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What do we know about on-farm reduction of foodborne pathogens?

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Introduction

The overall answer to the title's question is short: "Very little." Therefore, it might be necessary first to ask: "Why is it necessary to reduce foodborne pathogens at farm level?"

Although we appreciate the importance of final decontamination (e.g., pasteurization and irradiation) procedures in lowering the risk of foodborne infections, we also recognize that producing safe and wholesome food can only be assured if food safety practices occur throughout the production continuum—from "conception-to-consumption." It is true that, at least in cases of ubiquitous pathogens such as Salmonella and Listeria, microbes threatening human health can be introduced into the food chain at any production level, even during food distribution, kitchen preparation, and consumption. However, beginning the production chain with raw materials that carry pathogens at the lowest levels possible allows us to improve the effectiveness of food safety procedures at subsequent production levels.

The food safety continuum can be broken down into the pre-harvest, harvest, and post-harvest fractions. **Figure 1** illustrates these fractions.

Since the term "pre-harvest food safety" is currently widely used, it is necessary to construct a precise definition so we can reach a consensus about what it is able to provide and what its limitations are. Therefore, I propose the following as a definition:

Pre-harvest food safety:

> A complex of procedures and measures occurring at the farm level that aim to produce raw material (e.g., slaughter animals, milk, eggs) as supply for food production chains. These procedures and measures focus on *the production of a high quality food product posing the lowest possible risk to human health* in the subsequent production stages.

Any HACCP program at plant level needs to deal with the farm supply as critical control point (CCP). This fact will induce the gradual development of more and more monitoring of incoming raw material and the development of defined vertical supply chains with shared liability throughout the chain. Supply monitoring will lead to classification of suppliers based on data of pathogen in-herd prevalence. Consequently, producers with an in-herd prevalence considerably higher than the baseline will be asked to gradually reduce the frequency of the pathogen in question. This development will accelerate when producer networks and their partners in the vertical pork production chain start to develop quality assurance programs to distinguish their product from other pork production chains. Therefore, the veterinary profession must be prepared to assist those producers by developing and implementing farm- and case-specific pre-harvest food safety programs (Blaha, 1999).

There is a growing consensus that there is no "silver bullet" for the reduction of any of the foodborne pathogens. And it is obvious that every known and potentially new pathogen needs to be addressed with specific sets of measures which take the biological and epidemiological characteristics of each pathogen into account. These characteristics do not only dictate the "what-to-do," but also the "what-to achieve" which can range from "eradicate" to "continuously reduce" to "tolerate at present."

On-farm reduction of foodborne pathogens

There are foodborne pathogens that can and need to be dealt with at farm level immediately (e.g., *Salmonella* spp. and *Trichina spiralis*), and others (e.g., *Toxoplasma gondii*, *Campylobacter coli*, and *Yersinia enterocolitica*) that can be predicted as targets of future on-farm food safety and quality assurance programs.

Salmonella

Salmonella spp. are so widely occurring in the biotic and abiotic environment that the objective of any salmonella control program cannot be eradication. The realistic goal of any program targeting salmonella is to minimize the introduction into the food production chain at every level, including swine herds. An additional objective at farm level is to minimize the multiplication of those salmonella that have found their way into single animals by minimizing the shedding of salmonella by infected animals and minimizing the intake of shed salmonella by animals not yet infected.

There is still a host of open questions regarding how to prevent the introduction of *Salmonella* spp. and/or continuously reduce the prevalence of them within a herd. However, there has been remarkable progress in the area of on-farm salmonella control which was recently summarized at the 3rd International Symposium on the Epidemiology and Control of Salmonella in Pork, held in August 1999 in Washington DC.

The current knowledge can be described as follows (Bahnson, 1999):

- No single measure will provide prevention of the introduction of salmonella into a herd and/or continuous reduction of salmonella within a herd. Only a mixture of well coordinated measures will result in measurable effects.
- The following procedures (if proven to be effective as single measure) need to be combined: statistically justified monitoring of slaughter hogs, biosecurity (external and internal), cleaning and disinfection procedures targeted at salmonella for interrupting potential infection chains, reducing the multiplication of salmonella in infected animals via methods such as acidifying feed or water, vaccinating animals to reduce shedding, using competitive exclusion flora, etc.
- There is the growing understanding that it is necessary to design farm-specific control programs based on the identification of the "salmonella pattern" (introduction source, animal infection chain, animal-environment infection-contamination cycle, etc.) that can vary greatly between farms.

It is obvious that control programs at farm level (ideally coordinated within supplier groups) will not only contribute to a safer pork supply, but also to increase the marketability of the final products.

