addition, where the study is supported by other programmes that are relevant to the management of traceability, these should be stated, e.g. recall procedures.

Authority and responsibility for traceability (stage 2) should outline management commitment and responsibility and authority for the development, implementation and maintenance of traceability. The person(s) involved in traceability, including external advisors, and their functions in the organization should be identified. The responsibility and authority for traceability should be maintained over time.

The product should be defined (stage 3) in terms of the key parameters which are relevant to traceability, including for example, the nature or composition, specific product identity attributes, and traceability identification codes used (batch/lot definition and identification).

A clear and detailed flow diagram of the process should be prepared (stage 4) as defined in the scope. The flow diagram should include all the operational steps of the process in the correct sequence. An example of a flow diagram is given in the case study section (chapter 3).

The traceability analysis (stage 5) depicts the traceability system and indicates the traceability control points in an operation. The analysis is systematically applied to all the steps in the process in sequence as defined in the flow diagram (stage 4). In practice this involves asking three questions at each process step.

- What are the identification details referenced (read)?
- What records relevant to traceability are kept?
- What identification codes are transferred to the next step (new or retained)?

The purpose is to identify the traceability identification information that is read at the beginning of the process step and applied at the end, together with the record taken. If in the analysis it is determined that traceability is compromised at a process step and if control of traceability is necessary then the step, process or procedures can be modified to ensure that the appropriate level of traceability is implemented.

Performing test and review activities of the traceability system (stage 6) is similar in many ways to verification of Hazard Analysis and Critical Control Point (HACCP) systems. The aim is to establish procedures for verification to confirm that the system is working effectively. Verification demonstrates conformance (e.g. with stated procedures) and that the traceability system is effective (i.e. traceability objectives are being met). In traceability systems there are two key questions.

- Does traceability work in practice? That is, is there compliance with the traceability system as implemented and is it working in practice?
- Is the traceability system up to date? That is, has there been any change that affects traceability? This will involve a periodic review of the traceability system.

Typical examples of compliance testing are audits or other inspections of procedures and associated records, and testing the system in some way. Testing typically involves selecting a product lot and following production backwards from dispatch to receipt of raw materials or a raw material to finished product, and retrieving and collating associated records within target time frames. It may also include a quantity check or mass balance, that is a reconciliation of the amount of supplied materials against the amount used in the resulting product, taking into account waste and rework. Review on the other hand is the mechanism that drives the vital maintenance of the traceability system, that is keeps it up to date and relevant. There should be a formal scheduled review of the traceability system; typically this should be performed annually. In addition, there should also be a mechanism in place that will automatically “trigger” a review prior to significant changes due to internal or external factors, for example changes to product or process (internal) or legislation or customer requirements (external).

Documents critical to the management of traceability should be in place and controlled and records maintained to provide evidence of traceability (stage 7). There should be a documented traceability plan, the contents of which should contain details relevant to the components of a traceability system and supporting programmes. Record keeping appropriate to the components of traceability should be established, including records generated during the development, implementation, maintenance, compliance testing and review. The procedures should include the identification, collation, storage and retention time for these records. Records include those maintained by computer systems.

Table 1. Stages in conducting a traceability study

Stage 1	Define the scope of the study	The terms of reference of the traceability system should be defined clearly to enable the personnel involved with traceability to focus on the key issues and ensure the traceability system is effective.
Stage 2	Define authority and responsibility	A traceability study will require the collation and evaluation of technical data, and is best carried out by suitably qualified persons with appropriate knowledge and experience of the product and process operation.
Stage 3	Describe the product	A full description of the product(s) under study should be prepared, including defining key identity parameters which relate to traceability where applicable.
Stage 4	Define the process	Prior to the traceability study beginning it is necessary to carefully examine the product/process operations under study and produce a flow diagram around which the study can be based.
Stage 5	Conduct a traceability analysis	Identify and list the traceability attributes; conduct a traceability analysis to determine where identity needs to be read and applied.
Stage 6	Perform test and review activities	The traceability personnel should put into place procedures that can be used to demonstrate compliance with the traceability system and to determine its effectiveness in use.
Stage 7	Establish documentation and record keeping	Efficient and accurate record keeping is essential to the successful application of traceability. It is important for the operation to be able to demonstrate that the traceability system has been implemented and maintained, and that documentation and records have been kept in a way appropriate to the nature and size of the business.

Source: Campden BRI Guideline No. 60.



