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Experiences and challenges in the development of an organic HACCP system

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ABSTRACT

The use of Hazard Analysis and Critical Control Point (HACCP) based quality assurance has a well established place in controlling safety hazards in food supply chains. The work in the Integrated Project QUALITYLOWINPUTFOOD, QLIFWP 6.2 was designed to support the implementation of HACCP systems in the organic food sector. The structure of the organic food supply chain was examined to identify those aspects that are common throughout the food industry and those that require special attention in organic systems. These differences arise during the production and processing stage and in the distribution chain, and are prescribed by organic legislation and standards. Information generated in QLIF WP6.1 (analysis of structures, conduct and performance of supply chains for organic foods in Europe) and the output from COST action organic HACCP provided a background for the production of HACCP protocols. The detail in the protocols was obtained by further examination of the production chain for the six selected commodities by Campden BRI and Agro Eco. The manuals provide up-to-date information on the concept of prerequisite programmes (PRPs) and the different types of control point such as PRP and Operational PRP in addition to critical control points (CCPs). Consideration is also given to the use of HACCP to manage food quality and organic integrity in the supply chain in addition to the management of food safety hazards. The study resulted in six commodity-specific HACCP training manuals that focus on primary production. These have been used to disseminate HACCP knowledge to businesses in the organic food supply chain. The second phase of the work package enabled the information in the training manuals to be disseminated to the organic sector by offering training workshops. The training was arranged at five venues arranged by partner organizations in the QLIF project. The final deliverable of this part of the project was to consolidate the six training manuals into one organic HACCP protocol document that includes updated information from other QLIF work packages and experiences gained from delegates attending the training workshops.

1. Introduction

The use of Hazard Analysis and Critical Control Point (HACCP) based quality assurance has a well established place in controlling safety hazards in food supply chains. It is an assurance system based on the prevention of food safety problems and is accepted by international authorities as the most effective means of controlling food-borne diseases.

The practical implementation of HACCP systems in the food industry is promoted by the Codex Alimentarius Commission [1] and the work of Codex has become the reference for international food safety, including HACCP. The adoption of such assurance systems is a benefit to the international trade in food; this has attained further recognition with the development of International Standard ISO 22000 [2]. This standard combines the quality assurance requirements found in ISO 9000 and the food safety focused components found in a HACCP plan. The ISO 22000 standard emphasizes the role of ensuring that good practice is followed in food businesses, by what is referred to as the prerequisites programme (PRP).

Within Europe, systems based on HACCP principles (as defined by Codex) have been incorporated into the EC Food Hygiene Regulations [3] and also animal feed legislation. In addition, the requirements made on suppliers in the food industry by their customers include a HACCP plan as a fundamental component [4]. Systems based on Codex guidance are a specific requirement for some of these private industry standards. Guidance is available that will assist businesses to comply with these requirements [5].

European organic producers must ensure compliance with Regulation 834/2007 [6], which provides detailed objectives, principles and rules applicable to organic production. Reference to regulations and standards must be made by organic producers to identify

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Table 1
The seven principles of HACCP. *Source*: Codex Alimentarius Commission [1].

Principle 1	Conduct a hazard analysis. *Prepare a flow diagram of the steps in the process. Identify and list the hazards together with their causes/sources, conduct a hazard analysis to determine if the hazards are significant for food safety and specify the control measures.*
Principle 2	Determine the critical control points (CCPs). *A decision tree can be used.*
Principle 3	Establish critical limit(s) *that must be met to ensure that each CCP is under control.*
Principle 4	Establish a system to monitor control of the CCP *by scheduled testing or observations.*
Principle 5	Establish the corrective action to be taken when monitoring indicates that a particular CCP is not under control *or is moving out of control.*
Principle 6	Establish procedures for verification to confirm that the HACCP system is working effectively*; this should also include validation and review activities.*
Principle 7	Establish documentation concerning all procedures and records appropriate to these principles and their application.

N.B. The wording given in italics is not included in the principles of HACCP as documented by the Codex Alimentarius Commission [1] but is included here as additional explanatory notes.

criteria critical to organic compliance such as conversion periods, approved inputs, housing of livestock, inspection by certification bodies and labelling of organic status of outputs from the business.

