Food Defense

ITP 506  Current Issues in Food Science and Technology
2017

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Outlines

• New Era and New Concept of Food Safety?
• Food Defense
  Is it Real?
  Is Terror Real?
  Why did it happen?
  Be Aware, Be Prepared
• Food Defense vs Food Safety
  HACCP
  Food Defense US : FSMA : Food Safety Modernization Act
  Food Defense EU : PAS 96 2014: Guide to protecting and defending food and drink from deliberate attack
Beyond - Contamination?
- Hazards [physical, chemical & (micro)biological]

- A new Era?

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Concept of
- Food Safety?
- Food Quality?
- Biosecurity?
- Food Protection?

- A new Concept?

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Unintentional / Accidental Contamination

Intentional Contamination

Old Era/Concept Vs. New Era/Concept

Unintentional / Accidental Contamination

Intentional Contamination

Economically driven Motivation is “GAIN”

Ideologically driven Motivation is “HARM”

Food Quality

Food Fraud

Food Defense

Food Safety

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FOOD DEFENSE

- Originated from the US


- The Food Safety Modernization Act (FSMA), 2011:
  - Focus: intentional acts of adulteration where there is an intent to cause wide scale public health harm

2014:
The British Standards Institution (BSI) :
PAS 96 2014: Guide to protecting and defending food and drink from deliberate attack
FOOD DEFENSE

Intentional contamination has happened and can happen again.

- Salad bars with *Salmonella* – Oregon, 1984
- Cookies with needles, St. Louis, 1984
- Fast food with rat poison, China, 2002
- Ground beef with nicotine – Michigan, 2003

FOOD DEFENSE … is it real?

Terminology

- Watered down products using
  - non-potable / unsafe water
  - Cruise oil diluted with
    - potentially toxic tea tree oil

- Copies of popular foods,
  - not produced with
    - acceptable safety assurance

- Melamine added to enhance
  - protein value
  - Use of unauthorized additives
    - Sudan dyes in popc src
**FOOD DEFENSE … is it real?**

(Moore, et al. April 5, 2012, *Journal of Food Science*)

1,300 cases of food frauds (1980 – 2010)

Top Ten (10) adulterated foods:
1. Olive oil (% of total record: 16)
2. Milk (14)
3. Honey (7)
4. Saffron (*Crocus sativus* L., 4)
5. Orange juice (4)
6. Coffee (3)
7. Apple juice (2)
8. Grape wine (2)
9. Maple syrup (2)
10. Vanilla extract (2)
11. Rice (1)

