STOWARZYSZENIE EKONOMISTÓW ROLNICTWA I AGROBIZNESU
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DEVELOPMENT OF FOOD QUALITY AND SAFETY SYSTEM IN THE GREENHOUSE INDUSTRY – A CASE STUDY FROM USA PRACTICE

ROZWÓJ SYSTEMU JAKOŚCI I BEZPIECZEŃSTWA ŻYWNOŚCI W SEKTORZE PRODUKCJI SZKLARNIOWEJ – STUDIUM PRZYPADKU Z USA

Key words: food safety, Good Agricultural Practices (GAP), Good Manufacturing Practices (GMP)
Słowa kluczowe: *bezpieczeństwo żywności, Dobra Praktyka Rolnicza, Dobra Praktyka Produkcji*

Abstract. The food safety system is under serious stress, largely because of rapid change in the food system. An effective food safety system provides an array of important social and economic benefits, including maintenance of public confidence in the safety of the food supply, and support for the export food and agricultural products. These benefits flow from success in minimizing food safety risk. This is first and foremost the responsibility of food producers, processors, and also others throughout the food chain, including consumers; the government can play important roles in the effort to minimize food safety risk as well. In this study I will highlight the key elements of the food safety development in the greenhouse growing environment with an example of an Ohio vegetable producer.

Introduction

The food safety system is under serious stress, largely because of rapid change in the food system. A noticeable demand appeared for healthier products from consumers, along with the growth of integrated international supply chain that provides continuing opportunities for competitive suppliers of producers, by allowing them to target a market segment that suits their competitive profile. But complying with food safety and agricultural health standards have been a major source of concern on the international market, mostly because foodborne illnesses are prevalent in all parts of the world. Contaminated food contributes to 1.5 billion cases of diarrhea in children each year, resulting in more than three million premature deaths, according to the World Health Organization [WHO 2003]. Those deaths and illnesses are shared by both developed and developing nations. For example, in the United States, the Centers for Disease Control and Prevention (CDC) estimates that foodborne diseases cause approximately 76 million illnesses annually among the country's 290 million residents, as well as 325.000 hospitalizations, and 5.000 deaths [CNN 2002]. Also there is a noticeable pattern in the increased foodborne illness associated with fresh produce in absolute numbers and as a proportion of all reported foodborne outbreaks [Ender, Mikaczo 2007]. An effective food safety system can provide an array of important social and economic benefits, including maintenance of public confidence in the safety of the food supply, and support for the export food and agricultural products. These benefits flow from success in minimizing food safety risk. This is first and foremost the responsibility of food producers, processors, and also others throughout the food chain, including consumers; the government can play important roles in the effort to minimize food safety risk as well. Although based on the existing literature, can be said that the adoption decision of food businesses can not be attributed to governmental regulation alone [Henson, Holt 2000] and food firms adopt systems stemming from both internal and external incentives. Internal incentives can be specified as increased benefits resulting from adoption in terms of improvements in internal efficiency [Holleran et al. 1999], as well as decreased costs to the firm by minimizing product recalls [Jayasinghe-Mudalige, Henson 2007]. The external incentives for food firms to adopt food quality and safety controls include direct requirements imposed on firms by major customers [Holleran et al. 1999] and the government oversight of food safety has increased substantially in the last decade, including the introduction of ex ante direct regulations and ex post indirect controls [Henson, Caswell 1999].

Like in the mid 1990's in the USA the FDA evaluated a full range of food safety standards, and identified fruit and vegetable produce as an area of concern. As a result, the FDA and USDA – in cooperation with the produce industry – developed the „Guidance for Industry Guide to Minimize Microbial Food Safety Hazards for Fresh Fruits and Vegetables" in 1997. This document („the guide") addresses microbial food safety hazards and good agricultural and management practices, common to the growing,

harvesting, washing, sorting, packing, and transporting of most fruits and vegetables sold to consumers in an unprocessed or minimally processed (raw) form. Although „The guide" is voluntary an increasing number of national wholesalers and retailers have begun to require good agricultural practices GAP and good hygiene practices GHP certifications – approved by a third party auditor – as they source their food products. In response, major producers and growers associations have come to recognize the benefit (better market share, and lower liability), and the need for food safety implementation. Consequently, in the past half decade, GAP and GHP have been implemented by an increasing number of participants in production areas. Unfortunately however, obstacles exist due to the voluntary nature of regulation. Organizations interpret „the guide" differently, emphasizing different parts of the guide to suit their needs. Also, some third party auditors are more stringent than others. This creates non-uniformity within the market, making compliance monitoring more difficult for growers. And recently, consumers and growers associations are advocating for more defined and consistent mandatory programs that allow government oversight. However, small farms have criticized this proposal based on - administrative burden and „one size does not fit all" situations.

