

TRACEABILITY SYSTEM APPROACHES AND COST
ANALYSIS FOR THE BEEF INDUSTRY

by

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To the Faculty of Washington State University:

The members of the committee appointed to examine the thesis of
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Chair

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TRACEABILITY SYSTEM APPROACHES AND COST
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Abstract

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The paper provides a comprehensive review of the literature on the beef traceability by identifying its benefits and costs. It proposes the comparative view over several qualitative and quantitative papers to the reader. The review also includes the reason of applying traceability into food supply chain, especially into livestock. Moreover, in the literature, different types of traceability models were extensively discussed. Also the literature review provides detailed information on functions of traceability.

Furthermore, this research will analyze the various traceability applications in different countries around the globe. The analysis of various traceability applications in other countries is done by the use of existing experiences comparatively. The different traceability systems in other countries are compared with each other to identify common and unique characteristics that each system has. The comparative analysis of different traceability applications in other countries will help us to measure the ability of U.S.

Small and Medium Sized Enterprises to obtain compliance with the requirements of system

The paper depicts a very important theory that involves a monopolistic competitive market model of a firm aiming at maximizing profit by applying a traceability system. The model also lays out the extra revenue that will be brought in by the application of traceability and cost that will be incurred by the firms.

TABLE OF CONTENTS

	Page
ACKNOWLEDGMENTS.....	ii
ABSTRACT.....	iii
LIST OF TABLES.....	viii
LIST OF FIGURES.....	iv
Chapter	
1. INTRODUCTION.....	1
Research Objectives.....	5
Summary of Findings.....	6
Background of the Study.....	6
2. PREVIOUS STUDIES.....	10
Definitions.....	10
Traceability Functions.....	11
Different Types of Traceability Models.....	13
Comparisons of Different Traceability Applications in Different Countries.....	18
United States.....	20
Japan.....	24
European Union.....	28
Canada.....	31
Australia.....	34
U.S. National Animal Identification System (NAIS).....	36
Premises Identification.....	38
Animal Identification.....	40
Animal Tracking.....	45
AIN Management System.....	46

AIN Tag Manufacturers.....	47
AIN Tag Managers.....	48
AIN Tag Resellers.....	49
E-Authentication.....	50
Tracking Databases.....	51
Comparisons of National Animal Identification System (NAIS) and Country of Origin Labeling (COOL).....	52
DNA Based Traceability.....	43
3. METHODOLOGY AND RESULTS.....	54
Beef Supply Chain.....	54
Cow-Calf Producer (Ranch).....	55
Auction Market (Saleyard).....	57
Stocker.....	57
Feedlot Operator.....	57
Packer/Slaughterhouse.....	58
Radio Frequency Identification.....	58
Components of Radio Frequency Identification System (RFID).....	59
Transponder.....	59
Electronic Reader.....	60
Data Accumulator.....	61
Software/web-Based Analysis and Storage.....	61
Other.....	61
Cost Computation of Traceability from Farm to Fork.....	63
Cow/Calf Producer.....	65
Auction Market (Saleyard).....	67
Stocker.....	68
Feedlot Operator.....	69
Packing Plants.....	70
Traceability Cost from Slaughterhouse to Retailers.....	71
Estimation of Traceability Cost from Farm to Fork.....	74
Economic Interpretation of the results Found in Section 3.4...	75
4. WELFARE IMPLICATIONS	77
The Welfare of Traceability for Consumers.....	77
The Benefits of Traceability for firms.....	81

5. SUMMARY AND CONCLUSIONS.....	91
BIBLIOGRAPHY.....	93
APPANDIX A.....	98

LIST OF TABLES

Table		Page
1.1	Food Borne Disease and Contamination in the Asia-Pacific Economic Cooperation Region.....	3
2.1	Information Sent to National Repository.....	39
2.2	Breakdown of Premises registration Plan.....	40
2.3	AIN Tag Requirements and Description.....	43
2.4	Bovine and Cattle AIN/RF ISO Standards.....	44
2.5	Requirements of AIN Tag Manufacturers.....	48
2.6	Requirements of AIN Tag Managers.....	49
2.7	Requirements of AIN Tag Resellers.....	50
2.8	Information Stored on the Animal-Tracking Database.....	52
3.1	Number of Beef Cows Operations, By Size and Beef Cow Inventory, Selected States, 2003.....	56
3.2	U.S. Feedlot Number, Inventory, and Marketings, By Size, 2003.....	58
3.3	Breakdown of RFID Cost for Various Cow/Calf Producers.....	65
3.4	Breakdown of RFID Cost for Various Saleyard Operations.....	67
3.5	Breakdown of RFID Cost for Various Stocker Operations.....	68
3.6	Breakdown of RFID Cost for Various Feedlot Operations.....	69

LIST OF FIGURES

Figure		Page
2.1	Information Flow in <i>Ex Post</i> Traceability and <i>Ex Ante</i> Quality Verification Programs.....	17
2.2	US Traceability System and the Break in the Slaughterhouse.....	20
2.3	Drop in the Japanese Beef Imports After the Discovery of the First BSE Case.....	24
2.4	Japanese Safety System in Beef Industry.....	26
2.5	European Union Traceability System.....	30
2.6	CCIA Approved RFID Tags.....	33
2.7	Pictures of NLIS Ear Tags of Australia.....	35
2.8	Development Phase of NAIS.....	38
2.9	Premises Registration Plan.....	40
2.10	Projection of Animal AIN Distribution.....	41
2.11	Projection of Animals Slaughtered With AIN.....	45
2.12	The Projected Complete Movement Records of Animals by Year.....	46
3.1	Beef Value Chain.....	54
3.2	RFID Equipment.....	59
3.3	RFID Tag and its Appearance on Cattle.....	60
3.4	Handheld and Stationary Readers.....	60
3.5	Flow of Complete Traceability From Farm to Fork as a Combination.. Of Pending National Animal Identification and DNA.....	62

3.6	RFID Cost for Cow/Calf Producers.....	66	x
3.7	RFID Cost for Various Saleyard Operations.....	68	
3.8	RFID Cost for Various Stocker Operations.....	69	
3.9	RFID Cost for Various Feedlot Operations.....	70	
3.10	Connection of National Animal Identification System and DNA.....	72	
4.1	Short Run Case of Traceability effect and Abnormal Profit.....	86	
4.2	Effects of New Entrants on the First Firm.....	88	
4.3	The Long Run Case of an Individual firm in the Premium Market.....	89	
A.1	Allflex Electronic Ear Tag.....	99	
A.2	Allflex Handheld Readers.....	99	
A.3	Destron Walk-Thru Reader.....	100	

Dedication

To my parents:

Ismail and Mekiye MUS

CHAPTER 1

INTRODUCTION

An increasing demand by consumers for safe food products drives all players globally in integrated food value chains to improve their quality control programs and implement voluntary food safety standards. There are several reasons characterizing this increasing demand to improve food safety standards: of recent historical importance are a series of highly publicized outbreaks involving beef causing a prion based disease called BOVINE SPONGIFORM ENCEPHALOPATHY (BSE) also known as Mad Cow Disease that can lead to an illness in humans called variant **Cruetzfeld-Jacob Disease (vCJD)**. Because of the suspected long onset period for this illness in people, there may be many thousands of individuals who have consumed contaminated meat, but who will not appear to be ill for a number of years, possibly decades. Because of the factors associated with this disease, a number of animal feeding practices were changed in 1997 in the United States, the EU and other countries. Also, there has been an effective prohibition on the sale of animals over a certain age in specific markets as younger animals are less likely to have been exposed to, contracted and retained the prion compared to older animals. Despite the relatively simple preventive measures involving feeding and tracking animal age, adoption of an effective tracking program for beef at the farm level entering the human food chain has been long in coming.

Other food borne illness outbreaks involving bacterial contamination could also be better controlled by improved traceability measures at the slaughterhouse and processing facility. Probably, the most illustrious and highly publicized outbreaks involving beef over the past decade are illnesses associated with a pathogenic form of the *Escherichia coli*. Non-pathogenic forms of *Escherichia coli* colonize the intestinal tract of all warm-blooded animals, but cattle and other ruminants can harbor the pathogenic O157:H7 variant and not exhibit illness symptoms. One of the most famous outbreaks implicating beef occurred in Washington State and other Western states in 1992 involving undercooked ground beef. Later incidents occurred in Scotland in 1999. A 1995 incident in Australia resulted in the death of a child from *E.coli* O157:H7 contamination in sausage (Hobbs, 2003). Some other foodborne outbreaks and countries are outlined in Table 1.1.