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<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Number of records</th>
<th>Percentage of total records</th>
</tr>
</thead>
<tbody>
<tr>
<td>Olive oil (all)</td>
<td>167</td>
<td>16</td>
</tr>
<tr>
<td>Milk (all)</td>
<td>143</td>
<td>14</td>
</tr>
<tr>
<td>Honey</td>
<td>71</td>
<td>7</td>
</tr>
<tr>
<td>Saffron (<em>Crocus sativus</em> L.)</td>
<td>57</td>
<td>5</td>
</tr>
<tr>
<td>Orange juice</td>
<td>43</td>
<td>4</td>
</tr>
<tr>
<td>Coffee (all)</td>
<td>34</td>
<td>3</td>
</tr>
<tr>
<td>Apple juice</td>
<td>20</td>
<td>2</td>
</tr>
<tr>
<td>Grape wine (<em>Vitis vinifera</em>)</td>
<td>16</td>
<td>2</td>
</tr>
<tr>
<td>Maple syrup</td>
<td>16</td>
<td>2</td>
</tr>
<tr>
<td>Vanilla extract (all)</td>
<td>16</td>
<td>2</td>
</tr>
<tr>
<td>Rice (all)</td>
<td>14</td>
<td>1</td>
</tr>
<tr>
<td>Cheese (all)</td>
<td>13</td>
<td>1</td>
</tr>
<tr>
<td>Milk (all)</td>
<td>13</td>
<td>1</td>
</tr>
<tr>
<td>Turmeric</td>
<td>12</td>
<td>1</td>
</tr>
<tr>
<td>Vegetable (all)</td>
<td>11</td>
<td>1</td>
</tr>
<tr>
<td>Chili powder</td>
<td>10</td>
<td>1</td>
</tr>
<tr>
<td>Sesame oil</td>
<td>10</td>
<td>1</td>
</tr>
<tr>
<td>Cocoa powder</td>
<td>9</td>
<td>1</td>
</tr>
<tr>
<td>Strawberry preserve</td>
<td>9</td>
<td>1</td>
</tr>
<tr>
<td>Beeswax</td>
<td>8</td>
<td>1</td>
</tr>
<tr>
<td>Chinese star anise (<em>Anisum vulgare Hook.</em> E.)</td>
<td>8</td>
<td>1</td>
</tr>
<tr>
<td>Durum wheat (<em>Triticum durum</em>) pasta</td>
<td>8</td>
<td>1</td>
</tr>
<tr>
<td>Guar gum</td>
<td>7</td>
<td>1</td>
</tr>
<tr>
<td>Palm oil</td>
<td>7</td>
<td>1</td>
</tr>
<tr>
<td>Paprika</td>
<td>7</td>
<td>1</td>
</tr>
</tbody>
</table>

*All indicates that multiple ingredient subtypes were combined. For example, different types of olive oil (virgin and extra virgin) were combined into Olive oil (all) for this table.

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**FOOD DEFENSE … → who would do this?**

- Terrorists or Activists
- Competitors
- Disgruntled employees
- ? → EMA (Economically Motivated Adulteration)
FOOD DEFENSE … is “terror” real?

Coca Cola, Unilever, Nestle, Delta withdraw contamination threats

Food Safety News
Breaking news for everyone’s consumption

Terrorists threaten to poison food next 2 weeks

By Dan Flynn | December 22, 2016

So far targets include Coca-Cola, Nestle, Unilever and Delta. In response to the threats by the Greek eco-anarchy group that calls itself FAI/IRF, the companies have withdrawn certain products from an area of Greece. FAI/IRF, which likely grew out of Italy’s informal Anarchist Federation (FAI), shows how it could poison products with chlorine and hydrochloric acid while leaving packaging intact.

• Anger over national, business, or personal differences
• Seeking changes in culture
• Seeking economic disruption
• Seeking public fear
• Seeking harm to others
Factors that increase risk:
- Making large batches of food
- Foods with short shelf lives
- Uniformly mixed products
- Products that reach key populations
- Ease of access

**WHY?**
**WHY FOOD INDUSTRY?**

**FOOD DEFENSE … → imagine: WHAT IF?**

- People are ill, injured, or even dying.
- Your company name and product are involved.
- A recall is initiated.
- Production is halted—jobs lost.
- Financial losses occur locally and even nationally.

The Q: “What did WE do to prevent this?”
The food industry must unite to face terrorism threat

01 Jun 2017 | By Chris Elliott

The terrible terrorist event in Manchester brought the dark topic of food terrorism into my mind. As opposed to food fraud, these are acts where the perpetrator(s) want to make as many people as possible aware that food has been tainted.

Contamination of food systems that affect large numbers of people is rare due to the difficulties of adding chemicals or microbiological agents to large quantities of foods. This is reassuring to some degree, but the 'fear factor' is often large. Often chemicals are used as the weapon. One of the first recorded events occurred in 1978 when the Arab Revolutionary Army injected oranges grown in Israel with mercury. Four Dutch children complained about the taste of their fruit, and though a nationwide search found only 25 oranges that had been tampered with, the resultant demand for Israeli produce of oranges plummeted.

The Q: “What did WE do to prevent this?”

