

# **The Importance of Quality Assurance and Food Safety in Modern Food Production Systems**

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## **ABSTRACT**

The liberalization of the global trade, and the fact that the consumers in the industrialized countries are more and more demanding food to be not only economical, but also healthy, tasty, safe and sound in respect to animal welfare and the environment, are changing the so far quantity-oriented food production, guaranteeing the nutrient supply for a nation, into an international quality-oriented food market, where commodities, production areas, production chains and brands compete each other.

The competitiveness of food production will soon be more dependent on the reliability of the safety and the quality of the food and acceptability of the production procedures than on quantity and price.

In contrast to the quantity-oriented production that is often subsidized and producers can always sell everything they produce, since it is productivity-driven, quality-oriented production chains are market-driven.

Thus, apart from the steady increase of the national and international standards for food safety and public health, there is a growing influence of the consumer's demands (often completely ignorant of agriculture) on the animal production, its allied industries, advisers, consultants and food animal veterinarians.

All of this means that the agricultural supply of food production is facing remarkable changes in the years to come, which is both challenge and opportunity for food animal producers, packing plants and meat processors as well as for the veterinary profession.

The paper describes the foreseeable changes and their implications on livestock production and which on- and off-farm measures need to be developed and implemented in vertically coordinated supply chains rather than on single farms.

# **THE NEED TO IMPROVE FOOD SAFETY AND TO IMPLEMENT QUALITY ASSURANCE FROM FARM TO TABLE**

## **(The Example of Meat)**

In countries that have implemented a consistent mandatory meat inspection, this classical harvest food safety procedure and the more and more stringent rules for post-harvest food safety measures improving the hygiene standards during slaughter, meat processing, storage and distribution have led to a remarkable decline of meat related food-borne diseases in man. However, although meat inspection and food hygiene have been regarded as sufficient to guarantee safe meat over almost 100 years, new approaches to food safety and meat quality are becoming necessary. There are five major reasons for this need:

- 1.) Despite the generally recognized achievements in making food safer over the decades with the mandatory meat inspection and the principles of food hygiene being the most successful means in protecting the consumer against food-borne health risks, there are still deaths due to food-borne disease in man, e.g. 9000 deaths per year in the USA. Furthermore, the consumer's confidence in the safety of food is decreasing:

It is true that meat has never been as safe as today, but the perception of the risks due to meat is that there are more risks to human health than ever. This general recognition is highly supported by the media. The urban consumer does not differentiate between commodities or diseases so that reports on BSE and E. coli O:157 H:7 do not only have an adverse impact on beef, but on meat in general. The concerns with food safety in meat focus mainly on pathogens, antimicrobial and chemical residues, and hormones.

- 2.) Modern agriculture is contributing to the increase of drug-resistant pathogens in humans, and, thus often being attacked by the medical society and consequently by the public:

The latest and most serious attack is that of the Director General of the World Health Organization (WHO), who stated in his World Health Report 1996: "....Making matters worse are modern types of food production. Antimicrobials are used in meat production to increase growth, but not usually in sufficient amounts to kill microbes. Drug-resistant bacteria are then passed through the food chain to the consumer".

- 3.) Food safety issues can easily become non-tariff trade barriers and are increasingly used as marketing tools, nationally and internationally:

Nationally: Advertisements for meat use food safety concerns more and more often e.g. the grocery chain "Whole Foods Market" in several major cities of the USA advertises: "....Our fresh meat and meat products come from animals raised naturally without hormones and antibiotics...." It is obvious that such statements create new consumer demands and increase the distrust in meat without any safety or high-quality "label".

Internationally: Trade barriers that prevent national meat industries from getting access to international markets are more and more based on food safety

concerns. The Danish salmonella control program throughout the Danish pork industry is successfully used to increase the pork export from Denmark.

- 4.) The consumer has the tendency to ask more and more for fresh and naturally raised (organic) products:

The tendency “back to the farmers’ markets” results in the increasing consumption of food that is not or less processed than branded products with several processing procedures (cleaning, food additives such as preservatives, canning, packaging etc.) prior to marketing. The more fresh or organic the food is, the more is the consumer dependent on the absence of pathogens and contaminants in or on the raw material.

- 5.) The traditional mandatory meat inspection still is indispensable, but unable to control and prevent the emerging food-borne pathogens that nowadays pose risks to human health:

In the days of the so-called classical zoonoses, diseases such as tuberculosis and brucellosis caused both clinical diseases that could be recognized at farm level and lesions that could be recognized during meat inspection at slaughter. The emerging pathogens of today such as *Salmonella*, *Toxoplasma*, *Trichinella*, *Campylobacter* and *Yersinia* are only detectable through targeted monitoring systems, since they do neither cause clinical symptoms in affected animals nor lesions that could be helpful to recognize contaminated carcasses.

## **THE “PRE-HARVEST” FOOD SAFETY AND QUALITY APPROACH**

As outlined above, the majority of the real and perceived reasons for the increased concerns with the safety and quality of meat apply to the pre-harvest area of the food production chain. Furthermore, it is true that the harvest food safety measures (inspection and removing carcasses unfit for human consumption from the food chain) is assuring the consumer’s protection, but they do not prevent the major safety-related defects in the slaughter pig, i.e. they are only quality control at the end of the on-farm production phase.

