

HACCP based quality assurance systems for organic food production systems

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Abstract

HACCP provides an effective, logical and structured means of assuring food safety. Although first used in food manufacturing operations, HACCP can be – and, increasingly is – applied to food production and handling operations at all stages in the food chain. This includes the primary production sector. The purpose of this paper is to illustrate how the principles of HACCP can be applied to organic production with special reference to the primary sector.

Introduction

HACCP (Hazard Analysis and Critical Control Point) is a system which identifies, evaluates, and controls hazards which are significant to food safety. The HACCP system is based on seven principles (Codex 2003), and when conducting a HACCP study in organic production the seven principles may be applied in a number of stages. These include essential preparation tasks and establishing the HACCP plan.

A HACCP study can be applied throughout the food chain from primary production to final consumption. Revised EU hygiene legislation, which has in large part applied since January 2006, is based on a number of key measures including: implementation of an “farm to table” approach; and introduction of a HACCP system in all sectors of the food businesses except for the primary sector. In addition, a HACCP approach to food safety is an increasing feature of food industry self regulation, including for the primary sector. Although a HACCP approach to food safety assurance is not a legal requirement in the primary sector, it is increasingly recognised as an effective and logical means for food safety control throughout the food chain, including farming.

An additional consideration for organic producers is to ensure compliance with specific EU regulations which lay down detailed rules for organic production. However, the products of organic origin are also subject to the EU hygiene legislation. In terms of food safety, therefore, there is no difference between organic and conventionally produced food materials. In practical terms food safety hazards in organic production are likely to be the similar whereas market placing attributes may differ. A HACCP approach to food safety assurance is equally applicable to organic as well as other production sectors.

The aim of this paper is to provide a brief description of the stages that need to be considered in sequence to develop a HACCP system in organic production. The focus is on agricultural operations (including crop and animal husbandry, harvesting and post-harvest handling of organic products on farm) with special reference to food safety and organic market placing attributes. The guidance is drawn from the Codex

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Alimentarius Commission (Codex 2003), CCFRA Guidelines Nos. 10 and 42 (Knight & Stanley 2000, Gaze 2003) and the ISO 2200 Standard (ISO 2005).

Planning stages to enable hazard analysis

1. Define the terms of reference

In order for the HACCP study to be developed, implemented and fully effective it is essential that the scope of the study is clearly understood and outlined at the outset. It is necessary to consider factors such as: the study objective; the product and production details; which hazards are to be managed by the study; and the prerequisite programmes (PRPs) that underpin the HACCP study.

All the food safety, and other hazard types under consideration, that are reasonably expected to occur in relation to the type of product and production operations should be identified and recorded. The identification may be based on the experience of the organisation, industry norms and guidance, and legal and customer requirements. The aim is to assess and establish the hazards that are reasonably expected to occur, taking into account the severity of the consequence of occurrence and the likelihood of occurrence.

Tab. 1: Example Food Safety and Quality Issues in Organic Production

Food safety issues †	Quality/market placing attributes ‡
<i>Biological</i> , e.g. food-borne poisoning organisms (E.coli, Salmonella, etc.)	<i>Organic integrity</i> , e.g. compliance with adopted production standards, traceability
<i>Chemical</i> , e.g. food-borne contaminants above prescribed levels (pesticides, mycotoxins, heavy metals, nitrates, etc.)	<i>Visual defects</i> , e.g. blemishes, rots, presentation criteria (size, shape, etc.)
<i>Physical</i> , e.g. food-borne foreign bodies (glass, metal, wood, etc.)	<i>Sensory defects</i> , e.g. colour, flavour, texture

† Agents with the potential to cause an adverse health effect

‡ Attributes with the potential to cause an adverse reaction on the acceptance of the product

In an organic production operation there are few, issues that are specific to the organic product. The food safety issues will be similar to conventional products. Similarly product quality issues will not be significantly different at least in terms of how these are addressed in a HACCP system. For example quality issues such as visual defects or sensory attributes will be specific to the nature of the product and production operation, and are too specific to highlight in this paper. This is the same in non-organic products and production systems, where product quality is a function of the nature of the specific production systems. Examples of typical hazards in organic production are given in Table 1.