UK food and drink companies could be losing £12 billion annually to fraud

West Midlands businesses in the food and drink sector could increase profitability significantly by tackling fraud, say advisers.

The Q: “What did WE do to prevent this?”
FOOD DEFENSE → Develop (Write) a Plan

• Defining Food Defense
• Understanding why it matters
• Develop a Plan

Writing A Plan.

The Q: “What did WE do to prevent this?”

FOOD DEFENSE vs FOOD SAFETY

• Food defense is different from food safety.
• Food safety addresses predictable and unintentional risks.
  • Food safety is best addressed through HACCP.
  • Food defense addresses intentional attacks on the safety or quality of food. It is not well suited to HACCP.
### HACCP

**HACCP Principles**:
- Hazard Analysis
- Determination of CCP
- Determination of Critical Limit
- Determination of Monitoring Procedures
- Determination of Corrective Action
- Determination of Verification Procedures
- Determination of Documentation System

**Hazard**
- Agents (*biological*, *chemical* and *physical*) in food that can cause loss or harm which arises from a naturally occurring or accidental event or results from incompetence or ignorance of the people involved.

### TERMINOLOGY IN FOOD DEFENSE

**Food Defense**: The effort to protect food from acts of intentional adulteration (http://www.fda.gov/food/fooddefense/).

**Food Defence**: Procedures to ensure the security of food and drink and their supply chains from malicious and ideologically motivated attack leading to contamination or supply disruption (BSI, 2014).

**Food Protection**: Procedures adopted to deter and detect fraudulent attacks on food; intentional and unintentional.
FOOD DEFENSE

MOTIVATION
Adversary’s intent to do harm

CAPABILITY
Adversary’s knowledge, adulterant, and tactics

VULNERABILITY
Conditions of accessibility and likelihood that adulteration would cause an impact

From: FoodProtection.UMN.EDU, 2016

FOOD DEFENSE – US

Evolution of U.S. Food Defense Policy

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FOOD SAFETY MODERNIZATION ACT

FSMA Background

- Well-documented contamination and recall incidents in US food industry
- 9.3 million illnesses (1 in 31) a year due to foodborne illness, 53,245 hospitalizations and 2,377 deaths.
- Shift focus within the US food industry towards a proactive preventive strategy founded on "science-based standards"
- Imported foods to have the same requirements

JAN 4, 2011
Final Rule: Protecting Food Against Intentional Adulteration (IA)

http://www.fda.gov/fsma

Mitigation Strategies to Protect Food Against Intentional Adulteration

• Proposed on December 24, 2013
• Public comments: More than 200 for the original proposal
• Final rule publication date: May 27, 2016

The Intentional Adulteration (IA) Rule

• Establishes requirements to prevent or significantly minimize acts intended to cause wide-scale public health harm
• Uses a HACCP-type approach, with important differences from the Preventive Controls for Human Food rule
• Is risk-based and flexible
The Requirement for IA Rule

- Food Defense Plan
  - Vulnerability assessment
  - Mitigation strategies
  - Procedures for food defense monitoring
  - Food defense corrective action procedures
  - Food defense verification procedures
  - Records
- Training

Vulnerability Assessment

- Process of identifying and prioritizing susceptible points, steps, or procedures in a facility's food process to intentional adulteration
- Helps Identify:
  - Actionable Process Steps
  - Areas of an operation where Mitigation Strategies should be applied
Vulnerable Assessment Methodology

Three most important factors to consider :

• **Accessibility**: measure of the ease with which an attacker can physically access the intended target to intentionally adulterate the food.

• **Vulnerability**: measure of the ease with which a contaminant can be introduced in quantities sufficient to achieve the attacker’s purpose (once the target has been accessed).

• **Criticality (impact)**: What is the impact of a contamination at a certain point to the production and/or health.