In Europe at the end of 1990's, in response to overt lack of government participation in the food safety area prompted the creation of a private-sector consortium of major supermarket chains, fresh produce traders, and producer associations known as „Eurep" in 1999. This consortium changed its name to „GlobalGAP" in September, 2007. At this time, members created measures to reduce the cost and complication of each retailer issuing separate farm standards and running their own inspection systems, as currently still happens in the US. Several pre-existing national and private farm management standards were adapted to conform to GlobalGAP, so that farmers do not have to pay for several certifications in order to satisfy customers in different member regions. The primary focus of GlobalGAP is to prevent food contamination. Its secondary focus is on protection of farm workers, visitors and subcontractors from any harm caused by the growing and processing operations, and on fair treatment of workers and compliance with local labor laws. In 2002 the European Food safety Authority (EFSA) was founded and has worked to develop uniform and easily-adapted food safety principles, general standards and ideas that each member state can implement on its own. So the enforcement come from two different –external- directions to the European producers, in a form of direct command from the EFSA and from the retailers, as the market regulates itself.

The appearing food safety hazards on fresh fruit and vegetable produce can be ranked in three categories, during the steps of the food chain (processing – transportation – retail – preparation/ cooking – consumption): chemical hazards: pesticides, food additives, preservatives, cleaning supplies, and toxic metals (lead, copper, brass, zinc, antimony, and cadmium) that can leach into food through cookware, equipment, or plumbing lines; physical hazards: foreign objects that accidentally contaminate food that include hair, metal staples, broken glass, bones, needles, dirt, wood, nails and biological hazards: bacteria, viruses, parasites, some molds, poisonous plants, poisonous mushrooms, and seafood that naturally contains toxins.

From these three types of hazards the physical-, and the chemical hazards can occur more secluded, and less frequent can /will cause food safety epidemic. The most important is the biological hazard. Raw produce can become contaminated with pathogenic and non-pathogenic microorganisms at a number of different stages, by several means, from production through to consumption.

In 2007 a Codex Circular Letter (CL 2007/12-FH) called for the submission of scientific information about foodborne illnesses related to fresh fruit and vegetables during the period from 1996 to 2006, and to provide related information such as the implicated pathogen and food vehicle, the number of reported outbreaks and illnesses, whether the outbreaks were confirmed or suspected, and what follow-up actions were taken to prevent additional outbreaks. Twenty-two member countries submitted data from all five continents included.

As a result of this survey different vegetable and fruit commodities were separated into three priority levels from the microbial hazard point of view:

– priority level 1: leafy greens (can include any of the followings: spinach, raw cabbage, watercress, lettuce, and salad leaves (all varieties), fresh herbs, (cilantro, basil, parsley, chicory)) were accorded the highest priority based on the ranking criteria. According to the survey leafy green vegetables currently presented the greatest concern in terms of microbiological hazards, because leafy greens are grown and exported in large volume, also have been associated with multiple outbreaks with high numbers of illnesses in at least three regions of the world,
– priority level 2: this level includes: berries, green onions, melons, sprouted seeds, tomatoes as commodities were identified as being the second highest as level of concern in terms of microbial hazards,
– priority level 3: this is the largest group and includes carrots, cucumbers, almonds, baby corn, sesame

seeds, onions and garlic, mango, paw paw, celery and maimai. These were considered to be the lowest priority of the identified commodities of concern. While all these commodities have been implicated in cases or outbreaks of foodborne illness, the public health impact was considered to be low.

Material and methods

Based on the survey's results leafy green vegetables should be considered the highest priority in terms of fresh produce safety from a global perspective, and most of these items can/will be grown under greenhouse environment at least certain times of the year in most parts of the world. Therefore we are focusing this study on the food safety development specifically in a greenhouse environment. The scope of the work is to focuses on the key elements that can help to reduce potential hazards during the production. This paper will not investigate the entire production-to-consumption continuum, it will focus on the food safety at the primary production level, that contribute to the risk of foodborne disease, especially environmental hygiene, water for primary production, personnel health, personnel hygiene and sanitary facilities.

We are basing this study on the results of a partnership with the Chef's Garden. The method of the study was observation; it could be possible because we have been employed by the farm, so we had the chance to get hands on information on the daily basis, and participate in the development of the farm food safety system.