All food business operations in Europe and all businesses supplying food to a European retailer are required to implement HACCP. It is important to emphasize that this is not a legal requirement in primary production. Crop and livestock producers are required to follow the general principles of food hygiene, and a risk assessed HACCP approach to food safety hazards is encouraged by standards such as GlobalGAP [7]. Increasingly the implementation of HACCP in primary production is seen as best practice as it makes a connection with the systems in place in the food businesses of their customers.

One objective of the work described here is to raise awareness of the role of HACCP as an indicator of a high standard of food safety management for primary producers in the organic sector. This was attained first by preparing guidance documents that describe the steps that must be taken to implement a HACCP system; this was followed by a programme of training offered to advisors and certification bodies.

In addition to training the delegates in implementation of HACCP plans, the role of prerequisite programmes (PRPs) in maintaining the production environment was explained. Also the differentiation between identifying the control required at Critical Control Points (CCPs) and at Operational PRPs (Op PRPs) was developed.

A final component of the training was to introduce the concept of using HACCP as a systematic tool for controlling hazards to food quality or organic integrity in addition to food safety.

2. The HACCP principles

HACCP is a system that identifies specific hazards that adversely affect the safety of the food, and specifies measures for their control. The hazards are usually categorized as biological, chemical or physical. The system consists of seven principles (Table 1).

2.1. Planning stages

Successful implementation of a safety assurance system in a business requires preparation and planning. Guidance is provided by the European Commission [8]. The management must be committed to the need for a HACCP system and must give authority to appropriate staff to initiate and complete a number of planning stages before a hazard analysis can begin.

A team with a good understanding of the production process and final product must be formed; a leader and secretary are required to organize the activities and make records of the decisions made. Technical expertise is needed as well as practical knowledge of the production work undertaken; some skills in HACCP are needed though these may be provided by a consultant with wider knowledge of the application of HACCP to primary producers and food businesses. The study will need to have terms of reference defining the scope of the activities to be included. Appropriate hazards must be identified, defining which biological, chemical and physical safety and/or quality hazards are to be managed by the HACCP plan. The nature of the products of the business must be described and a flow diagram of the production process prepared. The good practice followed by the business necessary to establish good conditions for animal and crop production known as the prerequisite programme should be described.

2.2. Prerequisite programmes

Within a crop or animal production operation there will be many hazards or sources of contamination that are associated with the basic environmental and operating conditions of the production process. There are few if any points in the process where specific action is taken to eliminate or reduce a hazard in the product; control relies on reducing the likelihood of contamination in the first place rather than removing it once the contamination has occurred.

The control of these 'generic' hazards arising from the environment or operating conditions is normally part of good agricultural practice (GAP) or good hygiene practice (GHP). They are a prerequirement to HACCP and should be in place to underpin the HACCP system. Examples of prerequisites would include:

- Appropriate training programmes for staff;
- Preventive maintenance and calibration procedures;
- Established procedures and schedules for cleaning of equipment;
- An effective pest control programme;
- Appropriate control of glass and other foreign bodies.

There may also be instances where hazards that are normally considered 'site-wide' or non-process specific, and thus managed by prerequisite programmes, will need to be included in the HACCP plan at specific process steps. Within ISO 22000 [2] these would be called operational prerequisite programmes (Op PRPs). It may be that many hazards in crop and animal livestock production will fall into this category.

Good agricultural practice (GAP) encompasses all aspects of crop and livestock production, and might assume that all steps in the production process are of equal importance, so that resources cannot be targeted. However, this is often not the case; there are specific points in the process that are more important where control is applied and is necessary in order to prevent the occurrence of a hazard. The HACCP process highlights these critical steps, so that resources can be targeted.

The categorization of control activities into three types reduces the number of CCPs in a process and ensures sufficient focus of attention on specific steps:

(1) The general PRPs or GAP practices are often associated with lower risk hazards and are needed to maintain a hygienic environment,
(2) Operational PRPs are associated with higher risk hazards and are essential to control proliferation of food safety hazards, and
(3) CCPs are essential to eliminate food safety hazards.

Table 2
An example of process step, hazard and cause, and control measures.

Process step	Hazard and cause	Control measures	CCP or Op PRP[a]
Crop harvest	Introduction of food-borne pathogens from people (harvesting staff)	Implementation of personal hygiene standards by supervisors. Training of all staff to ensure understanding of requirements.	Op PRP

[a] CCP: critical control point; Op PRP: operational prerequisites programme.