2. Supporting programmes

A. Management commitment

Before any traceability study begins there must be commitment for the organization's management to provide the necessary resources for the study to be completed and implemented, together with the resources to review and update the study. This commitment must be in place whether it is a large operation with a defined management structure and defined responsibilities, or a small- or medium-sized enterprise where there is more direct involvement by management in the production operations.

Management should ensure responsibilities for traceability have been defined and are understood (stage 2 in conducting a traceability study). As the traceability system will need to be maintained over time it is essential there is ongoing management commitment.

B. Supporting programmes

There are a number of procedures in a food business operation that support, and interrelate with, a traceability system, which underpin the effective operation of traceability. Typically they form part of a Business Management System and are alternately referred to as Good Manufacturing Practice, Good Agricultural Practice, etc. Although not a constituent part of traceability, they nonetheless provide essential supporting activities to ensure the effective implementation and maintenance of traceability. These supporting programmes cover a number of areas including quality management system attributes and personnel. Typical examples include:

- Internal audit - Systems and procedures which cover the requirements of traceability are audited to ensure that they are in place, appropriate and complied with.
- Documentation control—All documents, records and data relating to the management of traceability should be in place and effectively controlled.
- Records—Genuine records should be retained to demonstrate effective control of traceability.
- Corrective and preventative action—Procedures should exist to record, investigate, and correct the cause of non-conformity against procedures which are critical to traceability.
- Management of incidents, product withdrawal and recall—There should be a plan and system in place to effectively manage incidents including product withdrawal and recall procedures.
- Training—Personnel performing work that affects traceability should be demonstrably competent to carry out their activity, through training or work experience.

Recall, for example is an integral part of legislation linked to traceability in Viet Nam. MARD Circular 74 is about traceability, recall and handling of unsafe agroforestry food products. Article 8 states that FBOs must set up a procedure for recall of their unsafe outbound lots and gives examples of where recall will be required. Product recall is defined as “taking measures to remove unsafe product from the chain of food production and trading”. Guidance is given on setting up a procedure for product recall, including testing the plan and approving it, and the procedure for product recall and handling.

C. Product identification

To achieve traceability of food materials within a food business operation or supply chain it is essential to identify the food item concerned and to provide some form of data carrier facility for maintaining identification of these items.

Identification is based on attributing an identifier to a discrete unit (e.g. a separate batch or lot) of materials in a form that can be attached or conveniently accompany that unit through or partly through an operation or supply chain. Where such identifiers are used partly within the chain, other identifiers may be introduced to accompany the entities, part-entities or combined entities as they are processed or handled.

Identification relies upon assigning a unique mark or code based on numbers or alphanumeric strings including exploiting available standards for numbering and identification where applicable. In the food supply chain these are invariably open systems where the identification codes and any additional information relating to the item, such as a batch number, weight, other identification numbers, production or use/sell-by date, adhere to a particular identification convention or standard.

In order to use an identifier for traceability purposes a data carrier is required. This is the physical thing which is attached to, directly marked on or accompanies the item and carries the identification code. Identifiers can either be in human or machine readable form or both. For automated system approaches to traceability, machine readable data carriers are required

A range of data carrier technologies and an even wider range of commercial systems are available to support identification at various level of sophistication, including for example, barcodes (see figure II), radio frequency identification tags (RFID) and smart labels (passive and active devices).

Figure II. Example GS1 128 bar code



A bar code is a machine-readable representation of data. Linear (or one dimensional) bar code data carriers are probably the most prominent and well established data carrier technology. They are used widely in a variety of situations including asset management, manufacturing, retail, warehouse management and distribution, including use in the food sector.

The data carrying part of a linear bar code comprises a number of alternating dark (bar) and light (space) parallel lines of variable width. The bars and spaces are structured to carry data in digital form. The rules by which they are structured, determine the type of bar code and the attributes they exhibit.

The differences between the different bar code types are mainly in the range of characters that they can encode, and the way in which these characters are represented by patterns of bars and spaces. Different bar code types have been developed to accommodate numerical or alphanumeric data, the use of different printing technologies, for higher security of data and for reliability in reading.

Bar codes can be read by optical scanners called bar code readers. Reading bar codes typically involves directing a beam of red light and detecting the light reflected. This is converted into a digital signal from which to determine, through a decoding process, the characters the signals represent.

