Application of hazard analysis – Critical control point (HACCP) principles to primary production: What is feasible and desirable?

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**Abstract**

We show that the HACCP system is not fully applicable at the primary production level, and that food safety is obtained through the careful implementation of good hygiene practice (GHP) at the farm. Guides to GHP intended at primary productions cover one activity, such as cattle rearing or corn production. Yet most farms have more than one activity. Hazards from one activity can be transferred to another activity, and in general this is not considered in one-activity guides. There is a need therefore for farmers to be able to detect and control such transfers. We suggest a horizontal complement to the Guides to GHP that would consider only the application of the Step 6 and Principle 1 of the HACCP system amended as follows: “List all potential hazards transferred from one activity to another within the farm, conduct a hazard analysis, and consider any measures to control identified hazards”. An outline in two parts is proposed. The first part would help at checking if all generic GHP are in place; the second part would help at disclosing interactions between farm specific activities. Detected hazard transfers could then be controlled with measures that are already described in existing guides. The horizontal complement would benefit from being drafted at the European Community level.

**1. Introduction**

According to Recital 11 of the European Union Regulation on the hygiene of foodstuffs No 852/2004 (EU, 2004), “the application of hazard analysis and critical control point (HACCP) principles to primary production\2 is not yet generally feasible”. Yet according to Article 16, the EU Commission had to “review the experience gained from the application of this Regulation and consider whether it would be desirable and practicable to provide for the extension of the requirements of Article 5 [put in place, implement and maintain a permanent procedure or procedures based on the HACCP principles] to food business operators carrying out primary production”.

Meanwhile, “Food business operators carrying out primary production [...] shall comply with the general hygiene provisions laid down in part A of Annex I and any specific requirements provided for in Regulation (EC) No 853/2004”. The Part A of Annex I describes hygiene provisions (“measures to control contamination” and “measures relating to animal health and welfare and plant health that have implication for human health”) and record keeping requirements.

In 2009, the EU Member States reported on the experience gained from the application of the hygiene Regulations (EU, 2009): “The current food hygiene rules for primary production are generally considered appropriate and adequate for the protection of primary products against contamination”. They added, “Guides to good practice, where available, have proven to be crucial tools to help primary producers to fulfill their obligations”.

In this paper, we will show and explain what makes the HACCP system not fully applicable to the primary production and try to answer the following questions: are the guides to good hygiene

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\2 According to Annex 1 of Regulation EC 852/2004 with respect to hygiene provisions, primary production includes “(a) the transport, storage and handling of primary products at the place of production, provided that this does not substantially alter their nature; (b) the transport of live animals, where this is necessary to achieve the objectives of this Regulation; and (c) in the case of products of plant origin, fishery products and wild game, transport operations to deliver primary products, the nature of which has not been substantially altered, from the place of production to an establishment”.

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practice in primary production as outlined in the European Regulation No 852/2004 (EU, 2004) sufficient to provide the appropriate level of food safety; if not, how could they be complemented?

1.1. The keystone of the HACCP system: the CCP

A critical control point (CCP) is “a step at which control can be applied and is essential to prevent or eliminate a food safety hazard or reduce it to an acceptable level” (CAC, 2003a). The important words in this definition are prevent (to keep from happening), eliminate (to get rid of), and reduce (to bring down). Prevention can be achieved by producing raw materials in conditions where no contamination does occur, or by selecting raw materials or ingredients. Elimination and reduction can be achieved by applying physical or chemical treatments, e.g., heat, ionizing radiations, filtration, high pressure, chemical sterilants or disinfectants.

Hazard control measures are determined at HACCP Step 6 according to Principle 1: “List all potential hazards associated with each step, conduct a hazard analysis, and consider any measures to control identified hazards”. Then, at HACCP Step 7 according to Principle 2, CCPs are chosen where control measures or combination of control measures as determined in Step 6 are essential to prevent or eliminate a hazard or reduce it to an acceptable level. At Step 8 according to Principle 3, critical limits are specified and validated for each CCP. A critical limit is “a criterion which separates acceptability from unacceptability”, “Critical limits should be measurable”. Examples of measurements of often used criteria are given: “temperature, time, moisture level, pH, Aw, available chlorine, and sensory parameters such as visual appearance and texture”.