TABLE 1.1. Food borne Disease and Contamination in the Asia-Pacific Economic Cooperation Region.

Disease/ Containment	Countries Reporting Outbreaks	Source or Vector
<i>Listeria monocytogenes</i>	Australia, Canada, US	Fruit salad, smoked salmon cream cheese, hot dogs, deli meats
<i>Salmonella</i>	Australia, Chile, Korea, New Zealand, U.S.	Pork rolls, unpasteurized orange juice, mayonnaise, meat raw eggs, fruit
<i>E.coli bacteria O-157</i>	Chile, Japan, Korea, U.S.	Fast food, radish sprouts, meat, unpasteurized juice, lettuce
<i>Staphylococcus aureus</i>	Japan	Unhygienic production-line valve at dairy company
<i>Cyclospora cayetanensis</i>	U.S.	Imported raspberries
<i>Norwalk-like virus</i>	Australia, New Zealand	Sick food handler, oysters
<i>Creutzfeldt-Jakob</i>	Canada (Saskatchewan)	Meat likely consumed in UK from cattle infected with BSE
<i>BSE</i>	Japan	Five cases confirmed since Sept. 2001
<i>Chloramphenicol</i>	Canada	Imported honey and honey products
<i>Cyanide</i>	Chile	Several grapes shipped to U.S. thought to be contaminated
<i>Antibiotics</i>	China	Exports of prawns, shrimp, poultry and rabbit meat
<i>Unreported</i>	China	Soybean drink consumed by students
<i>Rat poison</i>	China	Deliberate poisoning of food in food shop
<i>Cadmium or mercury</i>	Chinese Taipei (Central region)	Rice
<i>Polluted storm water</i>	Chinese Taipei (Taipei city)	Prepared box lunches
<i>High levels of pesticides</i>	Japan	Imported green soybeans
<i>Vibrio</i>	Korea	Seafood (claims)
<i>Dioxin</i>	Malaysia	Imported dairy and meat products
<i>3-MCPD, gravy genotoxic carcinogen</i>	Malaysia	Imported savory foods; soups; prepared meals, snacks, and mixes
<i>Hepatitis A</i>	U.S. (Michigan)	Imported strawberries; point of contamination unknown

Source: <http://www.ers.usda.gov/publications/agoutlook/Dec2002/ao297i.pdf>

Recent reports of food borne illness are posted at the Food and Drug Administration (FDA) and Centers for Disease Control (CDC) websites and in addition through publications such as *Morbidity and Mortality Weekly*.

Chemical contamination is another food safety problem that could be better controlled through improved food safety. A highly publicized food scare in Belgium, in January 1999, involved the contamination of animal feed with dioxin. In this incident, almost 1 gram of dioxins in oil coming from a municipal oil recycling plant was mixed with edible oil in a tank, and this was used to produce an ingredient incorporated into animal feed. Through animal feed, the dioxin passed into the food supply for humans.

Because of lack of a suitable traceability program, the contaminated food could not be readily found and removed from the marketplace. The resultant recall cost millions of Euros and stifled international trade in feed ingredients for over a year. This unfortunate case caused loss of consumer confidence in the safety of the food supply and resulted in millions of Euros losses to a number of companies affected by this recall (The Food Business Forum, 2005).

Such instances have caused more caution and concern about food safety characteristics. Also, these instances indicate that the current food safety and quality standards are not sufficient to satisfy the quality expectations of consumers to assure their trust in the safety of the food supply.

Due to the variety of food safety incidents occurring in different countries around the world, people have lost some confidence in the safety of the food products that they consume. This has led to initiatives that proposit to result in safer products, such as a movement to organic foods, and the marketing of “ecologically clean” products in the EU, Eastern Europe and Central Asia. The success of these programs, when they are legitimate, is due in large part to an assurance that the producer can verify that certain types of contaminants are not present in the food through the use of traceability programs. It is inevitable that traceability will be incorporated into food production practices as a means to gain people’s confidence. For example, Becker (2000) and Wall (1994) identify traceability as a very significant system to ensure the quality production practices and product quality at firm or industry level.

The results of those outbreaks or contamination incidents did not only increase consumers’ concerns over the food products that they consume but also such

instances damaged the reputation of companies operating in certain industries. Some industries suffered from loss of their buyers domestically and internationally and had to bear millions of US dollar investments to improve their reputation due to the outbreaks of food borne diseases. Others, like Hudson Beef went out of business due to a precautionary recall. Because of restructuring of the beef trade between the US and Canada from the BSE incident in December 2003, companies including Iowa Beef have sold operations as a means of remaining viable. To support firms or industries to control those outbreaks in meat sector and reducing costs related with the rehabilitation of the reputation of the industry, improved traceability methods have been introduced as a system and developed in certain countries successfully.

A number of traceability strategies have been applied as a tool to provide the capability to both provide information on the safety of food products and to more efficiently recover any impacted product from the marketplace. A very limited study has been undertaken to show what the potential economic benefits of an improved traceability program could be for an industry segment or for individual firms.

Research Objectives

The overall objective of this research is to highlight economic benefits of the traceability for small and medium sized enterprises (SMEs) by analyzing benefits and application costs. In other words, this research aims at identifying whether small and medium sized enterprises will be better off applying traceability in an integrated food supply chain. The analysis will also propose answers to the questions: will SMEs capture more market power and will they be able to differentiate their products by introducing the

new system to their production practices and work force? In addition, the research will address the following objectives:

1. The research will produce a set of technical assumptions that will show the importance of traceability in the development of trade and markets for SMEs.
2. It will identify and recommend strategies on how U.S. small and medium enterprises can benefit from traceability to improve their trading and marketing opportunities.

Summary of Findings

The study strongly suggests that traceability is a significant tool to assure consumers about food safety and enable firms to differentiate their products to gain advantage over their rivals. In addition, the firm also can benefit from economies of scale to improve efficiency of production practices as illustrated in the chapter 3, section 3.4.

The study also found that traceability has become a crucial issue for the US beef industry to compete in the international as well as domestic market, because major beef producing and exporting countries like Australia, EU, New Zealand and Canada achieved significant steps in producing traceable products to meet expectations of consumers.

Background of the Study

Many countries began mandating traceability in their food supply systems beginning in the 1960s in the form of lot codes for low acid and acidified thermally processed “canned” foods. Country of origin labeling began in the late 1970’s as a tool of government agricultural programs. They were further developed in the 1980s’ through the present day to address concerns over consumers’ right to know and to reduce

fraudulent representation of products in the marketplace. The most recent country (and specific regional) origin labeling came about in 2004 as part of the US Farm Bill and with proposed market restrictions on the use of specific place names tied to popular food products. Examples of the latter led to trade disputes over the use of the name Parmesan cheese (Parma Italy) and champagne (Champagne region of France) among several others. Country of origin labeling in the 1980s and 1990s was also tied with specific zoonotic disease control measures. European Union and Japan are the first to implement and then to mandate traceability through all stages of the production for mammalian muscle food products. As Schwagele (2005) stated, there was a need for traceability in Europe to provide quality verification information to consumers about the origin of the animal, its place of processing, distribution and wholesale, retail outlets. The system enabled certain food industries to instill consumer confidence in the food consumed and also empowered the related public health authorities to be more responsive in the unlikely event that food would have to be removed from the marketplace since it would be easier to identify and recall infected products.

In the international arena, the U.S. beef industry remains behind international competitors in terms of application and development of traceability in food and particularly in livestock (Smith, Tatum, Belk, Scanga, Grandin & Sofos, 2005), and consequently, this has caused U.S. meat exporters to lose market share and has weakened the market power of many US players. Japan, for example, banned the import of US beef because of one infected cow in 2003, and only removed the ban in late 2005. There were recent closures in January 2006 due to failure of U.S. shipments to comply with customer specifications in shipping beef, which contained nerve tissue. This incident resulted in

loss of tens of millions of dollars of export revenues for U.S. beef producers. In response, large U.S. firms that lost export market shares started to strengthen their focus and increase reliance on the domestic market. Also, the restructuring of the U.S. and Canadian beef industries in 2004 and 2005 resulting from restrictions on shipping cattle across the border has had a greater impact on smaller producers and ranchers with regard to both supply and price. Canadian ranchers, particularly those in the border states, were not able to send cattle for processing in the U.S. Similarly, a number of processors in the United States, already in financially tenuous situations, shut down as it became difficult to obtain enough animals to remain financially viable. A strategic change during this period among major players facilitated very strong competition in the market place and pushed SMEs out of the market, because SMEs were not as financially strong as the large firms and was not able to bear high costs of competition in the long run.