Industries with long experiences in growing competition initially used quality control to cope with increasing quality standards. The needs to produce and sell high quality products and increase the efficiency of the production process, however, has led to the development of quality assurance systems along production chains. The difference between quality control and quality assurance can be explained as follows:

**Quality control** is the evaluation of a final product prior to its marketing, i.e. it is based on quality checks at the end of a production chain aiming at assigning the final product to quality categories such as “high quality”, “regular quality”, “low quality” and “non-marketable”. Since, at the end of the production chain, there is no way to correct production failures or upgrade the quality of the final product, the low-quality products can only be sold at lower prices and the non-marketable products have to be discarded. Their production costs, however, had been as high as those of the high and

regular quality products. Thus, quality control has only a limited potential to increase the quality and efficiency of a multi-step production procedure.

**Quality Assurance**, in contrast to quality control, is the implementation of quality checks and procedures to immediately correct any failure and mistake that is able to reduce the quality of the interim products at every production step. Thus, the desired high quality of the final product is planned and obtained by conducting:

**Standard Operating Procedures (SOP's)** that guarantee the desired quality of the interim products at every production step.

If an entire production chain is following a written description (handbook) of all SOP's along the entire production chain, the demands for a

**Good Manufacturing Practice (GMP)** are met.

The management approach to long-term success through customer satisfaction, based on the participation of all members of an organization (suppliers included) in improving processes, products, services and the working culture is called:

**Total Quality Management (TQM).**

Examples for quality control versus quality assurance in the area of food safety are:

- the testing of carcasses for residues is quality control, the implementation of residue avoiding production procedures at farm level is quality assurance;
- the testing of meat products for salmonella prior to their marketing and consumption is quality control, the implementation of on- and off-farm salmonella-reducing measures as standard operating procedures is quality assurance.

In food production, where the safety of the produced food has the ultimate priority in the framework of quality, the

**Hazard Analysis Critical Control Point (HACCP)** system is the internationally recognized system to help assure safe food production. HACCP emphasizes prevention in the avoidance of food safety problems. HACCP combines common sense with an evaluation of risks to identify the points along the food production chain, where possible hazards may occur, and then to strictly manage and monitor these points to make sure the process is in control. The HACCP system is made up of three parts:

- 1.) The identification of hazards, and the determination of the severity of the hazard and risks.** These are risks associated with growing, harvesting, processing, distributing, preparing and/or using a raw material or food product. Hazard usually means the contamination, growth or survival of microorganisms related to food safety or spoilage. A hazard can also include dangerous chemical contaminants or foreign objects (glass or metal fragments). Risk is the estimate of how likely it is that the hazard will occur.
- 2.) The determination of critical control points (CCP) required to control the hazard.** A critical control point is a location, practice, procedure or process which can be used to minimize or prevent unacceptable contamination, survival or growth of food-borne pathogens or spoilage organisms, or introduction of unwanted chemicals or foreign objects.
- 3.) Establishment and implementation of monitoring procedures to determine that each CCP is under control.** Monitoring systems must be able to effectively

determine if a CCP is under control. Corrective action must be defined to be used when a CCP monitoring point shows that the system is out of control.

Before developing an HACCP plan for a production procedure, the establishment of SOP's and GMP's is indispensable. Only the combination of these principles provides the possibility to have the correctness and the high standard verified. Verification is the procedure that provides the guarantee to any customer and to the public that the product in question is of the quality the producer is claiming, since it has been produced according to a production procedure that is based on specific GMP and HACCP principles that are documented in a handbook. If the verification is performed by independent agencies, bodies or companies that are accredited by nationally or internationally approved quality assurance organizations, the procedure becomes a **Certification** procedure. There are several systems, one of the leading internationally approved certification procedures is **DIN ISO 9000** (9001 - 9004).

All this means that the traditional mandatory meat inspection and the classical post-harvest food safety measures have a limited potential for further major improvements of the safety and quality of meat. Therefore, additional measures must be taken:

- 1.) Pre-harvest food safety programs implementing the rules of GMP and the HACCP concept at farm level from breeding to the slaughterhouse gate have to be added to the existing harvest and post-harvest HACCP programs. Quality assurance systems throughout the entire food production chain are the precondition for any certification procedure.
- 2.) Governmental food safety programs and market-driven food safety/quality programs must be coordinated.

It is obvious that the potential impact of pre-harvest food safety measures based on the HACCP concept is different depending on the nature of the addressed defect or pathogen. There are different areas in which the defect or pathogen enters the food production chain and the possibility to reduce the risk in question by proper handling and/or cooking prior to consumption are different. In the case of residues, on- and off-farm residue avoidance programs are the only opportunity of prevention, since there is no pre-consumption procedure that reduces the residue-associated risks to human health. In contrast, proper handling and freezing and/or cooking of the final product reduces the risks due to pathogens, but pre-harvest risk-reduction programs can either prevent the contamination of the carcass (*Trichinella* and *Toxoplasma*) or remarkably contribute to minimizing the pathogen-associated risks (*Salmonella*, *Campylobacter*, *Yersinia*, *Listeria*).