At HACCP Step 9 according to Principle 4, a monitoring system for each CCP is established: “Monitoring is the scheduled measurement or observation of a CCP relative to its critical limits. The monitoring procedures must be able to detect loss of control at the CCP. Further, monitoring should ideally provide this information in time to make adjustments to ensure control of the process to prevent violating the critical limits”.

Validation has been recently redefined: “Obtaining evidence that a control measure or combination of control measures, if properly implemented, is capable of controlling the hazard to a specified outcome” (CAC, 2008). Validation is “performed at the time a control measure or a food safety control system is designed, or when changes indicate the need for re-validation”. In summary, a CCP requires:

- establishing critical limit(s) for criterion(a) separating acceptability from unacceptability,
- validating the critical limit(s),
- making the measurements that are needed to monitor criterion(a) and timely detect deviations.

Evidently there are CCPs in the realm of food processing for which the HACCP system was initially designed (Hulebak & Schlosser, 2002). For example heat treatments for pasteurization or sterilization can be monitored with measurements of time and temperature validated critical limits. Cooking can be monitored by experienced operators watching the color and/or testing the texture of the food. Water activity (or moisture level) and pH can be monitored with appropriate sensors. Therefore the HACCP system is applicable to food processes including e.g., heating, irradiation, drying, acidifying fermentation or addition of acid.

Yet there are also food operations where there are control measures able to prevent, eliminate or reduce hazards but where these control measures are not associated with measurement of validated critical limits. In other words, there is no CCP in these food operations. Examples are slaughtering, meat cutting, meat mincing, making butter or soft ripened cheese from raw milk, producing smoked fish, making ready-to-eat produce.

Unfortunately, none of the CCPs that are available in the food processing industry can be applied at the farm level in primary production (Sperber, 2005): there is no control measure at the farm that has all the characteristics requested of a CCP as listed above (ability to prevent, eliminate or reduce to an acceptable level, together with the availability of a monitorable measurement, the result of which can be compared to a critical limit). For example, the cooling of milk can be monitored and a critical limit can be set, but it does not prevent microbiological contamination and has no elimination or reduction effect. If the keystone principle of the HACCP system is lacking, the latter is not fully applicable: some “HACCP principles” are relevant (Andersen, 2007; Berends & van Knapen, 1999; Biagi, Nannipieri, Manenti, Signorini, & Girelli, 2006; Boersema, Noordhuizen, Vieira, Lievaart, & Baumgartner, 2008; Horchner, Brett, Gormley, Jenson, & Pointon, 2006; Knight & Stanley, 2007; Leifert, Ball, Volakakis, & Cooper, 2008; Malher & Noordhuizen, 2008; Ward, Fasenko, Gibson, & McMullen, 2006), not all “the HACCP principles”.

1.2. Can food safety be achieved where there is no CCP?

As indicated by the Codex Alimentarius Recommended international code of practice — General principles of food hygiene: “These General Principles lay a firm foundation for ensuring food hygiene and should be used in conjunction with each specific code of hygienic practice, where appropriate, and the guidelines on microbiological criteria. The document [... ] recommends a HACCP-based approach wherever possible to enhance food safety as described in Hazard Analysis and Critical Control Point (HACCP) System and Guidelines for its Application (Annex)” (CAC, 2003b). This makes it perfectly clear that the HACCP system is a tool that can be applied, where this is possible, in addition to good hygienic practices (GHP). In other words, GHP that constitute the foundation for ensuring food hygiene are implemented in the first place in any case, and the HACCP system is a potential add-on in the second place. Because the GHP are applied first, the standard ISO 22000 names them prerequisite programs (PRP): “basic conditions and activities that are necessary to maintain a hygienic environment throughout the food chain suitable for the production, handling and provision of safe products and food safe for human consumption” (ISO, 2005).