An additional factor affecting traceability in the U.S. food supply came after September 11, 2001 when US citizens became more concerned about the safety of critical infrastructure including food and water supplies following the attack on the Twin Towers in New York City. Terrorists had previously targeted the food supply in the United States, with the most notorious incident being a 1984 contamination of the salad bars in 10 restaurants in The Dalles Oregon, along a major east-west interstate highway, by a religious cult intent on throwing a local election. The terrorists intentionally contaminated products with *Salmonella typhimurium*.

As part of a larger program to address the threat of terrorism, Congress passed a law named as *the Public Health Security and Bioterrorism Preparedness and Response Act* (signed into law June 12, 2002) (Shapiro, 2002). The purpose of this law was to

improve government response programs to a public health crisis, including production smallpox vaccine and to change government regulatory control over food and public water supplies. This bill greatly expanded the authority the FDA experts over products it regulates and expanded the agency's jurisdiction over farm production and retail sale (Rasco & Bledsoe, 2005). Within this bill and the resulting regulations are mandatory traceability requirements.

Even today, in the United States traceability is not mandatory for all products, with those regulated by the USDA (meat and poultry) under less oversight than products under FDA control. Actual requirements for FDA regulated foods is open to interpretation, which provides some flexibility to food producers to select a traceability program that meet their needs and those of their customers. Due to the incoherent regulatory framework surrounding traceability in the United States, the primary incentives within the food industry are market driven, with a major incentive being inventory and supply chain management, as well as increased food safety and quality control (Golan, Krissoff, Kuchler, Calvin, Nelson & Price, 2004).

CHAPTER 2

PREVIOUS STUDIES

People are increasingly more concerned about food safety. They want to be confident that they consume safe food, which complies with well-accepted food safety standards and regulations. Nortje (2002) stated that consumers especially in developed countries such as the U.S., those of the EU and Japan are becoming more concerned about the safety of their food. Similarly higher income individuals in developing countries are demanding safer food as they now have the economic power to influence the marketplace to make provision of safer food a reality. Traceability is one of many means used in marketing programs to help people become more confident that the food they consume is safe since one of the key features of a traceability program is the ability to verify that the food complies with specific food safety standards. Another feature is the ability to isolate only affected products that might have become contaminated, allowing other similar product to remain on the market in the case of a recall event regarding food safety. In order to better understand what traceability is, we should first look at how it is defined.

Definitions

In the General Food Regulation Law of European Union, traceability is defined as “the ability to trace and follow a food, feed, food-producing animal or

substance intended to be or expected to be incorporated into a food, feed through all stages of production, processing and distribution.”(Article 18, General Food Law 2004, p.8).

Traceability is defined by the International Organization for Standardization (ISO) “as ability to trace the history, application or location of that which is under consideration.” (The Business Forum, 2005, p.7).

Previously provided definitions state that the traceability may be defined in several ways, all of which overlap to some degree. A general definition recognizes traceability as a method that enables tracking of inputs and outputs in all stages of the supply chain and tracing a product and its components back to their source of origin in the case of a contamination problem.

Traceability Functions

According to Hobbs (2004a) Traceability has three main functions to be performed, which are the follows:

First, is to make the trace back of the products easy and rapid in the event of a contaminated product or one, which does meet product standards, if it has to be removed from the market. By this, an effective traceability program limits the problem from spreading more and reduces the cost for companies of the impact of a recall or market withdrawal (*e.g.* less reduced loss of sales, less lost revenue, less affected product on the market, less damage to the company image and less lost goodwill with customers and the general public). Accurate and complete tracking records for products can reduce the impact of a product recall by limiting the scope since potentially affected product can be

better defined and contained. If there is an illness outbreak associated with food, traceability programs can provide background information that could improve diagnoses and reduce the overall cost for patient care since it may be possible to determine more quickly and accurately which individuals may have been made ill by an implicated food.

Second, is the ability to mitigate damages in a contract, commercial law and tort actions. The primary losses from a food recall to an affected firm come from disruptions in the supply chain. Consumer litigation under state product liability and consumer protection laws exposes a company responsible for the distribution of allegedly contaminated food to strict liability. The company distributing a contaminated product is likely liable for any damages resulting from the consumption of the food regardless of whether or not the company was negligent.

Buzby and Frenzen (1999; Buzby et al., 2001a, b) point out that the legal incentives for firms to produce safer foods and practice due diligence in the US are limited, because less than the 0.01% of the cases of food borne illness are taken to court, most likely because the source of contamination could not be attributable to a particular food product, and in addition, because negligent consumer food handling practices could not be ruled out. In the cases that are litigated, the rate of compensation is low. Regardless, the application of traceability provides an incentive to avoid litigation, particularly as it becomes widely adopted throughout the industry. A common legal standard for a defendant in suits brought under a negligence cause of action is that of a “prudent processor” an individual or company that can be shown to have exercised “reasonable care” in processing and handling a food. As industry practices improve, the level of care required of processors increases causing both a market driven improvement

in food safety and an improvement in overall quality standard practices. It is possible that litigation in the US will find fault with the effectiveness of a company's traceability program and introduce this deficiency in a food traceability program as evidence that the company failed to exercise reasonable care. For food products, including FDA regulated products, where traceability is mandated by regulation, failing to have a traceability program will constitute negligence *per se*, providing some evidence, but not conclusive evidence, that a company was negligent (Rasco, 1997; Buzby et al., 2002). Regardless of the legal theory that might be employed to impose liability upon a company, traceability programs will provide another incentive for firms to produce safer food, because they will know that in the case of an outbreak the supplier of the infected product could be easily determined.

Third, is basis for a developing a traceability program is for pre-purchase quality verification. With traceability information, a purchaser will be able to have relevant information on the quality properties of a product. With traceability, a purchaser may also be able to verify growing conditions, inspection protocols and nutrient content in addition to the information that is already provided such as the packing date, place, and producer etc. and what can be recovered through barcodes or product labeling to identify product features.

Different Types of Traceability Models

According to Hobbs (2004a), there are two distinct models for traceability: *ex post* traceability and an *ex ante* quality verification systems.

An *ex post* traceability system would be appropriate in the case of a foodborne disease outbreak or intentional contamination incident. It traces back the product to the lot or source of contamination and then traces forward to locate the contaminated product in the marketplace, providing the ability to isolate it from unaffected products.

Theoretically, similar products, which were not affected, would not be involved in the market withdrawal, reducing the costs of a recall and, hopefully, saving a company's reputation. As Hobbs (2004a) points out, there are three additional costs for a company in the case of an outbreak that results in a market withdrawal.

The first cost is the ***market penalty cost*** if the company is the provider of the contaminated food. A market penalty cost for a specific firm, is the cost associated with the loss of demand for the products, because fewer consumers are willing to purchase their products, which in turn, leads to lower revenue.

The second cost is the ***legal liability cost*** imposed on a firm, which is the supplier of the contaminated products since food producers, in the United States and the EU are strictly liable for damages such food borne illness or physical injury if a consumer is injured by consumption of their product. This cost greatly exceeds Hobb's concept of due diligence in producing food as companies are liable for damages without fault.

Employment of industry best practices will not insulate a company from strict liability claims. Due diligence is some protection against cases arising under a negligence cause of action and involves the steps taken to produce safer foods or products. An example to due diligence is a Hazard Analysis Critical Control Point (HACCP) food safety program. For seafood products under the FDA and meat and poultry products under the United States Department of Agriculture (USDA), which must follow HACCP, programs are

required and have been required for the past 8-10 years. Having a HACCP plan will not reduce liability exposure, but it could be useful of mitigating damages resulting from a recall. In addition to the formalized food safety programs, liability cost will be imposed to those firms that do not take steps to produce safer foods if they are not engaging in practices that would limit the liability of other companies down the supply chain. For examples, corporate buyers are less willing to purchase products from vendors that do not process under a validated HACCP plan and make it a requirement of vendors within a preferred supplier program to participate in corporate audit programs to show that the supplier firm is following industry best practices regarding manufacture and sanitation. The market penalty and liability costs arise in the absence of an effective traceability program for the buyer are greater if the supplier of the contaminated food cannot be clearly identified.