Trichina

Trichina spiralis is definitively the most likely candidate for being eradicated (or better—permanently kept out of swine production units) from the domestic swine population, at least from confinement swine herds. The collaborative effort between NPPC, the USDA's ARS, APHIS, and FSIS to develop and implement a nation-wide trichina herd certification program (Pyburn, 1999) is well under way. The ultimate goal of this program is to produce trichina-free pigs through certified on-farm procedures that guarantee the supply of pigs to slaughter are produced according to certified on-farm practices. These practices must be proven to reliably prevent the infection of the herd with *Trichina spiralis*. The major components of the on-farm program include the following:

- Stringent and permanent rodent control
- No feeding of uncooked garbage containing meat
- Total confinement, including wildlife-proof fencing
- Immediate removal of carcasses from pens and barns; rodent-proof storage and removal

Other complementary components of the program to match with international standards—e.g. with that of the European Union (EU, 1995)—are monitoring of the wildlife (rodents, wild boar, fox, raccoon, etc.) and serological random sampling of slaughter pigs. To be able to market trichina-free pork, packing plants must either get their entire supply on the program or separate certified trichina-free pigs from pigs with unknown trichina status.

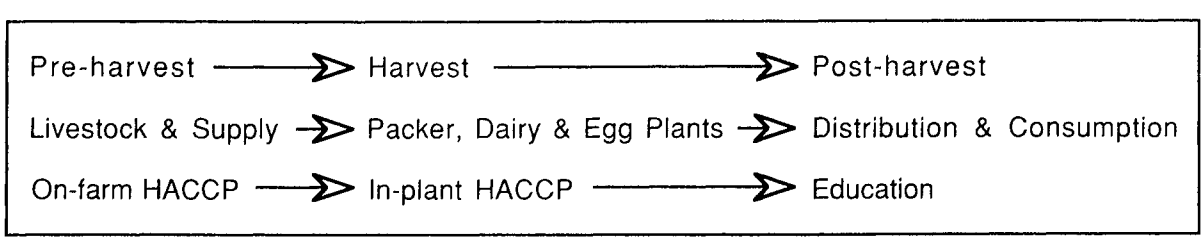
The implementation of the program is mainly important for improving access to international markets (Davies, 1997). Such a program would also help change the negative attitudes held by many domestic consumers who still fear trichinosis, despite the low prevalence (as low as 0.01%) of *Trichina spiralis* in US swine (NAHMS, 1995).

Veterinarians will play the key role in implementing the program at farm level and in establishing the certification procedure.

Toxoplasma

Toxoplasma gondii has gained topicality mainly due to the fact that there is a growing concern of public health authorities about the increasing percentage of immunocompromised people that are potentially at risk as well as sero-negative pregnant women (Dubey, 1994). At present, research is under way that focuses on the feasibility of implementing on-farm programs for toxoplasma-free pork production (e.g., the pre-harvest food safety project collaboratively carried out between of the University of

Figure 1: Food safety as continuum from "Conception-to-Consumption"



Minnesota, the USDA-ARS, and Farmland Industries, Inc.).

The principles of toxoplasma-free pork production resemble those of the trichina-free pork production with the additional component of allowing absolutely no access to the swine units by cats. As in the case of *Trichina spiralis*, veterinarians will play the key role in implementing on-farm programs to control and finally eradicate *Toxoplasma gondii* from swine herds.

Campylobacter

Campylobacter coli is, compared to *Campylobacter jejuni*, a minor source of foodborne illness in humans (Davies, 1999; Blaha, 1999). However, *Campylobacter coli* is mainly attributed to swine, which means that pre-harvest food safety programs focusing on identifying and controlling this pathogen can be expected for the years to come. Since there is very little information on the actual herd prevalence, research on the occurrence and distribution patterns is needed before any on-farm intervention can be developed.

Yersinia

Yersinia enterocolitica is probably one of the next pathogens with which the pork industry must deal since pigs are regarded as the major (if not the only) reservoir of the bacterium (Tauxe et al., 1987). The major feature of *Yersinia enterocolitica* is that it grows at refrigerator temperatures which is rather unique in foodborne bacteria. There are data on the prevalence of pathogenic *Yersinia* strains in slaughter pigs (Funk et al., 1998); thus, there is the potential that future on-farm programs will also focus on the control of *Yersinia enterocolitica*.

Conclusion

An effective pre-harvest food safety program will lead to improved food safety at subsequent production levels. If producer groups standardize their on-farm procedures, have them certified by third party certification entities, and if the pigs, which are produced under the defined good management practice rules, can be separated from the ordinary, non-standardized pig supply, the value of the final product can only increase.

All in all, the increasing demand for on-farm intervention strategies to reduce the prevalence of foodborne pathogens introduced into the food chain via latently infected pigs should be regarded as a great opportunity for swine practitioners to expand their service to the pork producing community.

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