The Chef's Garden currently has an active food safety system in place, cooperating with the American Institute of Baking, and other third party food audit facilities. As its name implies the Chefs Garden supplies vegetables, directly to high-end chefs and restaurants all over the United States and internationally as well. The mid size farm is currently farming about 150 acres (about 70 hectares) including indoor (greenhouse), and outdoor (field) production. The farm is located in northwest Ohio in city of Huron, on the shore of Lake Erie and enjoys a relatively mild climate. The area has a lake bottom and sandy fertile soil, where they are producing sustainably, a wide variety of miniature vegetables and lettuces, and also some kales, carrots, peppers, onions, and tomatoes. All of their produce is being sold as fresh cut produce. As used in this document, the term „fresh-cut produce" refers to minimally processed vegetables that have been altered in form by peeling, chopping, coring, or trimming, with or rarely without washing, prior to being packaged for use by the consumer or retail establishment. These fresh-cut produce does not require additional preparation, processing, or cooking before consumption, with the possible exception of washing or the addition of salad dressing or seasoning. Most of these products are generally considered „ready-to-eat" owing to the wash process used during their preparation and the protective packaging employed in their distribution. The main goal of this case study: provide guidance to farmers who are either unfamiliar with basic principles food safety, or are just in the process of building up their food safety program in a greenhouse operation; to highlight the key control points and their monitoring from the greenhouse food safety prospective; help to develop food safety systems for greenhouse producers and highlight some of the potential benefit and downside as well for a food safety system.

Results

In relation to food safety, there are many examples where a food item supplied to the consumer may not be free from a hazard. Knowing this, it is important that appropriate food safety measures are understood and put into practice to eliminate such risks. Food manufacturers like the Chef's Garden knew this when they established their food safety program. The food safety system built on a detailed understanding of the interaction between process and product. The investigated company is using HACCP (Hazard Analysis Critical Control Point) as an analytical tool to control and help to continuously develop their food safety system. See below the brief introduction of their system based on critical control points, through the production area of the product.

LOCATION SELECTION: This is usually a generally understated and forgotten point in case of a greenhouse production. The location choice in case of a new construction greenhouse, owners need to focus on any close surrounding livestock areas. This can pose some risk, especially if the production is taking place on the ground level. This risk can be significantly multiplied if the greenhouses are in a down slope area, because in this case possibly animal fecal -contaminated runoffs- can have the chance to potentially wash in the greenhouse area and contaminate the production. This should be a concern even if the production level is off the ground, because the seeping sewage can create a great opportunity for cross contamination.

SITE/PREMISES PREPARATION: This step involves the preparation of the environment and not the material itself. Any kind of chemicals such as fertilizer, pesticides, oil, fuel or paint need to be stored in designated locations possibly out of, and at least 10 m. away from production areas and their premises has to be cleaned regularly.

GREENHOUSE AREA: This topic will involve some actions that will help to decrease the chance of physical-, and / or biological hazards as well. During the greenhouse installation or at maintenance that grease or lubricant used needs to be consumable quality, so it will not harm the surrounding production. Also every glass or brittle plastic in the growing area needs to be signaled, inventoried and monitored on a periodic basis and any of their breakage needs to be reported. This will help to keep the product free of any shattered glass or brittle -physical hazard- during the production period.

Around the greenhouse premises pest –potential source of biological hazard- control program for rodents needs to be installed. Outside traps can be with or without poison, the inside ones needs to be without poison. Also, if the greenhouses has significant opening -from ground level- ventilation purposes these needs to be blocked off with some special device (like chicken wire, etc…) that will prohibit the intrusion of any domestic animal or lives stock. Also as part of the environmental and monitoring program the greenhouse interior and exterior environment is recommended to be audited and kept free of debris – potential pest harboring and providing habitat for pest reproduction- periodically.

APPLICATION OF INPUTS: In the greenhouse operation input can be most often seed, water, growing media, fertilizer and chemicals. The seed – as potential sources of contamination – can become infected during its production in the field from agricultural water, improperly managed animal manure, or from contact with wild animals. From the surface of the seed, contamination can spread with the help of irrigation water. Obviously the severity of contamination spread will highly depend on the amount of contaminated seeds and on the applied growing method in the greenhouse operation. Also seed should be stored under conditions that will protect against contamination and prevent deterioration

Amongst the inputs, the applied irrigation water represents very high risk, as source of possible food safety contamination. In order to reduce risk of microbial contamination through irrigation line, the applied irrigation water needs to meet the standards for recreational water and needs to be free of any human or animal feces. Therefore irrigation water needs to be monitored and tested on a regular base. The regularity depends on the risk represented by the source of water (municipal – lower risk, well – medium risk –, open water source – high risk –) and on the type of method used at irrigation (overhead watering – higher risk, drip irrigation – lower risk).