2.3. Hazard analysis

Hazard analysis (Principle 1) requires the team to identify and list hazards together with the causes, conduct a hazard analysis to determine if the hazards are significant to food safety and specify the control measures.

An important aspect of hazard analysis is the need to accurately define the hazard. Many HACCP practitioners have found it useful to use words to describe the hazard, for example:

- Presence of the hazard (typically used when the hazard is already present in the raw material),
- Introduction of the hazard (used when there is contamination by the hazard from people, equipment or the environment),
- Growth of the hazard (typically used for micro-organisms when they are able to multiply and/or produce a toxin), and
- Survival of the hazard (typically used when a hazard – micro-organism or physical – is not removed by a processed step that should have done so).

Typically, in crop and animal production operations, presence on raw materials and introduction may be the main hazards during the production process, but growth and survival cannot be ignored as potential hazards. There should be a deliberate policy to ensure that all conceivable and realistic hazards are identified.

Control measures in agriculture are predominantly actions associated with the process, for example, policies and procedures such as staff training, pest control, hygiene and housekeeping. Control measures as actions should, however, not be ignored, but are more likely to be associated with specific process steps, for example, drying of grain, chill storage of milk.

See Table 2 for an example of process step, hazard and cause, and control measures.

2.4. Determining Critical Control Points

Critical Control Points (CCPs) are those steps of the process that are essential to prevent or eliminate food safety hazards or reduce them to acceptable levels. The identification of CCPs requires professional judgement and may be aided by the application of a decision tree.

For each process step in the flow diagram the team must determine whether this step is a Critical Control Point for each hazard identified. If not a CCP, the team must determine whether the hazard is fully controlled by the PRP, and if so whether the control is an Operational PRP.

The identification of CCPs may be aided by the use of a decision tree. A number of decision trees have been developed, primarily with the aim of making the sequence of questions more user-friendly. The most widely recognized is the example given by Codex [1].

In general, control measures applied at a CCP require frequent monitoring to ensure that the hazard is controlled effectively, whereas checking of PRPs is limited to ensuring that the control is implemented.

2.5. Critical limits

Having determined all the CCPs the team should then proceed to identify the critical limits for the control measures at each CCP. The critical limit is the value that separates acceptability from unacceptability (e.g., safe from potentially unsafe). Examples of these in agriculture are measurement of time, temperature and moisture content, or visual assessment of product and operational practices.

Some critical limits may be defined in legislation, codes of practice and guideline documents, whilst some may need experimental data to be collected or referenced, or advice from specialists with expert knowledge.

PRPs are not generally accompanied by critical limits, as monitoring focuses on whether the PRP is implemented and complied with, and not on the food safety hazard itself. A common mistake is made when a critical limit is set on the hazard and not the control measure (e.g., no broken glass or numbers of food poisoning organisms). It is usually impossible to monitor such limits or measure them in real time. However, it can be appropriate to set operational limits for PRPs, in particular for the operational prerequisites.

2.6. Monitoring

Monitoring is a planned sequence of observations or measurements of CCP control measures. Monitoring must also be able to detect loss of control at the CCP so that corrective action can be taken to regain control.

Accurate records of the results of monitoring (and checking PRPs) must be maintained. All records associated with monitoring should be signed by the person doing the monitoring. For smaller operations it may be appropriate for the concept of 'exceptional recording' to be followed.

The monitoring system should preferably address four issues: (1) *how* the monitoring is to be carried out, i.e., *what* measurement or observation is being carried out, and *what* record is taken (2) *when* the monitoring is to be carried out, i.e., the frequency the measurement or observation is carried out, (3) *who* has responsibility for carrying out the monitoring, and (4) the *record* to be taken.

2.7. Corrective action

The HACCP team should specify the actions to be taken when the results of monitoring at a CCP show that there has been a failure to meet the critical limit. This could include actions to be taken when monitoring results indicate a trend towards loss of control.

Corrective actions should preferably involve the consideration of:

- the *present*, i.e., what is going to happen immediately in the production operation and how can control be regained, which may include an investigation of what went wrong,
- the *past*, i.e., what is going to be done with the product if it is judged to be non-conforming, that is out of specification in terms of safety and/or quality criteria,
- the *future*, i.e., how to prevent loss of control from happening again in the future,
- *who* is to act and has responsibility and authority for the actions taken, and
- the *record* to be taken.