The outcome of GHP/PRP is the global reduction of the contaminant load, whether they compromise food safety or food suitability. Yet in some cases the level of hazards can remain too high and unacceptable. This is why the food operator conducts a hazard analysis (HACCP Principle 1) after the GHP/PRP have been put in place and implemented. When a hazard(s) is(are) still identified for which there is(are) no CCP, the ISO 22000 standard recommends establishing operational prerequisite program(s) (oPRP): “PRP identified by the hazard analysis as essential in order to control the likelihood of introducing food safety hazards to and/or the contamination or proliferation of food safety hazards in the product(s) or in the processing environment” (ISO, 2005). The elements of an oPRP are those of a CCP except that no critical limit is required for the control measure(s).

Therefore food safety is achieved thanks to GHP/PRP and oPRP determined through the application of HACCP principles, and where possible through the establishment of CCPs. According to Article 7 of the European Regulation No 852/2004 (EU, 2004) these practices and programs can be detailed in “Guides to good practice for hygiene and for the application of HACCP principles” as regards food processing. Because the guides are so important for achieving food safety, Member States of the European Union “shall encourage
the[ir] development" (EU, 2004). In France alone in December 2010 70 guides were being evaluated by the competent authority (Ministère de l’agriculture, 2011a) and 41 guides were already available (Ministère de l’agriculture, 2011b).

As regards primary production according to Annex 1 of the same regulation, these practices and prerequisite programs can be detailed in “Guides to good hygiene practice”, without oPRP or CCP. That food safety is ensured through the application of such guides is acknowledged in the recent European Report (EU, 2009).

1.3. The guides

In many European countries or at the Community level guides for food business operations centered on one specific activity exist or are in preparation. A few examples are canning, fish smoking, poultry slaughtering, egg incubation, and raw milk collection. Yet other guides concern operations where multiple activities take place simultaneously or sequentially, e.g. catering, pastry making, food retail. These guides account for the interactions, mostly cross contamination, that arise between the production activities.

In France, guides in preparation for the primary productions are centered on one activity, such as growing corn, raising livestock. For cereals and oilseeds for example, the farmer’s work from plowing and sowing to harvest and storage up to shipping is described. A guide for livestock breeding concentrates on animal birth, feeding, milking, etc. Such guides are appropriate for the farms where only the described activity takes place. Nevertheless in farms where there is more than one activity, interactions can occur, which cannot be fully considered in one-activity guides. For example, cross contamination can occur where feed, seed and fertilizer are stored in the same barn, or where there are free range domestic fowls or pets. Farms with more than one activity are the majority in most countries.

We contend therefore that it would be useful for farmers to have a horizontal complement to the guides, focusing on consequences for food safety of interacting activities.

1.4. Horizontal complement focusing on interactions between farming activities

The complement should help the farmer detecting and combating cross contamination that can occur between production activities. The complement should first help establishing that generic GHP/PRP have already been implemented. Then the HACCP Step 6 is the only one that should be followed. Paraphrasing the Codex Alimentarius standard, it reads “List all potential hazards transferred from one activity to another activity, conduct a hazard analysis, and consider any measures to control identified hazards”.3

We therefore suggest the complement would include two parts:

1. Review of the application of generic GHP/PRP already in place.
2. Identification and evaluation of potential hazards which would be linked to interactions between activities.

The appropriate control measures can be found usually in existing specific guides to GHP.

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3 The whole HACCP Step 6 is incorrectly named “Hazard Analysis” in section 7.4 of the ISO 22000 standard.

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1. Environment
   - Surroundings
   - Design and organization of premises and flows
   - Sanitary status of premises
2. Equipment
3. Personnel
   - Health/hygiene
   - Training
   - Toilets
4. Inputs
   - Water
   - Feed, veterinary drugs
   - Fertilizers, drugs for plant pest control, biocidal products
5. Waste
   - Storage
   - Disposal/treatment
   - Waste water
6. Storage and transport
   - Storage
   - Transport
7. Health status
   - Vegetal productions
   - Animal productions
8. Recording/Traceability
   - Vegetal productions
   - Animal productions

1.5. Horizontal complement — part one

The aim of Part One is to help the farmer checking that generic prerequisite programs/GHP is implemented. Thus it contains the following heading and subheadings:

1.6. Horizontal complement — part two

The aim of Part Two is to help the farmer identifying that no hazard arising from one activity could harm the product(s) resulting from another activity. A short list of examples of the most important biological, chemical and physical hazards, their origin (environment, feces) and the food that they can contaminate is first given. Then the farmer is invited to list all farm products and their intended use, where the information on the use is available or where the products are intended to a particular purpose, e.g. baby food. It is important at this step that the list of products is exhaustive. It should include not only those productions that are of economic impact to the farm but also any production intended at home consumption. The farmer is therefore invited to inform the following items: Attention should be paid to productions requiring special care, such as raw milk cheese, raw pork meat preserves, etc.