The one area where organic products do differ from other production systems is in the market placing attributes, that is in relation to compliance with adopted production standards. For example, free range laying hens have specific requirements in terms of the number of animals per area, the number of animals with access to perch and nest sites. These may be defined as quality attribute hazards in the HACCP system. Similarly conversion period in crop production or animal rearing systems may be a quality hazard that can be addressed in the HACCP system.

Tab. 2: Example Organic Integrity Issues

Animal production	Crop production
<p><i>Free range laying hens</i></p> <ul style="list-style-type: none"> • Indoors: max. 6 birds per m², min. 18cm perch per animal, max. 8 hens per nest • Outdoors: 4 birds per m² • Maximum number of laying hens: 3000 per unit • Provision of maximum of 16 hours light per day • Empty houses after each batch of poultry • Leave outside runs empty for 2 months to allow vegetation to regrow 	<ul style="list-style-type: none"> • 2 years conversion before sowing of crop or 2 years before use of a grass crop • 3 years before harvest for perennial crops • segregation of organic and non-organic areas • use of different varieties in organic and non-organic crops • limits on heavy metals in compost

It is important, therefore that in determining the scope of the HACCP in the Terms of Reference, that careful consideration is given to both food safety and quality attributes. These will be dependant on the nature of the product and production operation. In any event it is desirable to distinguish clearly between safety and quality attributes in the HACCP system. For example the objective of the HACCP system may be stated as covering food safety issues and key quality attributes and where this is to be applied, such as at the point of distribution or consumption. It must be stressed that in terms of how these are addressed in the HACCP system is no different be they food safety or specific quality and market placing attributes. In this paper therefore it is the HACCP system that is described and not hazards which are specific to organic products. Some examples of specific organic quality attributes as they relate to organic integrity are given in Table 2.

2. Select the HACCP team

Depending on the size and nature of the operation, development and implementation of the system should, wherever possible, be undertaken by a team who have adequate knowledge and expertise in order to conduct the study, including the knowledge of the product sector and an understanding of HACCP. It is feasible for one person to develop the system but this individual should have full understanding of the operation, and should wherever necessary seek specialist support or information.

3. Describe the essential product characteristics

A full description of the product(s) under study should be prepared, including defining key parameters which influence the safety and/or quality of the product. For example, a description of the product, production activities, storage and transport conditions and intended use of the product.

4. Define the process

Prior to the hazard analysis beginning it is necessary to define the production process. This will involve careful examination of the process and operations under study and the production of a flow diagram around which the study can be based. In the flow

diagram all the operational steps in a logical sequence should be defined. The flow diagram should provide sufficient technical detail for the study to proceed.

Establishing the HACCP plan

5. Hazards and controls

5.1 Hazard analysis

Using the flow diagram as a guide, all the potential hazards, as defined in the terms of reference, that may be reasonably expected to occur at each step in the process should be identified. This consideration should include hazards that may be:

- present in raw materials used in the production operation, e.g. introduced in stages prior to the operation;
- introduced during the production operation, e.g. from people, equipment or the environment; and
- changed during the production operation, e.g. proliferate or survive a step designed to eliminate or reduce the hazard to an acceptable level.

The role of the hazard analysis is to determine which hazards are of such a nature that their elimination or reduction to acceptable levels is essential to the production of the food product. In practice, the decision process will need to take into account the risk associated with the hazard identification, i.e. the likelihood of the hazard causing an adverse effect taking into account the severity of that effect.

Two approaches are possible in undertaking the hazard analysis. The first is a classical HACCP approach whereby each hazard at each process step is identified in turn. The alternative approach is where hazards in general are identified then considering whether these are linked to specific steps or generic to the process. The latter is perhaps more applicable to the primary sector where few, if any steps, in organic production are specifically designed to eliminate or reduce a hazard to an acceptable level, that is at a Critical Control Point. An example of this approach is given in Table 3.

These approaches to the hazard analysis are applicable to food safety issues and organic product quality attributes. For quality issues it may be mainly a case of either presence of the hazard in the materials used, that is a hazard that has been introduced in previous stages, or introduction in the production operation due to people, equipment or environmental influences. In both these respects organic production is not unique in terms of how the hazard analysis is addressed in the HACCP system. The uniqueness in terms of HACCP comes in the nature of the particular product and production operation.