D. Management of traceability information

There are several types of data management in a typical food operation, e.g. transfer, joining and splitting. “Transfer” is the simplest of operations, where product identification is transferred with the product through one or more steps in a process. That is, where the traceability information is retained and the identification is transferred between the process steps. “Joining” is where one process step combines several traceability units each with a unique identification code and a new identification code is established. “Splitting” on the other hand is where a traceability unit is split and used in the production of new traceability units each with a new identity code, for example in different processes, products or customer destinations. Where product is transferred, joined or split it is necessary to ensure that the links are identified and recorded to ensure traceability is maintained.

In addition to the data operations described, the method of recording will depend on the nature of the production operation, including whether it is a batch or continuous operation. Batch operations are where the production operation is carried out on one batch at a time. The batch operation records can provide a direct linkage between the batch process and product produced. A continuous operation on the other hand (e.g. processing of products in a continuously operated line for a defined period) the linkage with the product is based on the particular production run start and finish time, date, etc.

Efficient and accurate record keeping is essential to the successful application of traceability. Traceability records need to be kept in a way appropriate to the nature and size of the operation and need to be organized and retained in good condition to enable easy retrieval. A working traceability system can generate many records. The method of recording may be paper-based or an electronic computerized system (including commercial record keeping system) or a combination of both. The procedures used will depend on the needs of the operation.

Retention and target retrieval time will be another important consideration. The length of time records are retained will depend on the nature of the product, and any legal or commercial requirements. The EU general food law does not foresee a minimum retention period. It is considered that commercial documents are usually retained for a period of five years for taxation purposes. This five year period would, therefore probably meet the requirements of the regulations. However, this common rule would need to be adapted in some cases, for example for perishable, shorter shelf life products.

A traceability system should allow necessary actions to be taken, such as isolation of a non-conforming batch, within an appropriate time frame. There is therefore a need to determine a target time of reaction for traceability data availability. In general food operators are required to have in place systems and procedures to ensure traceability of their products, which implies structured mechanisms to deliver needed information upon request.

The target time for retrieval of traceability data will depend on a number of factors, such as any regulatory requirements and customer expectations and industry norms taking into account the nature of the product and production operation or section of the food chain. This is likely to be measured in hours rather than days, for example between two and 24 hours depending on circumstance and data to be retrieved. It may be that certain critical information should be immediately available and other information may then be made available as soon as reasonably practical, within deadlines appropriate to the circumstances.



3. Case studies

A. Introduction

To demonstrate the application of traceability in green coffee production three case studies are presented. These examples are used to illustrate three scenarios:

1. External traceability systems based on the one step back/one step forward principle to identify what is received (one step back) and where finished product is sent (one step forward), that is to identify the producer and/or trader of previous and next stages in the supply chain.
2. Internal and external traceability systems that link what is received (external one step back traceability) with what is produced (internal process traceability) and where it is sent (external one step forward traceability), that is to trace what product is produced from what materials, when and how and where is it sent.
3. Bar code systems and how these facilitate the traceability and identify what is received (one step back), what is produced (process traceability) and where the product is sent (one step forward).

All three case studies have the same scope or terms of reference and are described below. This is for simplicity and to aid comparison of the different traceability system scenarios.

These examples are not complete traceability systems; they focus on the traceability analysis to illustrate the type of detail that might be read, recorded and applied in a typical green coffee operation. It must be stressed that:

- The details given are for illustrative purposes only;
- The example should not be taken as specific recommendations; and
- The information is not intended for direct use but only as a demonstration of how traceability might be applied in the green coffee supply chain (farm to market).

B. Applicability of case studies

It should be noted that the case studies presented are generic. That is, they represent typical processing operations. It is recognized that actual production operations may vary in practice in terms of the nature of the operations undertaken and the number and type of process steps involved. It is not possible to represent all possible variations in the case studies. However, the application of traceability as outlined in the case studies is applicable to all situations.

The green coffee supply chain also includes farmers and collectors who supply beans to the processors. There is also a diverse range of on-farm activities and green coffee collection scenarios ranging from small farm-by-farm suppliers to large collection groups and potentially multiple intermediary agents or collectors in a supply chain. There are therefore many points in the supply chain where traceability needs to be established. The application of traceability as exemplified by the case studies presented is equally applicable to these farming and collection operations. In terms of traceability each stage in the supply

chain should be able to identify from whom and to whom coffee beans has been supplied even if there is mixing of supplied material before it is supplied to the next point in the chain. This is not a problem in terms of traceability if external traceability can be established—i.e. the inputs and outputs are identified.