### Accessibility Scale
(Can I get to the target?)

<table>
<thead>
<tr>
<th>CRITERIA</th>
<th>SCALE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Easily Accessible</strong> (e.g., target is outside building and no perimeter fence).</td>
<td>9 – 10</td>
</tr>
<tr>
<td><strong>Accessible</strong> (e.g., target is inside building, but in unsecured part of facility).</td>
<td>7 – 8</td>
</tr>
<tr>
<td><strong>Partially Accessible</strong> (e.g., inside building, but in a relatively unsecured, but busy, part of facility).</td>
<td>5 – 6</td>
</tr>
<tr>
<td><strong>Hardly Accessible</strong> (e.g., inside building in a secured part of facility).</td>
<td>3 – 4</td>
</tr>
<tr>
<td><strong>Not Accessible</strong> (e.g., there are physical barriers, alarms, and human observation to prevent reaching the target).</td>
<td>1 – 2</td>
</tr>
</tbody>
</table>
## Vulnerability Scale
(Once I get to the target, can I adulterate the product?)

<table>
<thead>
<tr>
<th>CRITERIA</th>
<th>SCALE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highly Vulnerable (e.g., product is openly exposed and there is lots of</td>
<td>9 – 10</td>
</tr>
<tr>
<td>time to allow for easy introduction of contaminants without being seen).</td>
<td></td>
</tr>
<tr>
<td>Vulnerable (e.g., product has some open exposure and there is sufficient</td>
<td>7 – 8</td>
</tr>
<tr>
<td>time to almost always allow for introduction of contaminants without</td>
<td></td>
</tr>
<tr>
<td>being seen).</td>
<td></td>
</tr>
<tr>
<td>Somewhat Vulnerable (e.g., product has limited exposure points and</td>
<td>5 – 6</td>
</tr>
<tr>
<td>limited times when contaminant can be added without being seen).</td>
<td></td>
</tr>
<tr>
<td>Barely Vulnerable (e.g., product has limited exposure points but is almost</td>
<td>3 – 4</td>
</tr>
<tr>
<td>always under observation while in production).</td>
<td></td>
</tr>
<tr>
<td>Not Vulnerable (e.g., product is in sealed vessels/pipes with no practical</td>
<td>1 – 2</td>
</tr>
<tr>
<td>exposure points or it is under full and controlled observation).</td>
<td></td>
</tr>
</tbody>
</table>

## Criticality Scale
(If I can adulterate the target, what is the impact?)

<table>
<thead>
<tr>
<th>CRITERIA</th>
<th>SCALE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Large Volume Impact</td>
<td>9 – 10</td>
</tr>
<tr>
<td>(e.g., a single instance of contamination at</td>
<td></td>
</tr>
<tr>
<td>this point would contaminate multiple days</td>
<td></td>
</tr>
<tr>
<td>of the production of this line).</td>
<td></td>
</tr>
<tr>
<td>Large Volume Impact</td>
<td>7 – 8</td>
</tr>
<tr>
<td>(e.g., a single instance of contamination at</td>
<td></td>
</tr>
<tr>
<td>this point would contaminate multiple shifts</td>
<td></td>
</tr>
<tr>
<td>of the production of this line).</td>
<td></td>
</tr>
<tr>
<td>Medium Volume Impact</td>
<td>5 – 6</td>
</tr>
<tr>
<td>(e.g., a single instance of contamination at</td>
<td></td>
</tr>
<tr>
<td>this point would contaminate one shift or</td>
<td></td>
</tr>
<tr>
<td>less of the production of this line).</td>
<td></td>
</tr>
<tr>
<td>Small Volume Impact</td>
<td>3 – 4</td>
</tr>
<tr>
<td>(e.g., a single instance of contamination at</td>
<td></td>
</tr>
<tr>
<td>this point would contaminate two hours or</td>
<td></td>
</tr>
<tr>
<td>less of the production of this line).</td>
<td></td>
</tr>
<tr>
<td>Low Volume Impact</td>
<td>1 – 2</td>
</tr>
<tr>
<td>(e.g., a single instance of contamination at</td>
<td></td>
</tr>
<tr>
<td>this point would contaminate 30 minutes or</td>
<td></td>
</tr>
<tr>
<td>less of the production of this line).</td>
<td></td>
</tr>
</tbody>
</table>
Facility-Specific Vulnerability Assessment