The growing media (soil or other material) can be source of foodborne pathogens, therefore the testing of it is recommended before seeding. In case of soil, mostly the contamination source is raw manure, therefore the use of this fertility material need to be avoided.

Chemical treatment refers to any use of a chemical agent, to the growing material itself, during any stage. Every pesticide handler recommended receiving special training regarding to the proper pesticide handling. All chemicals need to be stored outside of the growing area, under a lockable well ventilated location. Any of their usage must be authorized, recorded, and the disposal of any empty container should follow environmental friendly regulations.

Pesticide applications must follow label recommendation. Sprayers must be calibrated regularly and cleaned after each usage. The sprayed area must be signaled and clearly show the possible reentry interval. The same applied to any disinfectant agent is used to clean equipments, greenhouse surfaces, greenhouse soil, and the surface of the plants to reduce any kind of microbial risk.

Fertilizers, as we mentioned earlier application of raw manure needs to be avoided, but usage of properly composted manure is possible in the growing area. In case of liquid fertility treatment applied as foliar application through the irrigation line, backflow devices needs to be installed –to prevent back siphoning-, and the injectors used needs to be calibrated on a regular basis.

PERSONAL HYGINE: Any sick worker in the production are can spread microorganism to the growing / harvested plants, therefore monitoring and educating the workers can be critical. Good personal hygiene can include the followings: adequate hand washing practices and frequency, also focusing on maintaining personal cleanliness and behavior on the daily basis. According to this production area workers can be required to wear clean and appropriate clothing, wear gloves, hairnets and possibly other protective clothing (like lab coat, apron, etc…) during product handling. This can help to reduce unsanitary habits and actions during handling product. Another part of this program the illness reporting, according to this no person with potentially hazardous condition can contact with product neither in growing areas nor in the packing facilities. Continuous trainings and presentations of the requirements to the team, can help workers, to gain more understanding in the huge importance of this matter.

SANITATION: Any harvest utensil can be assigned – for easy monitoring- to supervisors or harvesters. The person with assignment needs to ensure that the equipment is functioning properly and it's proper sanitation during usage and cleaning and sanitation at least at the end of the shift. Any repetitively used harvesting tubs need to be cleaned and sanitized after each load of product to prevent cross-contamination between contents. Other equipments located in the growing / harvesting areas need to be cleaned and disinfected on a regular basis.

ESTABLISHMENT AND PRODUCTION: This period involves from seeding to harvesting the product life cycle. During this period the growers need to assure and maintain the cleanliness of the surrounding areas, and eliminating every chance to contact of plants with any kind of possible food product.

HARVESTING: This method of collecting materials can include picking, cutting or digging vegetables, and especially cut surfaces provide a good growth environment and potential for internalization for microbes following proper protocols can reduce risk of possible contamination. Therefore any applied utensil during harvesting needs to be cleaned and disinfected at least on the daily basis. The harvesters need to wear protective clothing (hairnet, gloves, mask as well as needed) during the harvesting period to avoid potential cross contamination. Harvester's need to exclude any kind of physically damaged or visually contaminated plant from harvesting. Any visually contaminated item and several inches of it's surrounding are needs to be removed and disposed. All harvested product needs to be placed into sanitized tubs. Because foodborne pathogens can grow on plant tissue after harvest cooling of the product is needed as soon as it is possible to slow down any further growth of the organism.

POST HARVEST: In order to reduce risk, any water used during post harvest has to be monitored because contaminated water can transmit diseases that decay the produce or adversely affect human health

TRANSPORT AND STORAGE: After harvesting the products needs to be transferred to the packing facility as soon as possible, possibly by refrigerated trucks. Each tub needs to be labeled according to their contents, dated, and separated from each other by a protective sheet in order to avoid any cross contamination between tubs. In the packing facility items has to be stored in separate coolers according to product groups and according to if they are washed or unwashed.

For easier separation we can say the turning point to the process is the transport and storage. All of the steps which occur until the harvesting can be considered as part of the good agricultural practices (GAP), all of the steps that take place in the packing facility can be considered as part of the good manufacturing practices (GMP). Some steps as the personnel hygiene and the sanitation are part of the GAP's and also for the GMP's.