To help him/her finding any potential transfer of hazard(s) between activities, the farmer is invited to use a table to link

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**Farm products:**
- 1/intended to be sold,
- 2/intended for home consumption

**Intended use**, including the type of food which is being produced from farm product(s)

**Existing Guide(s) to GHP or appropriate documents**

**Hazards** that are identified in the existing Guide(s) to GHP or other documents
sources and targets of contamination and/or a graph to depict all flows within the farm: These flows should be considered on a daily basis. Occasional flows should also be accounted for: seasonal activities, deliveries, expeditions. Transfer from other production sites should not be forgotten, e.g. when the farm belongs to a producers' group or a cooperative.

Finally, when a list of potentially transferable hazard is established, the farmer is invited to examine control measures offered in the Guide(s) or other appropriate document(s), to make a choice and implement them as PRP or even oPRP. He/she is reminded that a given measure can control more than one hazard, and that a combination of control measures can be needed to control a given hazard.

2. First trial

A trial was done to assess the farmers' awareness of the Hygiene Package impact on the primary production, prior knowledge of the Guides, responsiveness to the horizontal complement described above and acceptability of the approach tested. Eight members of the Farm HACCP Working Group selected 14 farms on the basis of their willingness to participate in the study (Fig. 1). The farms had at least two activities (Table 1). The farmers were first informed of the remit of the working group, viz. studying the applicability of the HACCP principles to the primary production. The horizontal complement (available on request to the corresponding author) was then sent a few days before a face to face interview.

The duration of the interviews was limited on purpose to 3 h in order not to disturb the farmer's work, but most often lasted for 2 h. It began with a visit of the farm premises.

2.1. Farmers' reactions to the horizontal complement — part one

The farmers were asked to read the part one of the document, commenting and asking questions.

Three farmers did not adhere to the approach (8, 10, 14, see Table 1). One was unaware of the Hygiene Package. Another reacted by “We are not in a laboratory”.

Two farmers (1 and 3) who did implement good hygiene practices considered the document added nothing to what they already did.

Nine farmers (2, 4–7, 9, 11–13) had a satisfactory level of knowledge and understanding of the issues and vocabulary. Their responses were positive because they were receptive, had a personal reflection on the control of hygiene and were already used to implement some good hygiene practices. Farmer 11 found the phraseology was too theoretical and farmer 12 found the statements were excessive in their writing. Farmer 2 noted that the implementation of good hygiene practices requires time. Farmer 5 showed obvious interest to formalize these practices.

2.2. Farmers' reactions to the horizontal complement — part two

The farmers were first asked to list all farm products and their intended use including those intended at home consumption, to cite existing guides to GHP, charters, contracts or other appropriate documents and lastly to describe shortly the hazards that are indentified in them. All farmers filled in easily the form as regards the list of farm productions. Yet, farmers 8–10 and 14 were not willing or were unable to go further. The fact that farmers mentioned guides or other documents did not imply they had used them. One of them (8) even disagreed with the one he should have used for cheese making.

Then, the farmers were invited to pay attention to specific hazards and hazards associated with interactions between activities within the farm. To do this, two methods were recommended:

(a) draw a map of the farm so as to reflect the flow of hazards;
(b) or complete a proposed table with flow vectors in horizontal lines (air, water, materials, operators, animals, vehicles) and activities in columns, so as to represent the interactions that can exist between the activities by means of arrows showing the direction of each flow.

From the chosen representation of flows and once the interactions were identified, the farmers were invited to think of the list of possible control measures that could be established. Six farmers (1–3, 5–7) preferred using the map and farmers 4, 11–13 preferred filling in the table. The latter ten farmers were able to identify most of the control measures that were needed.