• Perform a **vulnerability assessment** using appropriate methods and qualified individual(s)

• **Identify and prioritize** points in food operation that are vulnerable to intentional adulteration

• Identify **actionable process** steps for significant vulnerabilities: *a point, step, or procedure in a food process at which food defense measures can be applied and are essential to prevent or eliminate a significant vulnerability or reduce such vulnerability to an acceptable level.*

Elements of Facility-Specific Vulnerability Assessment

• Evaluate agents of concern
• Assemble VA team
• Develop process flow diagram
• Identify Significant Vulnerabilities, consider:
  – Public health impact
  – Volume of product impacted
  – Downstream processing
  – Physical access to product
  – Ability of aggressor to contaminate product
• Identify Actionable Process Steps
Mitigation strategies should be identified and implemented at each actionable process step to provide assurances that vulnerabilities will be minimized or prevented.

The mitigation strategies must be tailored to the facility and its procedures.

Example for mitigation: a fence around the entire facility to protect facility from outsider, other way may be needed to protect the actionable process step from an insider attack.

Mitigation strategy management components

• Monitoring: Establishing and implementing procedures, including the frequency with which they are to be performed, for monitoring the mitigation strategies.

• Corrective actions: The response if mitigation strategies are not properly implemented.

• Verification: Verification activities would ensure that monitoring is being conducted and appropriate decisions about corrective actions are being made.
A written food defense plan under the new rule include the following:
- Vulnerability Assessment
- Actionable process steps
- Mitigation strategies
  - Monitoring
  - Corrective actions
  - Verification
  - Training
- Recordkeeping
PAS 96 2014

Background

- HACCP not used to detect or mitigate deliberate attacks on a system or process: food safety implications & harm organizations (damage business reputation, extortion)
- The common factor for deliberate acts: people, motivation
- PAS 96 is to guide food business managers through approaches and procedures to improve the resilience of supply chains to fraud or other forms of attack
- PAS 96 describes Threat Assessment Critical Control Points (TACCP).
- The TACCP process assumes and builds on a business’ existing effective operation of HACCP.

Threat Assessment Critical Control Point (TACCP)

**TACCP**

systematic management of risk through the evaluation of threats, identification of vulnerabilities, and implementation of controls to materials and products, purchasing, processes, premises, distribution networks and business systems by a knowledgeable and trusted team with the authority to implement changes to procedures

**Threat**

something that can cause loss or harm which arises from the ill-intent of people
Types of Threat

**Economically motivated adulteration (EMA)**
- case example: in 2013, allegations were reported that a food factory in Asia was labeling cooking oil as peanut, chilli and olive when it contained none of these oils

**Malicious contamination**
- case example: in 2005, a major British bakery reported that several customers had found glass fragments and sewing needles inside the wrapper of loaves

**Extortion**
- case example: in 1990, a former police officer was convicted of extortion after contaminating baby food with glass and demanding money from the multi-national manufacturer

**Espionage**
- case example: one business consultancy uses the theft of the intellectual property of a fictitious innovative snack product as an example of commercial espionage

**Counterfeiting**
- case example: in 2013, enforcement officers seized 9000 bottles of fake Glen’s Vodka from an illegal factory

**Cyber crime**
- case example: in 2014, fraudsters are attempting to target their customers in a new phone scam. They phone restaurants claiming there is a problem with their card payments system, the restaurant is then told to redirect any card payments to a phone number of the fraudster
TACCP

Objectives:
• reduce the likelihood (chance) of a deliberate attack;
• reduce the consequences (impact) of an attack;
• protect organizational reputation;
• reassure customers, press, public that proportionate steps are in place to protect food
• satisfy international expectations and support the work of trading partners
• demonstrate that reasonable precautions are taken and due diligence is exercised in protecting food.