All lots of product that have been affected by a non-conforming situation should be held or segregated under the control of the business until they have been evaluated. This applies to growing crops and raising livestock as well as to harvested or collected products.

Table 3
An example of monitoring/corrective action.

Process step	Hazard	Control	CCP or Op PRP[a]	Critical limit	Monitoring procedures	Corrective action
Crop harvest	Introduction of food-borne pathogens from people (harvesting staff)	Implementation of personal hygiene standards by supervisors. Training of all staff to ensure understanding of requirements.	Op PRP	Not applicable	Scheduled audit of hygiene standards (procedures and facilities) and staff records (hygiene training and medical screening).	Review hygiene procedures and training needs. Record actions taken.

[a] CCP: critical control point; Op PRP: operational prerequisites programme.

Examples showing monitoring/corrective action are listed in Table 3.

2.8. Verification

Verification procedures are used to demonstrate that the HACCP system is operating correctly and effectively. Verification demonstrates conformance (e.g., with stated procedures) by gathering information that the HACCP system and prerequisites are effective (i.e., safety requirements are being met). Verification should, therefore, examine the entire HACCP system including records.

The contents of the HACCP plan must be validated prior to implementation. The main objectives of validation are to ensure that the hazards identified in the study are complete and correct, and that selected controls are suitable, i.e., hazards can be effectively managed.

In agriculture, validation is most likely to be a documented review of the HACCP plan (i.e., desk-based activity). Confirmation of the effectiveness of the controls relies on the knowledge and experience of the HACCP team and by reference to industry norms and adopted codes of practice and organic standards.

The HACCP team should perform a formal scheduled review of the HACCP system. The frequency of the reviews should be based on a number of factors such as the nature of the product and production operation and its intended use. Typically, this may be performed annually or prior to a crop or livestock production cycle.

2.9. Documentation

Efficient and accurate record keeping is essential to the successful application of HACCP. It is important for the operation to be able to demonstrate that the principles of HACCP have been applied correctly, and that documentation and records have been kept in a way appropriate to the nature and size of the business.

Examples of HACCP documentation include:

- documentation of the system, providing evidence that each of the 7 principles of HACCP have been implemented (e.g., the HACCP plan);
- supporting information, e.g., associated procedures and work instructions, and records (from monitoring, corrective action and verification activities).

It is also appropriate for an organization to consider how a HACCP system can be integrated into the existing operations in order to minimize additional cost and personnel time. This would apply to both existing procedures, such as GAP requirements, and organic record keeping systems that are already in place.

3. The HACCP manuals

The application of HACCP to six different organic production systems was evaluated and documented using the procedures described above. The aim of the manuals is to provide specific guidance on establishing a HACCP system for the production of organic crops and livestock enterprises. The guidance given is drawn from Codex [1], Campden BRI Guideline No. 10 (*HACCP in Agriculture and Horticulture, 2009*) [11], and ISO [2]. The focus is on farm operations for crops and livestock with special reference to food safety issues and quality attributes specific to organic products including organic integrity. The manuals were prepared by staff with agricultural expertise and organic knowledge at Campden BRI and Agro Eco, using HACCP specialists at Campden BRI. The draft documents were reviewed by selected specialists involved in the QLIF project.

Six manuals were produced on the following topics: organic egg production, organic field vegetable production, organic pork meat, organic bread making wheat, organic apple production, and organic milk production.

The manuals were prepared to help growers and advisors in organic agriculture throughout Europe. However, they do not provide a pre-made HACCP plan that is universally applicable. In each situation, the process of developing a HACCP plan must take into account the specific circumstances of the farm and production operation.

The series of manuals considers not only food safety issues but also product quality attributes. Two groups of product quality attributes are distinguished: (1) those that relate to the product, such as physical and sensory attributes, and (2) product integrity issues, which relate to the way the product is produced as specified in organic production standards. Quality attributes and non-compliance with the rules in production standards can be treated as hazards using the same hazard analysis and control principles as used for food safety hazards. However, it is preferable that a clear distinction is made between food safety issues and product quality in a HACCP plan.

There are three sections to the guideline documents. The first section gives a brief description of the stages that need to be considered in sequence to develop a HACCP system in organic production. The second section describes typical hazards in specific production activities, including food safety issues and key product quality attributes, including organic integrity issues. The third section gives a worked example to demonstrate the application of the HACCP technique in an organic enterprise.