The third cost discussed by Hobbs (2004a) arises is named *externality cost*. Because contaminated product suppliers cannot be detected in the absence of traceability system, all the firms operating in the industry incur the cost caused by a lower demand by consumers for all the industry products regardless of the provider of the product because of a lack of confidence in the product category. This is known as an *externality cost*.

*Ex ante*¹ quality verification works differently than *ex post*² programs. In an *ex ante* system, a third party verifies the quality of the products or the compliance of the producers with the standards. The effectiveness of such a program from a profit

¹ The *ex ante* is Latin word means in the context of the traceability: “tracing the product up to the consumer by providing quality verification information.

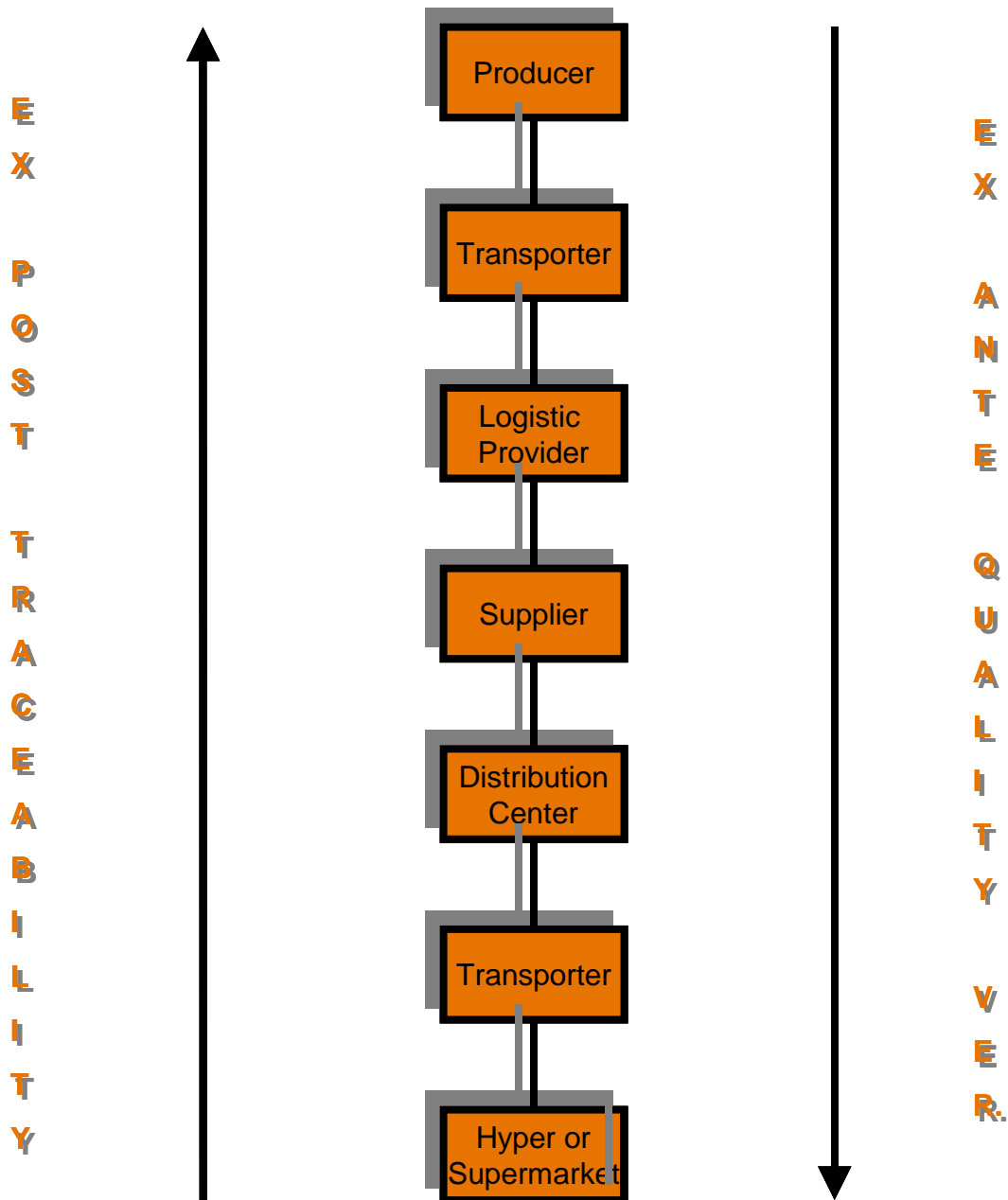
² The *ex post* is also Latin word means in the context of the traceability: “tracing the product from consumer to the origin or farm.

maximizing company depends on the effectiveness of the monitoring party. As Hobbs (2004a, p.408) claims “traceability has little value for *physical quality* characteristics identifiable by the buyer through a search process prior to purchase” (Hobbs, 2004a). An *ex ante* program can verify following attributes such as:

1. Health Quality: these are attributes that a consumer cannot detect prior to purchase. Monitoring by a third party is required to verify that products are in compliance with the specified standards (e.g. fat and trans fat content, cholesterol, fiber, phytochemical type and content).
2. Ethical Quality: These attributes refer to agricultural, marketing and labor practices. Some ethical quality attributes would include whether animal welfare friendly methods were used in production. A company may use products promoting the sustainable agricultural practices in its production, which would be extremely difficult if not impossible to detect by an analysis of the product, as it would be rare for the sensory attributes, physical structure or chemical composition of the product to be different in foods that did not have the target ethical quality attributes. The only way to verify if such a program is being followed is for a third party to audit the program ensuring that the specified guidelines are met.
3. Environmental Quality: Certain aspects of organic farming fall under this criteria as far as soil and water management issues are concerned. Other issue with organic farming, such as the presence of impermissible levels of agricultural chemicals or drug residues can be detected, albeit at a high cost.

To better understand these two systems, Figure 2.1 depicts both *ex post* traceability and *ex ante* quality verification systems.

FIGURE 2.1 Information Flow in *Ex Post* Traceability and *Ex Ante* Quality Verification Programs



Comparison of Different Traceability Applications
in Different Countries

As it is stated in the previous parts of the study, traceability is increasingly becoming an important means to assure food safety and provide valuable market information about a product that is not readily discernible.

The main objective of traceability is to maintain consumers' confidence. Firms, however, would like to gain the confidence to be more competitive compared to their rivals and make more profits since businesses exist to make money. Public authorities would like to have traceability in their supply chain to protect the public's health and to pinpoint the responsible player for the contamination within a very short period of time.

There are some countries, which have made traceability mandatory, and some, which recognize voluntary programs for beef products. Countries of the EU and Japan have made traceability compulsory for the firms operating in the food sector; the level of traceability applied in these countries is from farm origin to table (Souze-Monteiro & Caswell, 2004). In Australia and Brazil, traceability is voluntary for the local market but it is mandatory for companies that are exporting to Europe and Japan (Souze-Monteiro & Caswell, 2004) Argentina imposed traceability only upon exporting firms and to companies, which produce meat and livestock products in regions where animal diseases are often encountered. In the Argentinean domestic market traceability is not compulsory if the firm produces meat in a recognized safe region (Souze-Monteiro & Caswell, 2004).

In this part of thesis work, the different traceability systems are analyzed and compared in those countries, which are stated above.

There are certain differences among traceability systems applied by different countries. In order to understand these differences, the definition and description of breadth depth, and precision must be known.

Breadth: *breadth* “describes the amount of information the traceability system records. There is a lot to know about the food we eat and a record keeping system cataloging all of a food’s attributes would be enormous, expensive, and unnecessary.”

Depth: *depth* “describes how far back or forwards the system tracks. In most cases, the depth of a system is largely determined by its breadth: once the firm or regulator has decided which attributes are worth tracking, the depth of the system is fundamentally determined.”

Precision: precision “reflects the degree of assurance with which the tracing system can pinpoint a particular food product’s movement or characteristics. The unit of analysis used in the system and the acceptable error rate determines precision.” (Golan et al., 2004).