The principle is that the farmer, agent, collector or collection group should identify all beans coming into their possession—i.e. from the supplier (preceding stage in the supply chain)—and leaving their control—i.e. to the customer (proceeding stage in the supply chain). In terms of traceability this requires a system that enables beans to be traced one step back/one step forward—i.e. from supplier and to customer be that a farmer, agent, collector or green coffee processor. This is the basis of an external traceability system that is most appropriate for farmers, agents, collectors of collector groups and a typical scenario for establishing traceability is illustrated in the following table.

Table 2. One step back/one step forward

One step back—i.e. details of materials or green coffee beans received into the business			One step forward—i.e. details of beans supplied to another business	
Keep accurate records of:	Keep the name and address of the supplier which the beans have come from; this includes details of farmers and or consignors such as agents or collectors when the beans have not come directly from the farmer.	Keep a note of lot, batch or consignment reference where applicable.	Keep accurate records of:	Keep a note of the date of despatch.
<ul style="list-style-type: none"> • what the product is, • the quantity, • who supplied it and • the date it came in. 			<ul style="list-style-type: none"> • what product you supplied, • to whom you supplied beans, including the name and address of the customer which it is being supplied to; this includes details of consignors such as agents or collectors, • and any lot, batch or consignment reference that is applied where applicable. 	

- It is up to the operator to decide what is classed as a lot, batch or consignment. However, it should be borne in mind that if there is a problem and if the whole production of the business is considered a lot or batch then the whole stock may be considered suspect.
- It is for the operator to decide how they keep and pass on their traceability information. However, traceability can be demonstrated via receipts or commercial documents providing the information contained in the table above is included.
- Traceability records should be kept in a way allowing them to be produced to whoever needs to know without undue delay—e.g. regulatory authorities or customers.

C. Case study scope

Product: Example—green coffee

Process: The processing, storage and packing of green coffee beans. The process is a batch operation based on a production run.

- Start point: Receipt of beans from suppliers, i.e. the previous point in the supply chain
- Finish point: Dispatch of finished product to customer, i.e. the next point in supply chain

Process flow: The sequence of operations (process steps) and product flow is shown in the example in figure III and the steps described in the traceability analysis charts.

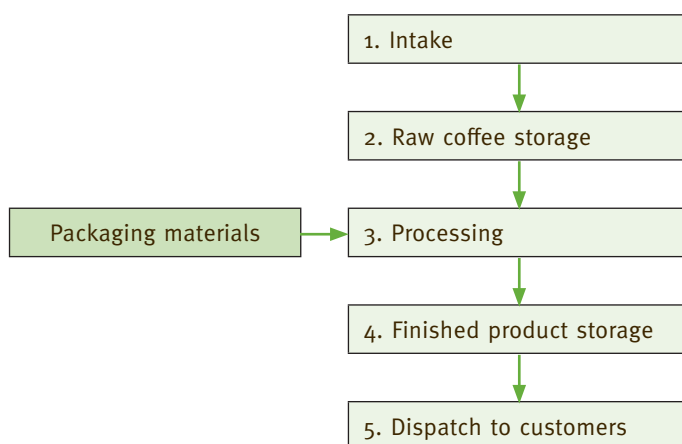
Objectives:

- To support food safety and quality objectives.
- To fulfil legal requirements and customer expectations.
- To document the history and origin of the product.
- To facilitate the search for the cause of non-conformity and the ability to withdraw and/or recall of products if necessary.

In the case studies below the following applies:

- Quantity refers to how many units (sacks/bags) or weight of material
- Type refers to product grade, other quality classification or specification

Figure III. Example process flow for green coffee processing



This process flow and description of the process represents the basics of a typical operation. It is for illustrative purposes only and is not designed to be an accurate representation of a process. The processing step, for example may include a number of discrete operations such as cleaning, de-stoning, grading, sorting and packing. If traceability of the packaging materials used is required then this may be defined in a separate process step.

Case study one: External traceability

This case study illustrates the identification of materials one step back/one step forward, that is to trace where raw materials were acquired from (supplier traceability) and to which customer/organization the products was supplied to (customer traceability).