Copies of the training manuals were distributed to the course delegates to provide guidance when developing or auditing HACCP plans.

The six manuals were consolidated and updated after the courses were completed, the final project deliverable being an Organic Agriculture HACCP document is published by Campden BRI.

4. The training programme

The dissemination of this specialist HACCP knowledge to the organic sector was attained by arranging a series of training courses, each hosted by partners in the QLIF project. A total of 5 courses were completed and these were attended by a total of 93 delegates. Delegates typically were auditors for certification bodies and advisors

and technical staff from food businesses. The delegates included students taking courses in food or agriculture subjects. For some delegates this was an introduction to HACCP, for others with more experience there was an opportunity to discuss the application of HACCP to organic businesses in more detail.

Delegates were invited to provide comments on the training. This indicated a high level of satisfaction, particularly with the group exercises, during which there was an opportunity to hear how other delegates approached HACCP in their field of work.

The five courses were arranged by using the support of partner organizations in the QLIF project: Marmara Research Centre, Turkey, Agro Eco Wageningen, Netherlands, Campden BRI, UK, FiBL Research Institute for Organic Agriculture, Switzerland and Warsaw University of Life Sciences, Poland.

5. The benefits to the organic sector

The HACCP methodology creates more awareness among primary producers of the whole production chain. For some products, organic primary producers lag behind in terms of quality control compared with their conventional colleagues. Even if they consider their produce superior, they will have to upgrade their quality control especially when they are selling to the same retailers. Although many organic primary producers strive for short supply chains and some prefer to sell directly to consumers, even these producers benefit from a greater awareness about the whole supply chain and the possibilities of a HACCP methodology to avoid hazards.

One of the benefits of this new HACCP approach in organic primary production is that producers learn to use a risk analysis to manage their organic production system. There is currently a discussion within the organic sector about whether the regulation should embrace the current trend of a risk-based approach, with inspection limited to a few 'critical control points' or if it should return to a more complete and global vision and inspection of the whole farming system. Organic inspectors and certifiers already make use of risk analyses, in addition to a more complete checklist that reflects the organic standard, recognizing that the risk analysis makes the inspection much more efficient. Similarly, producers that apply the HACCP methodology will also be more effective in avoiding accidental organic non-compliances.

Although HACCP has already been used in the supply chain after primary production, hazards in the primary production itself were mainly controlled by codes of good agricultural practices. The risk-based approach in the HACCP methodology is likely to be more efficient and probably also more effective in avoiding food safety, quality and organic integrity hazards. How effective and efficient it really is will need to be evaluated after this HACCP methodology has been practised in a number of organic enterprises for a number of years.

The dissemination and publication of the HACCP training materials has increased awareness of the role of HACCP in the organic supply chain. Delegates on the training courses were able to take part in case studies for organic businesses and learn from the tutors and their fellow delegates how to build up a HACCP study. The training emphasized the preparation stages and the steps required to follow the application route to apply the seven HACCP principles. As a result the organic sector will be better prepared to comply with the European food safety regulations.

Delegates with more experience were able to explore the potential use of HACCP to manage the quality and organic integrity of crop and livestock products. This may be exemplified by considering the requirements of organic production and using a HACCP study to record evidence that organic approaches have been followed. For example, it is generally recognized that organic apple production is most successful when the orchard environment includes hedges, wild flower strips and ecological areas that provide biodiversity of flora and fauna and enhance the population of beneficial antagonists for pest control [9]. Details of these environmental features of the orchard environment can be recorded in the HACCP study. Another example may be in organic egg production: laying birds may be permitted to be fed a proportion of non-organic feed in their diet. Record keeping of purchase of feedstuffs will be an essential part of the evidence that the requirements of the organic regulation have been met. Such records will form an integral part of the HACCP study. Further evaluation of the influence of production methods on the quality of organic produce can be found in the Handbook of Organic Food Safety and Quality [10].

The final deliverable of the project was to consolidate the six training manuals into one Organic HACCP protocol document that includes updated information from other QLIF work packages and experiences gained from delegates attending the training workshops. This publication has been published as a Campden BRI guideline document and is available to food businesses in the organic sector, HACCP in Organic Agriculture: A Practical Guide. Campden BRI Guideline No 61 (2009) [12].

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