TACCP Process

• In most cases TACCP should be a team activity. For many small businesses the team approach is not practicable and it may be the job of one person.
• The TACCP team deals with four underlining questions:
  a) Who might want to attack us?
  b) How might they do it?
  c) Where are we vulnerable?
  d) How can we stop them?
TACCP Process

TACCP team should be formed, which could include individuals with the following expertise:

- security;
- human resources;
- food technology;
- process engineering;
- production and operations;
- purchasing and supply;
- distribution;
- communications; and
- commercial/marketing.

Steps

- identifying specific threats to the company’s business
- assessing the likelihood of an attack by considering:
  - motivation of the prospective attacker,
  - vulnerability of the process,
  - opportunity and capability to carry out the attack,
  - assessing the potential impact
- judging the priority to be given to different threats by comparing their likelihood and impact
- Deciding proportionate controls needed to discourage the attacker and give early notification of an attack
- Maintaining information and intelligence systems to enable revision of priorities
TACCP Process

1. Assess new information
2. Identify and assess threat to organization
3. Identify and assess threat to operation
4. Select product
5. Identify and assess threat to product
6. Device flowchart of product supply chain
11. Likelihood v. impact : priority
10. Determine if control procedures will detect the threats
9. Identify which supply points are most critical
8. Consider impact of threats identified
7. Identify key staff and vulnerable points
12. Who could carry it out
13. Decide and implement necessary controls
14. Review and revise
15. Monitor horizon scans and emerging risks

Assessing Threat for the premises:
- Are the premises located in a politically or socially sensitive area?
- Do the premises share access or key services with controversial neighbours?
- Are new recruits, especially agency and seasonal staff, appropriately screened?
- Are services to the premises adequately protected?
- Are external utilities adequately protected?
- Are hazardous materials, which could be valuable to hostile groups, stored on site?
- Are large numbers of people (including the general public) using the location?
- Do any employees have reason to feel disgruntled or show signs of dissatisfaction?
- Are internal audit arrangements independent?
  Have key roles been occupied by staff for many years with little supervision?
Threat Assessment In TACCP

For the organization:

- Are we under foreign ownership by nations involved in international conflict?
- Do we have a celebrity or high profile chief executive or proprietor?
- Do we have a reputation for having significant links, customers, suppliers, etc. with unstable regions of the world?
- Are our brands regarded as controversial by some?
- Do we or our customers supply high profile customers or events?

Threat Assessment In TACCP

For the product:

- Have there been significant cost increases which have affected this product?
- Does this product have particular religious, ethical or moral significance for some people?
- Could this product be used as an ingredient in a wide range of popular foods?
- Does the product contain ingredients or other material sourced from overseas?
Vulnerability Assessment In TACCP

For EMA:

- Are low cost substitute materials available?
- Have there been significant material cost increases?
- Has pressure increased on suppliers’ trading margins?
- Do you trust your suppliers’ managers, and their suppliers’ managers?
- Do key suppliers use personnel security practices?
- Do suppliers think that we monitor their operation and analyze their products?
- Which suppliers are not routinely audited?
- Are we supplied through remote, obscure chains?
- Are major materials becoming less available (e.g. from crop failure) or alternatives plentiful (e.g. from overproduction)?

Vulnerability Assessment In TACCP

For EMA:

- How do suppliers dispose of excessive amounts of waste materials?
- Are we aware of shortcuts to the process which could affect us?
- Are our staff and those of suppliers encouraged to report concerns (whistleblowing)?
- Are accreditation records, certificates of conformance and analyzes reports independent?
Vulnerability Assessment In TACCP

For Malicious Contamination:

- Are food safety audits rigorous and up-to-date?
- Are personnel security procedures in use?
- Is access to product restricted to those with a business need?
- Do storage containers have tamper-evident seals?
- Is the organization involved with controversial trade?
- Is the organization owned by nationals from conflict areas?
- Is there opportunity for access by sympathizers of single issue groups?
- Do any employees bear a grudge against the organization?
- Is staff boredom, discipline, recruitment a problem?
- Have business competitors been accused of espionage or sabotage?