2.3. Analysis

This sample of farmers was small and the duration of the interviews was short but information could nevertheless be drawn. A minority of three out of 14 were refractory to the Hygiene Package. Farmer 9 was persuaded he was already doing well with no specific consideration to GHPs. The others were more or less aware of the implications, and only three had already implemented some GHPs. All these showed interest to the two parts of the

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**Air:** including wind
**Water:** including rain, streams, aerosols
**Matters:** agriculture products that are harvested, stored, transported; seeds, fertilizers, feed, pesticides, etc.
**Persons:** hands and fecal contamination, cough, sneeze, expectorations; hair, clothes, shoes, etc.
**Animals:** livestock, farmyard animals intended at home consumption, pets such as cats or dogs, wild birds and rodents, etc.
**Vehicles:** cars, carriages, trucks, mobile equipment, etc.
Table 1

<table>
<thead>
<tr>
<th>Department</th>
<th>Productions</th>
<th>Reaction to part one</th>
<th>Preferred approach to part two</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ille-et-Vilaine</td>
<td>Poultry, rabbits, cereals</td>
<td>±</td>
<td>map</td>
</tr>
<tr>
<td>Côtes d'Armor</td>
<td>Poultry, feeder-calves, cereals</td>
<td>+</td>
<td>map</td>
</tr>
<tr>
<td>Morbihan</td>
<td>In two sites: turkeys, milk, pigs, cereals (200 ha)</td>
<td>±</td>
<td>map</td>
</tr>
<tr>
<td>Tarn</td>
<td>Honey (800 hives), 1500 ducks in forced feeding with cutting meat plant, cereals</td>
<td>+</td>
<td>table</td>
</tr>
<tr>
<td>Landes</td>
<td>Cereals (60 ha), poultry (high quality label), capons, pigeons</td>
<td>+</td>
<td>map</td>
</tr>
<tr>
<td>Gers</td>
<td>Cereals (140 ha), cereal storage</td>
<td>+</td>
<td>map</td>
</tr>
<tr>
<td>Haute-Garonne</td>
<td>Cereals (365 ha), cereal storage</td>
<td>+</td>
<td>no map or table</td>
</tr>
<tr>
<td>Ardèche</td>
<td>Milk and goat milk (organic production) and a cheese making plant, chestnut trees, goat kids, feeder-calves, poultry</td>
<td>+</td>
<td>no map or table</td>
</tr>
<tr>
<td>Vaucluse</td>
<td>Honey (400 hives), truffles (from specially planted truffle-fields with 450 trees), walnut trees (1 ha), 50 chestnut trees</td>
<td>+</td>
<td>no map or table</td>
</tr>
<tr>
<td>Drôme</td>
<td>Cereals (33 ha), apricots (organic production)</td>
<td>+</td>
<td>map</td>
</tr>
<tr>
<td>Doubs</td>
<td>Milk, beef cattle, cereals</td>
<td>+</td>
<td>table</td>
</tr>
<tr>
<td>Doubs</td>
<td>Milk, young bulls, feeder-calves</td>
<td>+</td>
<td>map</td>
</tr>
<tr>
<td>Doubs</td>
<td>Milk, hens, apples</td>
<td>+</td>
<td>table and map</td>
</tr>
<tr>
<td>Yonne</td>
<td>Honey (120 hives), 10 ha orchard (apples, pears, peaches, nectarines, cherries, plums), 30 ewes</td>
<td>–</td>
<td>no map or table</td>
</tr>
</tbody>
</table>

3. Conclusion

The trial demonstrated low awareness of the Hygiene Package of most interviewed farmers, and lack of awareness of existing guides or the non application of them when they were known. It also demonstrated a global acceptance and understanding of our approach. In the time available, most farmers discovered and applied a new method of thinking and felt it could be useful. The horizontal complement we suggest is quite generic. Its drafting still needs work to make it easier to understand and/or adapted to various contexts within the EU. It will have to be kept simple. It could be a document per se as well as the basis of a common add-on to the guides. To ensure its use throughout the European Community, it could be produced at the Community level.

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References