Tab. 3: Typical food safety and quality hazards in organic production

Hazard descriptor	Significant hazard	Cause or source
Presence on raw materials, inputs, production site (e.g. soil)	Food poisoning organisms	Due to contamination at previous stages (e.g. by supplier)
	Organic integrity is compromised	Due to failure at previous stages (e.g. by supplier)
	Chemical hazards	Due to contamination at previous stages (e.g. by supplier)

Introduction from people at harvest and during post-harvest handling	Food poisoning organisms	Personal hygiene and medical condition of food handlers
	Organic integrity is compromised	Due to people not competent to make decisions or not complying with adopted standards
Introduction from equipment at harvest and during post harvest handling	Food poisoning organisms	Unclean machinery, tools, containers used to handle product
	Organic integrity is compromised	Equipment is not dedicated to organic use, used in the correct sequence or cleaned prior to use for organic materials
Introduction from the environment during production and post-harvest handling	Food poisoning organisms	From pests, domestic and stock animals, farm buildings
	Organic integrity is compromised	Production facilities are not segregated spatially or by time for organic use
Growth of hazards (change of pre-existing hazard) during post-harvest handling	Food poisoning organisms	Due to time and temperature abuse in chill storage
Survival of hazards (change of pre-existing hazard) during post-harvest operations	Food poisoning organisms	Due to ineffective heat treatment, e.g. milk pasteurisation

This is not an exhaustive list of hazards, nor is the risk (likelihood and severity of occurrence) of the hazards the same for different product types or in all production situations.

5.2 Control measures

The next stage is to specify what control measures should be applied for each identified hazard. Controls are actions or activities that are applied to prevent or eliminate a hazard or reduce it to an acceptable level. For practical purposes control measures may be divided into distinct groups: prerequisites (including operational PRPs) and measures applied at Critical Control Points (CCPs).

PRPs and operational PRPs tend to be activities associated with the production process, i.e. policies and procedures that reduce the likelihood of the introduction and/or proliferation of food safety hazards. These activities have an indirect influence on hazards in products. Actions as controls on the other hand are measures that prevent or eliminate food safety hazards or significantly reduce the level in the product, i.e. have a direct effect on hazards in products. These actions may be applied at CCPs. In practice most if not all control measures in an organic crop production operation are PRPs or Operational PRPs. That is, the basis of food safety management in crop production is to minimise the likelihood of introducing and/or proliferation of hazards, as opposed to eliminating or reducing a hazard already present in the crop product.

The hazard analysis determines the appropriate control measures and allows for their categorisation into PRPs or measures applied at CCPs. PRPs that manage the basic environmental and operating conditions underpin the hazard analysis and are identified in the HACCP system as in place, maintained and reviewed. This categorisation of control measures facilitates the application of different management

strategies in respect to monitoring, validation and handling of non-conforming control measures and resulting products.

6. Determine CCPs

For each hazard identified in Stage 5 determine whether the process step is a CCP or operational PRP. The identification of CCPs/operational PRPs requires professional judgement and may be aided by the use of a decision tree.

In practice, there are few if any steps in a primary production operation that are specifically designed to eliminate a food safety hazard or reduce it to an acceptable level, that is at a CCP. There may however be a number of steps where control is applied at a specific step and is necessary to reduce the likelihood of introducing a hazard, that is by an Operational PRP

7. Establish critical limits

For each CCP, the critical limits for the control measures should be identified. The critical limit is the predetermined value for the control measure applied at each CCP, and is the criterion which separates acceptability from unacceptability (e.g. safe from unsafe). It should represent some measurable related parameter that can be assessed quickly and easily in monitoring. It may also be helpful to identify working limits or targets for operational PRPs as these are similar to CCPs in respect of their importance as a control measure at a specific step.

8. Establish a monitoring system

Monitoring is a planned sequence of observations or measurements of control measures. The monitoring system describes the methods which confirm that all CCPs are under control. It also produces a record of performance for future use and should be supported by adequate record keeping. Monitoring must also be able to detect loss of control at the CCP so that corrective action can be taken to regain control.

PRPs and operational PRPs should also be checked to ensure they are effective. It may, therefore, be helpful to establish monitoring systems for these PRPs. In many instances the frequency of checking PRPs will be at a rate below that which is relevant for a CCP.