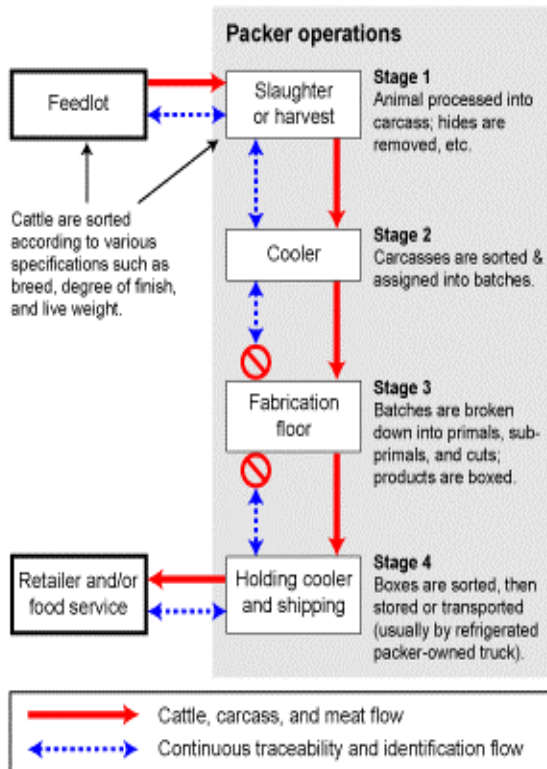
United States

In the states of Washington and Texas in December 2003 and June 2005 respectively, two BSE infected cows were identified, which led the United States to seek a better tracking system for use in livestock sector (Bailey, Robb & Checketts, 2005).

Currently, the U.S. traceability system is based on two steps. The first step is from farm to slaughterhouse and the second is from processing plant to retailer (Bailey,

Robb & Checketts, 2005). The following diagram in Figure 2.2 better illustrates the how the two-step U.S. traceability works, and where the break occurs

FIGURE 2.2. US Traceability System and the Break in the Slaughterhouse



Source: Bailey, Robb & Checketts, 2005

Unfortunately, by using this two-step traceability, beef and beef related products could not be traced from the farm to the retailer in a seamless fashion because of the break between slaughter and processing. During processing, carcasses are cut into pieces and portions of meat from different animal can become commingled on the fabrication floor (Bailey, Robb & Checketts, 2005). This should be less of a problem for US beef producers if younger animals are being slaughtered. “Recently, the World Organization for Animal Health (OIE) recommended that deboned skeletal muscle meat from animals less than 30 months should not require any BSE-related conditions” (Bailey, Robb & Checketts, 2005, p.4). If this standard is taken as base in the meat trade

then, this break in two-step U.S. traceability system will not prevent traceability from retailer to farm, at least for the risk of BSE, however problems would still exist for other types of possible contamination. For example, this 'break' in traceability would increase response time for recalling product that would be affected in an incident involving chemical contamination of feed, such as the dioxin incident in Western Europe in 1999.

In the United States, food producers have developed an enormous ability to track the flow of food products through the supply chain. Since there is no strict mandatory protocol, companies are able to develop individualized traceability systems that are effective for their operations; therefore the systems used vary widely across the country and between different industry segments.

The US Congress mandated Country of Origin Labeling (known as COOL) for many crops and products including beef in the 2002 Farm Bill (Smith et al., 2005). "Regardless of whether pressure for better tracking comes from consumers, suppliers, or procurers, it is likely that the U.S. meat system will continue to move toward more traceability" (Bailey, Robb and Checketts, 2005, p.8). Moreover, the COOL would inform consumers about the country of origin and enable retailers to label whether the beef product of the cattle were born and raised in US (Smith et al., 2005). Except wild and farm-raised and shellfish implementation of provisions for all covered commodities has been delayed until September 30, 2008 (<http://www.ams.usda.gov/COOL>).

The BSE cases in Canada and the U.S. have changed the approach of government and industry toward how the USDA addresses traceability for products under its jurisdiction in the United States (Souza-Monteiro & Caswell, 2004). The government started taking more serious actions and has constituted an expert team to work on the

Animal Identification Plan (USAIP), also known as National Animal Identification Plan (NAIS) for U.S. livestock. In the United States, currently, traceability systems such as animal identification are voluntary and it is more market driven. Golan et al (2004) specified the incentives for US firms for applying traceability in their systems as follows:

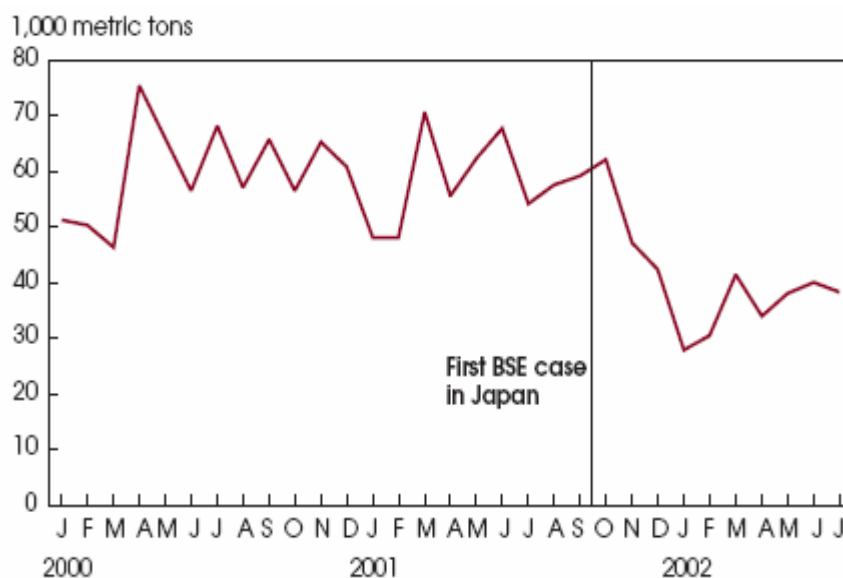
1. **Supply-side Management:** The ability of a firm to reduce cost such as movement, storage, and control of products in the supply chain is the determinant for that company to be successful or to go bankrupt. Since companies operating in the food industry where profit margins are very low, then, supply-side management becomes more important if a firm is to remain competitive in the market. Therefore, an effective and efficient traceability system is a key factor to reducing the cost associated with the above given supply-related activities.
2. **Food Safety and Quality Control:** Traceability for food safety and quality control is an essential tool to facilitate the isolation of a source of contamination and reduce the impact of a food safety problem. If the system applied is very precise, then it can be very fast to identify the problem and resolve it. The incentive for firms is to have the ability within a traceability system to minimize the production and distribution of unsafe or poor quality products, which will in turn, minimize the potential for bad publicity, liability and recalls.
3. **Differentiate and Market Foods With Subtle or Undetectable Quality Attributes:** Since the food industry and especially the meat sector is very competitive, firms operating in this sector are trying to differentiate their

products in order to stay competitive in the market. Companies use a number of different ways to differentiate their products from those of their competitors; including taste, texture, nutritional content, feeding techniques and origin. Consumers can discern some of the characteristics and cannot discern others, which are known as credence attributes. The only means to allow consumers to discern these attributes is traceability. Credence attributes can be gathered under two basic topics:

- I. Content Attributes: These attributes can affect the physical characteristics of products and they are difficult for consumers to realize.
- II. Process Attributes: These attributes do not have any affect on the products consumers purchase (known as a final product). However, these attributes refer to characteristics of the production process, such as country of origin, free-range, dolphin-safe, or earth friendly.

Both US public and private authorities are more careful in responding to the concerns of international and domestic markets (Souza-Monteiro & Caswell, 2004, p.21), because the markets have become very sensitive to food safety issues. For example, the first Japanese domestic BSE case dramatically decreased beef imports, which can be seen in Figure 2.3.

FIGURE 2.3. Drop in the Japanese Beef Imports After the Discovery of the First BSE Case



Source: <http://www.ers.usda.gov/publications/agoutlook/Dec2002/ao297i.pdf>

Since the US was the top exporter of beef to Japan, it incurred the most severe cost. In addition, in 2003, as the result of a single incident of a US BSE infected cow, which came originally from Canada, Japan closed its market to US beef for 2 years. This ban was removed in December 2005. In January 2006 because of shipment of veal that did not meet specifications Japan again closed its market.