Therefore, the targets for intervention measures in the food chain should be prioritized as follows:

- 1.) On-farm residue avoidance programs with consistent record keeping, proper drug use, storage and extended withdrawal times. In general, an overall reduction of antimicrobial substances used in agriculture both for medical and production purposes is necessary. Off-farm residue programs via GMP and HACCP programs

in the supplying feed mills aiming at the prevention of cross-contamination and proper labeling.

- 2.) On- and off-farm programs to develop *Trichinella*-and *Toxoplasma*-free herds, regions, areas and countries with a well-coordinated cooperation between packers, producers, veterinary officers and practitioners, and epidemiologists.
- 3.) On-farm salmonella reduction programs with a statistically justified monitoring, either bacteriologically or serologically, of the salmonella load of the animals supplied for slaughter. Research is still needed to evaluate the risk factors for the introduction of salmonella into herds, to evaluate the feasibility and effectiveness of *Salmonella*-reducing measures. It is also still necessary to evaluate to which extend the recommended pre-harvest salmonella-reducing measures contribute to a measurable *Salmonella* reduction in the final product.
- 4.) On-farm labeling programs to reduce the introduction of *Yersinia enterocolitica*, *Campylobacter jejuni* and *Listeria monocytogenes*. However, more research on the prevalence of these pathogens in swine herds and on the feasibility of control measures is needed.

To reliably decrease the food-borne health risks and to improve the consumer's confidence in food of animal origin, pre-harvest food safety programs should consist of three elements:

- 1.) Implementation of GMP and HACCP programs aiming at reducing food-borne risks to human health at farm level.
- 2.) Implementation of monitoring and surveillance programs at slaughter to determine the frequency of the introduction of food-borne health risks into the food chain identifying the farms of origin and mechanisms to develop incentives for the farming community to reduce these risks. This element is, as a rule, the "trigger" and "modulator" of any pre-harvest food safety program.
- 3.) Implementation of a certification procedure involving independent agencies and persons such as accredited veterinarians and quality consultants.

## **THE IMPLICATIONS OF PRE-HARVEST FOOD SAFETY AND QUALITY ASSURANCE**

The role of the livestock producer is changing from just raising animals to being an indispensable part of the food production chain that supplies a product that is the basis for the production of a wholesome, safe and high quality food product. The food animal practitioner's former focusing at treating diseased animals, then at herd health and productivity will change to focusing at supporting the livestock producer to provide slaughter animals with quality properties that meet the demands of slaughter-houses and meat processors, wholesalers, retailers and finally the consumer. Along with a consistent herd/flock health management, the food animal veterinarian will more

and more be involved in on-farm pathogen control and on-farm residue avoidance programs, monitoring systems and verification procedures.

To take advantage of this development, it is necessary to introduce epidemiological methods for data collection, processing and analyzing into the daily work of the food animal veterinarian. The implementation of information feedback systems is needed to have the management tool at hand that combines data from the slaughter plant (disease-related lesions, quality deficiencies, and monitoring results) with on-farm data on animal health and residues (mortality, morbidity, pathogens, and drug use) and on the performance of the herds of origin.

Once such an information system has been implemented, it is quite easy to deal with any additional food safety/quality data set to address problems such as animal welfare improvement, e.g. the porcine stress syndrome and transport and/or environmental protection measures, e.g. data on antimicrobials in manure and the nutritional use of heavy metals.

Producing animals for the production of **certified high quality and safe** food products will make the livestock producer a competitive, publicly accepted and appreciated component of the food production chain. The food animal veterinarian will play an active role in the process of guiding animal production into becoming a transparent and high quality supply of food production chains.

The implementation of pre-harvest food safety programs using **information feedback systems** will be the major tool to prevent any negative impact of food safety problems on a country's export of food. First, the probability of food-borne risks to human health through meat produced from animals using a pre-harvest food safety approach is lower. Second, if food safety concerns are misused as non-tariff trade barriers, any food production chain using a science-based and transparent pre-harvest food safety program, is much more defensive than the traditional livestock production. Without consistent data on the entire production chain, it is almost impossible to deliver scientific evidence that the production in question is following the standards and guidelines of the FAO/WHO Codex Alimentarius Commission and the OFFICE INTERNATIONAL DES EPIZOOTIES (O.I.E.). However, if it can be proven that the production of the refused food is meeting the internationally approved standards, the "Agreement on the Application of Sanitary and Phytosanitary Measures" - appendix of the Marrakesh Agreement that established the World Trade Organization in April 1994 - will protect the exporting country against the unfair or unjustified use of food safety concerns as non-tariff trade barriers.

The major characteristics of modern food production systems that are organized as described above are:

- 1) vertically coordinated supply chains provide distinct market segments with defined (branded) food products;
- 2) any food product is traceable throughout the production chain up to the farm of origin; and
- 3) the use of pre-harvest food safety and quality assurance programs with third-party certification allows the livestock producer to offer shared liability in case of safety or quality deficiencies.