Risk Assessment In TACCP

Example of Risk Scoring Matrix

<table>
<thead>
<tr>
<th>Likelihood of threat happening</th>
<th>Score</th>
<th>Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very High Chance</td>
<td>5</td>
<td>Catastrophic</td>
</tr>
<tr>
<td>High Chance</td>
<td>4</td>
<td>Major</td>
</tr>
<tr>
<td>Some Chance</td>
<td>3</td>
<td>Significant</td>
</tr>
<tr>
<td>May Happen</td>
<td>2</td>
<td>Some</td>
</tr>
<tr>
<td>Unlikely to Happen</td>
<td>1</td>
<td>Minor</td>
</tr>
</tbody>
</table>
Risk Assessment In TACCP

Example of Risk Scoring Matrix

<table>
<thead>
<tr>
<th>Likelihood of threat happening</th>
<th>Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very High Chance</td>
<td>Threat 1</td>
</tr>
<tr>
<td>High Chance</td>
<td>Threat 3</td>
</tr>
<tr>
<td>Some Chance</td>
<td></td>
</tr>
<tr>
<td>May Happen</td>
<td></td>
</tr>
<tr>
<td>Unlikely to Happen</td>
<td>Threat 2</td>
</tr>
</tbody>
</table>

Bogor Agricultural University

Table A.4 – Threat assessment report 20140421

<table>
<thead>
<tr>
<th>Threat</th>
<th>From</th>
<th>Threat</th>
<th>Vulnerability</th>
<th>Mitigate</th>
<th>Consequence</th>
<th>Impact</th>
<th>Likelihood</th>
<th>Protective action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Suppliers</td>
<td>Non-organic supply</td>
<td>Top-up milk; bought from downstream</td>
<td>All goods from accredited suppliers</td>
<td>Loss of organic status</td>
<td>5</td>
<td>2</td>
<td>Requires certificate of authenticity for all ad hoc purchases</td>
</tr>
<tr>
<td>2</td>
<td>Neighbours</td>
<td>Accessing the plant</td>
<td>Whipped livestock disease</td>
<td>Right of way</td>
<td>Biosecurity management</td>
<td>Loss of herd and/or income in the case of high cost</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>BCC staff</td>
<td>Malicious contamination</td>
<td>Manual operations, unawareness (possibly illegal self-control)</td>
<td>All staff are security trained</td>
<td>Loss of prestige</td>
<td>2</td>
<td>1</td>
<td>No further action</td>
</tr>
<tr>
<td>4</td>
<td>Adjacent farms</td>
<td>Theft of corn</td>
<td>Non-recovered</td>
<td>Association</td>
<td>Loss of organic status</td>
<td>4</td>
<td>3</td>
<td>Cooperative action with trade association to stop theft of officials</td>
</tr>
<tr>
<td>5</td>
<td>Opportunity criminals</td>
<td>Theft of product</td>
<td>Distribution, sale of smuggled and un AUDI</td>
<td>Loss of goods; loss of reputation for reliability</td>
<td>3</td>
<td>2</td>
<td>Replace with more modern vehicle in earliest opportunity</td>
<td></td>
</tr>
</tbody>
</table>

A1: See Figure A.3 for the full vulnerability assessment.
A2: Other goods are routinely sourced from long-standing accredited suppliers.
Reading Materials

- SGS. 2016. Understanding the US Food Safety Modernization Act (FSMA)
- Food Defense Training Materials. FoodProtection.UMN.Edu

Thank You