Japan

Like the EU, Japan has experienced a number of food related outbreaks that have been used to impose trade restrictions. BSE was present in its domestic cattle production, which caused a major scare among the Japanese people. The Japanese government tried to take steps to control the problem. In response to outbreaks the Japanese government introduced a series of new regulations and assurance programs and

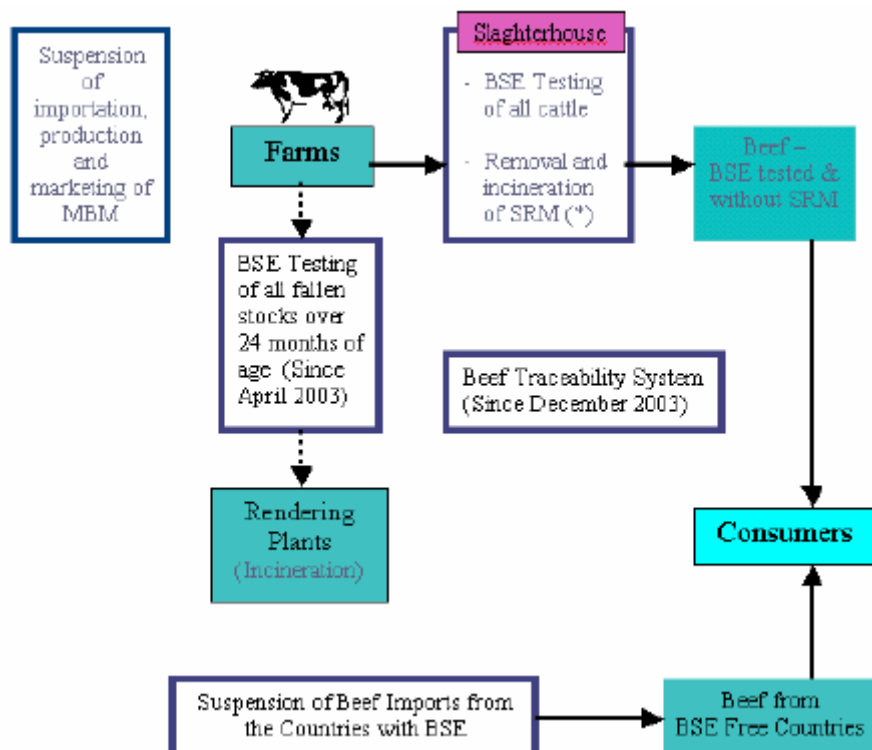
many of these were at least based upon traceability systems (Clemens 2003b). As Clemens (2003a) stated these new assurance programs with traceability will bring extra cost to agents in the meat supply chain and also, if importers' demand regarding traceability cannot be met by their suppliers may lead to loss of market share to competitors.

The Japanese government applied traceability in livestock to identify the cohorts in the event of animal diseases and passed a law to control BSE in July 2002, which required traceability from feedlot to packing plant (Clemens 2003 b). In this new system, each cow was given an identification number and producers must submit information such as date of birth, sex, breed, name and address of the owner, place and date of fattening begun and date of slaughter (Clemens 2003 b). The Japanese government was responsible for enforcement of this system and the collected data on individual animals was entered into a database called. "Family Register" (Clemens 2003b).

In June 2003, the Japanese government passed another law, which required traceability from farm to retail sale and all the stakeholders in the supply chain requiring processors, distributors, and retailers to implement a traceability system and prove information by December 1, 2004 (Clemens 2003 b).

The Japanese traceability system is mandatory for domestically produced products (Clemens, 2003a). The Figure 2.4 demonstrates how the Japanese safety system works.

FIGURE 2.4. Japanese Safety System in Beef Industry



(*) SRM (Specific risk materials) includes, among others, brain, spinal cord and eyeballs, as well as the distal part of the ileum, of every cattle regardless of the age.

Source: Steinhoff, 2005.

Many of the Japanese supermarket chains are making traceability information available to their consumers as a means of gaining their customers' confidence and can provide individual identification of cuts back to individual animals. A similar system has been in place in the UK since 2003.

For instance, Jusco supermarkets (Aeon Company, Ltd) applied one of the most comprehensive traceability systems in the Japanese meat market. Under this system customers can enter the 10-digit code on the product into computers located in its outlets

to get information about the products they purchased (Clemens, 2003a, b). Customers can read as well as print out the BSE certificate, which the Government issues, and include an official stamp and a statement indicating that the meat was delivered to their company (Clemens, 2003 a). This certificate also includes information such as date of slaughter, breed, sex, slaughter number, name of the producer, the carcass number, the unique identification number and date. In addition to this information, the name and address of the packing plant and the inspector's name is identified.

Second, customers can read and print out another certificate, which enables customers to trace the animal back to its time and place of birth, and the information in this certificate is similar to that of the first certificate and information such as the shipping date, ear tag number, and slaughter date and processing plant (Clemens, 2003a). Finally, by entering the 10-digit code consumers can see the producers' picture, because market research shows that Japanese consumers feel more comfortable about the meat they purchase when they see they can identify with the individual or individual company responsible for producing their food (Clemens, 2003a). Other Japanese markets are using similar systems to assure consumers about the safety of their products of the producers.

As Souza-Monteiro and Caswell (2004) point out, the introduction of a mandatory traceability system in the Japanese meat sector has had some effects on beef trade. Since Japan is one of the major beef importers, many of its beef suppliers are facing the challenge of introducing traceability in their production practice to market to Japanese supermarkets. Souza-Monteiro and Caswell (2004) also point out, the breadth of Japanese traceability system is broader than that of European Union and both countries Japan and European Union have equal traceability in place regarding precision.

Moreover, the precision of the system is from individual animals to their place of birth and the integrity verification is DNA.

European Union

On the first of July 1987, the Single European Act took effect with the objective of completing the Single European Market by 1992 (McGrann & Wiseman, 2005). The freedom of movement of live animals such as cattle, pigs, sheep and goats for different purposes make it obvious that an effective identification and tracking system is needed within the new single market (McGrann & Wiseman, 2005).

After the unification of the single market, insufficient transnational traceability within the new market became a serious threat to health of people and animals being traded (McGrann & Wiseman, 2005). According to a European Union research, 11% of the food that is controlled in the EU does not comply with the EU legislation (Trienekens & Beulens, 2001).

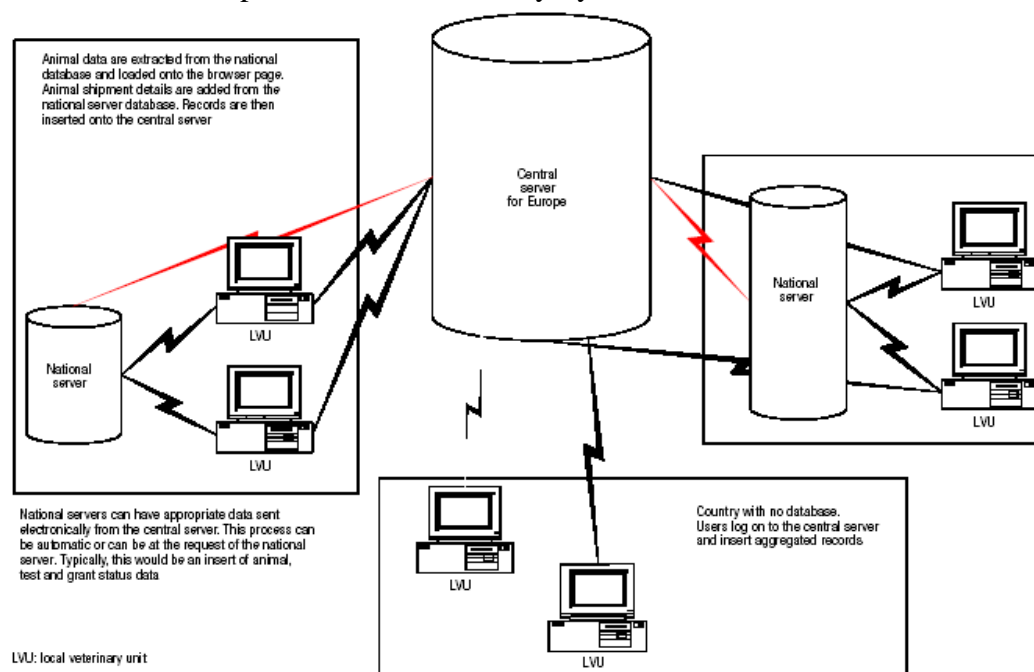
Between 1990 and 1999, beef consumption went down by 6% because of the discovery of variant Creutzfeldt-Jacobs disease, the human variant of BSE (Trienekens & Beulens, 2001). In 2000, new BSE cases were found in France and Germany, which led to 80% reduction in cattle meat sales in Germany, by mid-February 2001. The occurrence of such BSE cases in the EU increased the necessity of an effective traceability system in the European Union. Article 18 of General Food Law 2002 states the traceability is to be applied at all stages of production for food, feed, food-producing animals, and any other substance that is intended to be or expected to be incorporated into a food or feed. By this

law food and feed businesses or operators should be able to identify their suppliers. For this, such businesses and operators should have the needed systems in the place to make any information query available to the competent authorities in the charge.