RECALL PROGRAM /TRACEBILITY: Although this program does not aim in reducing any hazard directly in the production area, it focuses on a much broader area, and it helps to reduce or stop the risk of spreading any potentially contaminated item with food borne pathogens along the food chain, and it represents very high importance amongst food safety regulations. The purpose of this program is to be able to recall from any user all products that have been determined or suspected to be hazardous to the health of individuals. The program requires 100% accountability of product from source to destination within two hours. This is accomplished at the observing farm by using a coding system, from source to customer. To support the recall program the Chef's Garden is using a custom design program. Through this program with a bar coding system every grown item can be traced back from seed (even seed supplier) through harvest (and harvester) to the packing facilities. The trace back of the information is fairly simple because the information is digitalized. It is a critical step for the good agricultural and management practices to minimize liability and lower the food safety risk for the final consumer's.

MICRBIOLOGICAL PROGRAM: The purpose of this program to randomly test product, utensils, at the packing and growing locations and other growing related materials for *E.Coli, Salmonella, Listeria*, and *Staphylococcus* Au. This is a proactive approach and used as a management tool to look for possible infections, but in case of a positive test it automatically triggers a re-cleaning step or potentially the recall program.

RULE OF MAINTENANCE: All equipment needs to be inspected before usage, for any possible contamination sources and any problem needs to be fixed and reported in a documented form. This can be an important proactive step to protect the employee and produce safety as well.

TRAINING AND EDUCATING TEAM MEMBERS: Any measurements and criteria can be set up but if the actual growers and harvesters do not have the general understanding these will „fall onto death ears". Because the training will help to ensure the proper execution of any food safety program therefore the training can be considered as a primary preventive control tool. To ensure that safety practices will be enhanced, team members need to be trained and continuously educated to look for and to avoid potential contamination sources, cross contaminations, safe growing-, harvesting-, and safe product handling techniques. Key issues (like personnel hygiene and cleanliness) advised to be discussed and forced at the entire operation level and the entire food safety program needs to be presented for the production workers in certain depth. Obviously any regulation as part of daily activities or if they pose a potentially higher risk from the food safety point of view, needs to be discussed more in details. At the supervisory level systematic approaches need to be developed that can help in long term to understand and identify any, even newly appearing hazards in and around the production areas. Also it is important to measure the

success of these trainings and to check the understanding level of the workers. Therefore, the investigated farm's management required set up food safety tests, based on the training material's, and seasonal workers are being trained/ tested at the beginning of the season, all year round employees are being trained/ tested continuously during the curse of the year.

MANAGEMENT SUPPORT: Implementation and execution of a food safety program can be costly not just time wise, but financially as well, for any producer. For case of instance, because most of the listed steps need done and documented on the daily/ weekly/ yearly basis as they occur, this documentation requirement does put a high pressure not just on the employees but on the management as well because, besides accomplishing the food safety requirements, the daily work still needs to be done (cost)efficiently and productively. Therefore, the commitment of management / owners is required, in order to develop and maintain a well functioning food safety program. Despite the generally high cost, more and more producers install food safety regulations because it can increase sales -major retailers and food producers require proof of food safety-, help to differentiate on a crowded market place especially in case of a foodborne outbreak. Food safety also can provide health related financial benefits associated with reduced food risk, although these will be seen mostly on the public or at the government level.

Conclusion

Protecting the safety of the fresh produce supply requires a comprehensive and coordinated effort through the production and processing system. In this document we provided some basic principles and execution of food safety practices from the analysis of the Chef's Garden farm fresh-cut produce food safety operational system. Starting from the location selection of a greenhouse we outlined several potential physical, chemical and microbial contamination points and sources through the production. Obviously these outlined steps can vary between farms to farm. Growers should consider the variety of physical characteristics of their produce and growing conditions need to be modified according to the specific needs of these plants. Any planned food safety program should be based on these factors, due to their importance and effect on the potential sources of physical and microbial contaminations associated with their operation. Based on these factors a systematic food safety approach needs to be developed -including good agricultural practices, good manufacturing practices, and good management practices. This needs to be detailed, adequate, and the most possible cost effective for the individual producer. Once the good agricultural practices are in place, continued monitoring and employee training needs to take place along with following the set guidelines of GAP's. Basically this will not just require but also ensure that the process is working correctly at all levels. Also the applied technologies at company level need to be continuously improved, according to the food safety researchers providing more and more information, regarding microorganism, and in case of product-microorganism interact, as well the agricultural sector will develop newer and newer growing techniques. In order to achieve this complete management support is needed not just financially, but morally as well.

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Streszczenie

W artykule, na przykładzie USA, przedstawiono wdrożenie systemów jakości i bezpieczeństwa żywności w kontekście zmian na świecie.

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