Traceability analysis

Process operation	Identification read	Recorded information	Identification applied
<p>1. Intake Receipt of inbound coffee beans from suppliers (producers/traders)—previous point in the supply chain—including intake checks.</p>	Suppliers' delivery documentation.	<p>For each lot received the following data is recorded (goods received record):</p> <ul style="list-style-type: none"> Supplier details—name, address, purchase contract Product details—date received, quantity, quality, etc. Intake personnel responsible 	None
<p>2. Raw coffee storage The individual lots received are not identified in store. Product is retained in original packing or as a mixed bulk of different received lots.</p>	None	<p>An up-to-date stock inventory is maintained which records the following data (stock control record):</p> <ul style="list-style-type: none"> the store contents (quantity and type, by number of sacks, or weight) the materials in and out (date, quantity and type) 	None
<p>3. Processing A process run is a batch operation comprising materials from one or more supplied lots, and includes cleaning, de-stoning, grading, sorting and bagging (by grade/type of product). If product is not of the required quality it can be reprocessed.</p>	None	<p>For each process run the following data is recorded (process run record):</p> <ul style="list-style-type: none"> Process run date and time, personnel responsible, etc. input quantity, output quantity, grade, waste, etc. 	None
<p>4. Finished product storage Processed product is stored by type. Individual process runs are not kept separate. <i>Alternatively product is stored in pre-assembled consignment lots ready for dispatch to customers</i></p>	None	<p>An up to date stock inventory is maintained which records the following data (stock control record):</p> <ul style="list-style-type: none"> the store contents (quantity and type, by number of sacks, or weight) the materials in and out (date, quantity and type) 	None
<p>5. Dispatch Packed product is assembled into a consignment lot (e.g. pallet or container) which may be made up of one or more production runs. Loading of transport/containers for onward delivery to customers—next point in the supply chain.</p>	None	<p>For each lot dispatched the following details are recorded (product consignment record):</p> <ul style="list-style-type: none"> Product details—quantity, type Customer details—purchase order, customer destination Dispatch details—transport, date, consignment number 	Product consignment documentation including consignment number

Traceability summary

- Supplier traceability (one step back): information relating to suppliers (previous point in the supply chain) of materials received is linked to the goods received record.
- Process traceability: information relating to products produced from which raw materials what, when and how is not established.
- Customer traceability (one step forward): Information relating to whom product is supplied (next point in the supply chain) is linked to the product consignment record.

This case study represents external traceability only—i.e. the application of the one step back and one set forward approach. It represents the minimum that might be reasonably expected of a business in terms of traceability. It is the simplest to establish, implement and maintain. It does not necessarily meet the requirements of all customers. It may however be suitable as a first step in establishing a full traceability system. It can be reviewed once it is up and running successfully and additional traceability stages implemented—e.g. in terms of establishing internal process traceability to match of inputs to outputs. This would have the advantage of a stepwise approach which may be more cost effective and practical in terms of implementing the associated procedures and record keeping.

Case study two: Internal traceability

This case study illustrates the identification of materials one step back/one step forward, that is to trace where raw materials were acquired from (supplier traceability) and to which customer/organization the products was supplied to (customer traceability), and process traceability, that is what is produced from which raw materials, when and how.

Traceability analysis

Process operation	Identification read	Recorded information	Identification applied
<p>1. Intake</p> <p>Receipt of inbound coffee beans from suppliers (producers/traders)—previous point in the supply chain—including intake checks.</p>	Suppliers' delivery documentation.	<p>For each lot received the following data is recorded (goods received record):</p> <ul style="list-style-type: none"> Supplier details—name, address, purchase details Product details—date and time received, quantity, type Allocated Goods Received Number (GRN) 	Each lot of received beans is identified by a unique Goods Received Number (GRN)
<p>2. Raw coffee storage</p> <p>The individual lots received are held separately in store and identified by the GRN. Product is retained in original packing. If material is mixed as a bulk of different received lots a new GRN is allocated for the mix and a record made of the constituent GRNs.</p>	Goods Received Number	<p>An up to date stock inventory is maintained which records the following data (stock control record):</p> <ul style="list-style-type: none"> the store contents (GRN, type, quantity) the materials in and out (GRN, date, quantity and type) 	The GRN is retained for stored materials, including part used lots.
<p>3. Processing</p> <p>A process run is a batch operation comprising materials from one or more supplied lots, and includes cleaning, de-stoning, grading, sorting and bagging (by grade/type of product).</p> <p>If product is not of the required quality it can be reprocessed.</p>	Goods Received Number (or PPN for materials being reworked)	<p>For each process run the following data is recorded (process run record):</p> <ul style="list-style-type: none"> Process run date and time, personnel responsible Input GRN/PPN, quantity, type Output quantity, type, allocated processed product number (PPN) 	Product from each process run is identified by a Processed Product Number (PPN).
<p>4. Finished product storage</p> <p>Processed product is stored by PPN. Individual process runs are kept separate.</p> <p><i>Alternatively product is stored in pre-assembled consignment lots ready for dispatch to customers.</i></p>	Processed Product Number	<p>An up to date stock inventory is maintained which records the following data (stock control record):</p> <ul style="list-style-type: none"> the store contents (PPN, quantity and type) the materials in and out (PPN, date, quantity, type) 	The PPN is retained with the stored materials including part used lots.
<p>5. Dispatch</p> <p>Packed product is assembled into a consignment lot (e.g. pallet or container load) by type, which may be made up of one or more production runs (PCNs)</p> <p>Loading of transport/containers for onward delivery to customer destination—next point in the supply chain.</p>	Processed Product Number	<p>For each consignment lot for the following details are recorded (product consignment record):</p> <ul style="list-style-type: none"> Product details—PPN, quantity, type, allocated consignment number (PCN) Dispatch details—purchase order, customer destination, transport (company, vehicle or container number), date 	Each consignment lot is identified by a unique Product Consignment Number (PCN).