On January 1, 2005 the European Union mandated the traceability for all food and feeds produced within the EU and imported into the EU (<http://useu.usmission.gov>). There are two important provisions under the Regulation (EC) 1760/2000. Under Title I as Souza-Monteiro and Caswell (2004) point out; two individual ear tags must be used as part of the mandatory animal identification. One of them is an animal passport, which is a document, issued for each animal within 14 days after birth and includes information regarding animal health, movements and production procedures. “The second one is a computerized database in each member state used to provide the link between farms and abattoirs where animals are slaughtered” (Souza-Monteiro & Caswell 2004, p.8). Figure 2.5 better illustrates the way the system works in the European Union. As seen on the below Figure 2.5 there is a central database for Europe which collects information from individual state’s servers. As McGrann and Wiseman (2001, p. 410) state:

“The advantages of this approach are low maintenance and installation costs. The animal movement database application would be managed centrally. Maintenance of master files and look-up tables would also occur centrally. National servers would be updated electronically from the central server. Users would not need to dial up to transmit or receive messages. In addition, message would be available for users to query immediately after inversion”.

FIGURE 2.5. European Union Traceability System



Source: McGrann & Wiseman, 2001

Under Title II, as Souza-Monteiro and Caswell (2004) state, there are two labeling schemes to assure traceability from slaughterhouse to retail. Under the mandatory community beef labeling system each beef must be labeled with a reference number to provide a strong link between meat and animals or group of animals and for further processing, the labels must show the place of processing. Under the voluntary labeling system, all parties involved in meat production must provide the authorities with a specification for approval in the member states where the business takes place for the sale of the beef being considered.

In the European Union beef market, DNA-based traceability has been used to provide a clear link between the source of the carcass and meat pack by matching the DNA profiles of batch of origin and the code on the beef pack in the market (Loftus, 2005).

The mandatory traceability system being applied in the European Union is quite precise, deep and narrow in terms of breadth (Souza-Monteiro & Caswell, 2004). The possible shortcoming of the European traceability occurs in the slaughterhouse because of the links established with group of animals (Souza-Monteiro & Caswell, 2004).

Canada

The Canadian Cattle identification (CCID) is an industry initiated trace back system established to contain and eradicate animal disease. The Canadian Cattle Identification Agency (CCIA) established in 1998 to implement the identification system in Canadian livestock. The CCIA launched the identification in the Canadian livestock as a voluntary system in July 2001 and it became mandatory in July 2002 (Lawrence, Strohbehn, Loy & Clause, 2003). The Canadian identification system is simpler compared to that of Japan and European Union (Souza-Monteiro & Caswell, 2004). In this system, cattle that are going to leave the herd are issued an ear tag, which has a unique number (Hobbs, 2004b). The cattle carry the tag until the slaughterhouse whether it is removed by the operator in the facility and reported to the authorities within 30 days (Souza-Monteiro & Caswell, 2004). The tags are distributed by centers that are authorized by CCIA and report to CCIA on the issued ID number to the producers (Hobbs, 2004b). The CCIA provides the necessary software to those authorized centers to report the sales of tags promptly and CCIA provides a premise identification number to producers. The sales of tags are registered to this number and reported to CCIA through the software. There are 1500 retailers or authorized centers across Canada provide tags to

producers (Lawrence et al., 2003) There are penalties issued to non-compliant producers by CCIA. If more than 5% of the cattle in a group is not tagged or missed tag, a C\$^{\$} 250 (\$226) penalty is issued to producer (Lawrence et al., 2003). If there is commercial non-compliance, the penalty changes from C\$ 500 (\$452) to C\$6000 (\$5424). If the CCIA official tag is deliberately dropped out, the penalty is 1,000 C\$ (Lawrence et al., 2003).

The Canadian Cattle Identification system is the world leader in animal identification with its 97% compliance (www.canadaid.com). The following example better illustrate the effectiveness, (Lawrence et al., 2003):

“A Canadian Food Inspection Agency (CFIA) inspector detects problems during a post mortem inspection at a packing plant. He states that the tag number is 298278605. CCIA or CFIA enters the necessary passwords to get into the database and requests a tag history for that tag number. Within seconds the screen reports that the tag number had been allocated by CCIA to Ketchum Manufacturing for production purposes on November 16, 2000. On March 20, 2001, the tag was sold through a Ketchum distributor to John Newman. On August 1, 2002, the tag number was retired from Better Beef Packing plant in Guelph, Ontario. Double clicking on John Newman’s name provides his contact information”.

The Canadian Cattle Identification Agency (CCIA) is in the process of moving into electronic bar codes scanners and Radio Frequency Identification[®] (RFID) readers to make the system more efficient and credible. The overall goal of RFID Reader Program is to ensure the cattle industry has the ability and necessary equipment for comprehensive tracking and traceability. All the cattle leaving the farm must be tagged with a CCIA approved RFID as of September 1, 2006. CCIA will recognize the bar coded tags until December 31, 2007 to facilitate the transition. There are a number of benefits of RFID listed on the CCIA website:

^{\$} Canadian Dollar, 1 US \$=1.1062 C\$,
http://teachmefinance.com/Charts/US_Dollar_Foreign_Exchange_Rates.html , 06/10,2006, 13:04

[®] Radio Frequency Identification (RFID) is a type of technology that uses reader to scan the ear tags and transmit the data to receiver, which is usually a computer.

1. Provides the necessary basis for full animal movement tracking;
2. Provides accurate and efficient trace back information;
3. Ensures Canada has an accurate and comprehensive age verification system;
4. Allows for optimal retention;
5. Allows for the electronic reading of numbers without previously required line of sight;

The producer can only use the CCIA approved RFID tags. The pictures of the CCIA approved RFID tags have been depicted below in Figure 2.6.

FIGURE 2.6. CCIA Approved RFID Tags



Source: www.canadaid.com

CCIA conducts audits to ensure that all the tags entering the market place are CCIA approved.

Souza-Monteiro and Caswell (2004) state that the effect of Canadian traceability on the supply chain is smaller than that in Japan and European Union,

because Canadian traceability is not extended to retail outlets. However, it does trace back the beef from export ports to farm (Souza-Monteiro and Caswell, 2004).

Australia

Australia maintains its position as being the world's largest beef exporter by supplying over 100 global markets. It has been internationally accepted as being free of all major animal illnesses such as Foot and Mouth disease (FMD) and BSE (www.mla.com.au).

To protect the reputation of Australian beef, government and industry jointly established the SAFEMEAT to ensure that beef produced in Australia meets all sanitary and safety standards (www.mla.com.au). Due to the application of strict and comprehensive measures to protect Australia's free of major animal's illnesses, it is recognized as Level 1 free of BSE by the European Commission Scientific Steering Committee.

In order to identify livestock in the country, in 1996 Australia, jointly with the industry, developed the National Livestock Identification System (NLIS). The NLIS was implemented voluntarily in all Australian states and the State of Victoria mandated the NLIS (Souza-Monteiro & Caswell, 2004). "The NLIS is a whole of life identification system that enables the individual animals to be traced back from property of birth to slaughter for food safety, product integrity and market access purpose" (Meat and Livestock of Australia, 2006). The most important reason for the full implementation of the NLIS is the fear whether the current tagging system can enable tracing of cattle in case of a Food and Mouth Disease (FMD), because a government study showed that the

overall economic loss as a result of a FMD outbreak could be between \$2 to \$13 billion (www.mla.com.au).