9. Establish a corrective action plan

If in the process of monitoring, it is found that there is a loss of control, it is important that appropriate action is taken. Corrective actions should aim to bring the production process back under control and deal with non-conforming product where appropriate. It is important that the action taken is logical and rational and should involve a thorough review to determine what necessary action needs to be taken.

If when PRPs are checked they are found not to be effective then appropriate remedial action should also be taken in the same way that corrective action for CCPs is taken.

10 Establish verification procedures

Verification procedures are used to demonstrate compliance with the HACCP system - that is, that it is operating correctly and effectively. Verification demonstrates conformance (e.g. with stated procedures) and 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.

Verification should aim to answer three questions:

- am I doing what I say;
- does the product and process meet the defined criteria; and
- is the HACCP plan up to date.

A periodic review of the HACCP plan should be carried out to ensure it is up to date. Typically this is annual or once a production cycle for primary production. It is essential that the review should consider any changes which affect the HACCP plan or crop production process be these internal or external. In addition, there should be an automatic assessment to determine if a review is required when a change occurs outside the normal review period, such as during crop development.

11. Documentation and record keeping

It is important for the organic production business 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. The key document is the HACCP plan and any associated procedures. Records provide evidence that systems operate as specified. The retention period for documents and records should also be considered and defined.

Discussion

There are no specific rules for the format of a HACCP plan (presentation is a matter of preference). The plan should, however, clearly outline in a logical sequence the process whereby hazards which are significant for food safety are identified, evaluated and controlled. The HACCP plan should provide sufficient technical detail for the study to be effective.

An organisation can focus on having as many control measures as possible managed by PRPs and only a few managed at CCPs, or the opposite. It should be noted that in some operations, no CCP can be identified and control of identified food safety hazards is by PRPs and Operational PRPs. Where this is the case such prerequisites must be defined as part of the HACCP system and verified to ensure their effectiveness. Primary production may be such an operation where no CCP is identified, in this case control of food safety hazards is reliant on PRPs and Operational PRPs.

The HACCP technique is primarily applicable to issues of product safety associated with biological, chemical and physical hazards. There is also an increasing interest in the application of the HACCP technique to identify hazards and control measures associated with quality, that is market placing attributes. The philosophy inherent in the HACCP technique is equally applicable to these food safety and quality issues. However, it is desirable that HACCP is focussed on safety issues, and where quality issues are included a clear distinction between safety and quality is shown.

As stated previously there is little if any difference compared to other product types as to how food safety and quality hazards in organic production are addressed in a HACCP system. The key in an organic HACCP is in clearly defining the hazards, that is in terms of the scope of the HACCP. The significant hazards in an organic production operation will depend on the nature of the production and production

operation. Many food safety issues and product quality attributes (product acceptance criteria including visual and sensory attributes) will be no different, except where there are specific issues which relate to market requirements. The area of most difference will be in terms of the integrity of the production system. These may be defined in the adopted production standard be that based on regulatory requirements or a private organisation's standard.

It is necessary not only to clearly define the hazard but also understand the cause or source of the hazard. This will be important when undertaking the hazard analysis. This will be more straight forward for food safety and product quality attributes such as presentational and integrity criteria but will be more problematic for attributes where the cause is less obvious or understood, in which case the controls and monitoring activities will be less easy to define. Sensory attributes or perceived hazards are a particular case in point. Care should be taken when deciding whether the significance is sufficient or understood to be addressed in the HACCP study.

An effective HACCP system in organic production will take time and resources to develop. However, the benefits that can be derived from an effective system include meeting legal and food safety requirements and customer expectations, and continuous improvement of the management of the production operations. A HACCP approach is an effective (and cost-effective), logical and structured means of providing an organic production food safety control system. The level of sophistication of the HACCP system will depend on the nature and size of the business. A larger business may reasonably be expected to have a more detailed system than a small or medium sized operation.

More detailed guidance including worked examples to demonstrate the application of the HACCP technique in specific production sectors (field vegetables, cereals, apples, eggs, pork and dairy) will be published in due course. For those with an interest in organic food processing a useful Code of Practice which describes the most important requirements for the organic food sector with special reference to food safety and quality has been produced as part of the QLIF project report (Beck 2005).

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