Traceability summary

- Supplier traceability (one step back): information relating to from whom materials are received (previous point in the supply chain) is linked to the goods received record.
- Process traceability: information relating to products produced (from what materials, when and how) is linked to Goods Received Number (materials used) and Processed Product Number (processing history).
- Customer traceability (one step forward): Information relating to whom product is supplied (next point in the supply chain) is linked to the product consignment record.

This case study represents full external and internal traceability. It does represent good practice and is consistent with meeting the requirements of international standards and most private voluntary standards. It is based on internationally accepted norms for traceability. It would provide customers with the assurance of traceability required. There is however a need for suitable resources to be provided, including good quality personnel, time for training and development of the system, and potential Improvement activities.

Case study three: bar code traceability

This case study illustrates the use of bar codes to facilitate the identification of materials in a traceability system.

Traceability analysis

Process operation	Identification read	Recorded information	Identification applied
<p>1. Intake</p> <p>Receipt of inbound coffee beans from suppliers (producers/traders)—previous point in the supply chain—including intake checks.</p>	Suppliers' delivery documentation.	<p>For each lot received the following data is recorded (goods received record):</p> <ul style="list-style-type: none"> • Supplier details—name, address, purchase details • Product details—date and time received, quantity, type • Goods Received Number (GRN) and copy of bar code 	Each lot of received beans is identified by a unique Goods Received Number and labelled with a GRN bar code
<p>2. Raw coffee storage</p> <p>The individual lots received are held separately in store and identified by the GRN and bar code. Product is retained in original packing. If material is mixed as a bulk of different received lots a new GRN and bar code is allocated for the mix and a record made of the constituent GRNs.</p>	Goods Received Number and bar code.	<p>An up to date stock inventory is maintained which records the following data (stock control record):</p> <ul style="list-style-type: none"> • the store contents (GRN, type, quantity) • the materials in and out (GRN, date, quantity and type) <p><i>Stock control is facilitated by the use of the bar code to identify and record stock held and materials in and out.</i></p>	GRN and bar code is retained with stored materials, including part used lots.
<p>3. Processing</p> <p>A process run is a batch operation comprising one or more goods received lots, and includes cleaning, de-stoning, grading, sorting and bagging (by grade/type of product).</p> <p>If product is not of the required quality it can be reprocessed.</p>	<p>Goods Received Number (for new raw materials used in a process run)</p> <p>Processed Product Number (for rework materials used in a process run)</p>	<p>For each process run the following data is recorded (process run record):</p> <ul style="list-style-type: none"> • Process details: date and time, personnel responsible • Input materials: GRN/PPN, quantity, type • Output product: quantity, type, allocated processed product number (PPN) <p><i>Process recording is facilitated by the use of the bar code to identify and record materials used.</i></p>	Product from each process run is identified by a Processed Product Number (PPN) and labelled with the PPN bar code.

Process operation	Identification read	Recorded information	Identification applied
<p>4. Finished product storage</p> <p>Processed product is stored by PPN. Individual process runs are kept separate.</p> <p><i>Alternatively product is stored in pre-assembled consignment lots ready for dispatch to customers.</i></p>	<p>Processed Product Number and bar code.</p>	<p>An up to date stock inventory is maintained which records the following data (stock control record):</p> <ul style="list-style-type: none"> the store contents (PPN, quantity and type) the materials in and out (PPN, date, quantity, type) <p><i>Stock control is facilitated by the use of the bar code to identify and record stock held and materials in and out.</i></p>	<p>The PPN is retained with the stored materials including part used lots and labelled with the PPN bar code.</p>
<p>5. Dispatch</p> <p>Packed product is assembled into a consignment lot (e.g. pallet or container load) by type, which may be made up of one or more production runs (PCNs)</p> <p>Loading of transport/containers for onward delivery to customer destination—next point in the supply chain.</p>	<p>Processed Product Number bar code.</p>	<p>For each consignment lot the following details are recorded (product consignment record):</p> <ul style="list-style-type: none"> Product details—PPN, quantity, type, allocated consignment number (PCN) Dispatch details—purchase order, customer destination, transport (company, vehicle or container number), date <p><i>The consignment record is facilitated by the use of the PPN bar code to identify processed products used in the consignment.</i></p>	<p>Each consignment lot is identified by a unique Product Consignment Number and labelled with a PCH bar code.</p>

Traceability summary

- Supplier traceability (one step back): information relating to from whom materials are received (previous point in the supply chain) is linked to the goods received record and GRN bar code.
- Process traceability: information relating to products produced (from what materials, when and how) is linked to Goods Received Number (materials used) and Processed Product Number (processing history) and GRN and PPN bar codes.
- Customer traceability (one step forward): Information relating to whom product is supplied (next point in the supply chain) is linked to the product consignment record and PCN bar code.

As in the second case study this represents full external and internal traceability, including associated benefits and potential concerns. However, there are additional significant benefits; principally relating to the identification of product lots/batches based on the adoption of international accepted standards and norms that uses readily available and well accepted technologies. The downside however relates to the need for capital expenditure for the equipment and associated software, and potential ongoing maintenance requirements for the bar-coding equipment, software etc.



4. Bar codes

The bar codes are detailed below and are designed to illustrate the type of information that can be encoded. The actual code to be used will depend on the preferences of the organization and the nature of the product and process. In its simplest form each code may be a sequential number against which essential identity information is detailed elsewhere in some form of computer record. In this case study example certain essential details are also encoded in the lot number using an alpha-numeric code. The bar codes and their encoded information are described below.

The bar codes used in this case study are GS1 128 and have been prepared by QUATEST 3, Ho Chi Min City, Viet Nam (www.quatest3.com.vn). Other types of bar codes (“symbolologies”) are available, the choice of bar code system which will depend on the required application, including type of information to be encoded.

Figure IV. Example: Goods Received Number (GRN) bar code



The information encoded in this bar code in figure IV is described below.

Identifier	Description
91	Indicates that the bar code is an internal company code
CAM	Reference code for the producer organisation (e.g. CAM is the designation for Campden)
GRN	Indicates that it is a Goods Received Number
12345	A unique number of a lot of goods received (a sequential number from 00001 to 99999)
YY	Year code (e.g. 12 is year code for 2012)
ABC	Reference code for the supplier of the goods received (e.g. ABC is the designation for Abc trader)

Figure V. Example: Processed Product Number (PPN) bar code



The information encoded in the bar code in figure V is described below.

Identifier	Description
91	Indicates that the bar code is an internal company code
CAM	Reference code for the producer organization (e.g. CAM is the designation for Campden)
PPN	Indicates that it is a Processed Product Number
12345	A unique number of a lot of processed product (a sequential number from 00001 to 99999)
YY	Year code (e.g. 12 is year code for 2012)
ABC	Reference code for the product (e.g. ABC is the designation for product Abc)

Figure VI. Example: Product Consignment Number (PCN) bar code



The information encoded in the bar code in figure VI is described below.

Identifier	Description
91	Indicates that the bar code is an internal company code
CAM	Reference code for the producer organization (e.g. CAM is the designation for Campden)
PCN	Indicates that it is a Product Consignment Number
12345	A unique lot number for a consignment of product (a sequential number from 00001 to 99999) to a specified customer destination
YY	Year code (e.g. 12 is year code for 2012)
ABC	Reference code for the product (e.g. ABC is the designation for product type Abc)
XYZ	Reference code for the origin of the consignment (e.g. XYZ is the designation for Xyz company)



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