Before the introduction of NLIS, Property Identification Code (PIC) known as a mandatory tagging system has been in place since the 1960s. In this system, each producer that breeds cattle is assigned a unique identification number and every cattle on the land is tagged at the tail with that specific assigned number before the cattle leaves the farm or the land (www.mla.com.au). In fact, this system constitutes the basis of the current applied NLIS.

The reliability of NLIS is higher than other available identification systems, because, the tags are read electronically and the data obtained is transmitted safely, accurately, and quickly via the internet (www.dpi.vic.gov.au). The information collected by the NLIS devices about the animal's movement and history is stored on the national NLIS database, which allows tracing of the cattle from farm to the point of slaughter.

For the cattle, there are two different types of NLIS tags used as seen below.

FIGURE 2.7. Pictures of NLIS Ear Tags of Australia



Breeder Tag



Post Breeder Tag

Source: www.allflex.com.au

The breeder tag is used for the cattle before it leaves its birth of place, and the post tag is attached to animals that are not anymore at the birthplace and are not attached white breeder tag.

In order to identify the cattle, machine-readable Radio Frequency Identification devices are used, which are depicted above, in the NLIS. These devices are endorsed by NLIS and have a microchip with a unique identification number linked to the PIC (www.mla.com.au). In case of an outbreak, the cattle can easily be traced back and linked to the farm it was raised by accessing the database, where all the information about the cattle stored.

A study conducted by the Eclipse Group (2004, p.4) offers the following findings about NLIS.

1. “All data sourced from the data sources was valid;
2. Any difference between the source data and data held in the NLIS database was due to subsequent movements of the animals; and
3. The NLIS database accurately records animal movements.”

Souza-Monteiro and Caswell (2004) concluded that the NLIS is precise and more reliable than the identification systems in Europe and Japan because of the electronic identification tags. The reason is that, in the RFID technology, reading the microchip placed in the ear tag does identification and the radio waves are converted into information and stored in the firm’s database (Kelepouris & Pramataris, 2005).

Therefore, the error rate is very low and the information collection is very rapid and precise.

U.S. National Animal Identification System (NAIS)

The increased number of animal disease outbreaks and the two cases of BSE, also known as mad cow disease, are the important developments that drew attention for the need of a nationwide identification system in the United States. In order to safeguard

US animal health and provide traceability in the supply chain, the USDA introduced the National Animal Identification System (NAIS), which is a Federal-State joint program carried out by the Animal and Plant Health Inspection Service (APHIS). In fact, the United States is familiar with identification systems. In 1940s, in order to identify the cattle that got vaccinated for brucellosis from those of not vaccinated, ear tattoo used which government officials provided. The main objectives of the implementation of National Animal Identification System are to:

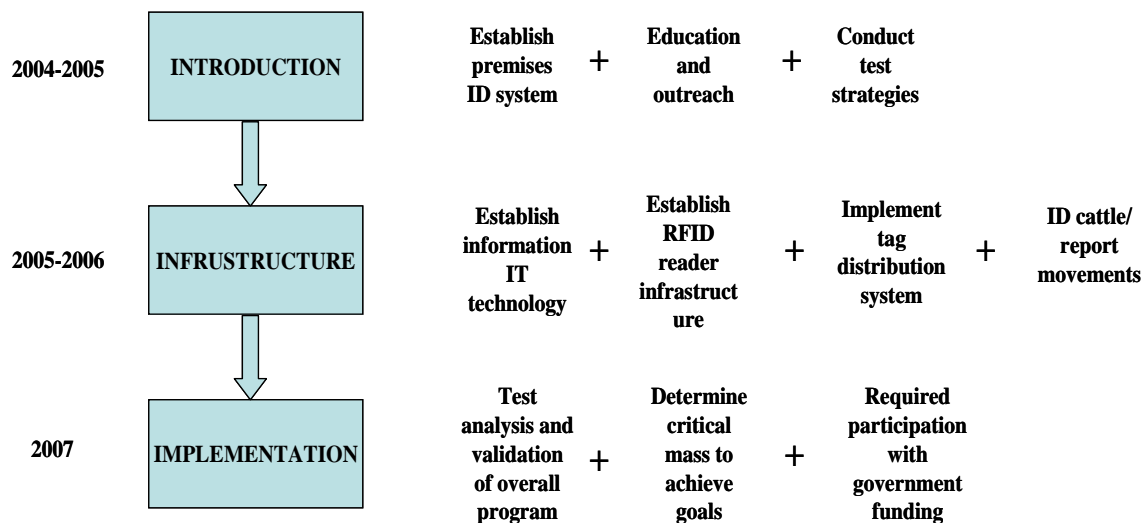
1. Enable State and Federal animal agencies to swiftly determine animal health status to issue intrastate, interstate or international animal certificates.
2. Enable State and Federal agencies to identify the lost or scattered animals caused by natural disasters.
3. Enable State and Federal agencies to take actions against animal disease outbreak.

The ultimate long-term goal of NAIS is to identify all the premises and animals the infected animal had contact with within 48 hours after the discovery of the disease.

The National Animal Identification System is a *voluntary* program. The USDA would make the program mandatory only if it decides that it is necessary to do so.

Figure 2.8 depicts the development phase of NAIS.

FIGURE 2.8. Development Phase of NAIS



Source: Lawrence and Martin, 2004

Premises Identification

Premises identification constitutes the foundation of NAIS. USDA assigns all participating premises in the program a unique seven-digit identifying number, which is also known as premises identification number (PIN). Registering the premises by assigning them an identifying number will enable the officials to contain the animal disease panic rapidly and efficiently (NAIS, 2006).

The premises registration will be carried out by States which will forward some of the information necessary for the national level health officials to rapidly find out the premises the infected cattle had been in case of a disease outbreak to the national premises information repository maintained by USDA. The national premises system includes three parts, as follows:

1. The Premises Number Allocator: It is carried out at a national level and in connection with the premises registration at State level. USDA assigns a

unique seven digit-premises identification number through the premises number allocator.

2. Premises Registration System: This is a database program, which has the necessary information about the premises and provides premises identification number. States carry out the premises registration and necessary information collection.
3. National Premises Information Repository: This is the National level database where some of the necessary information for contacting and immediately identifying a specific premises is forwarded. Table 2.1 depicts the information forwarded to national premises information repository:

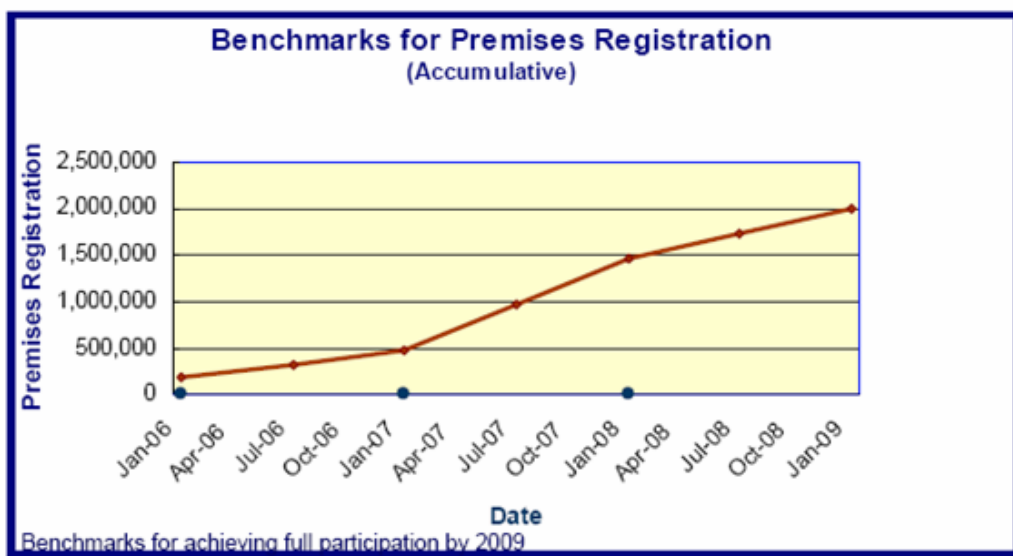
TABLE 2.1. Information Sent to National Repository

Data Elements
Premises ID Number
Name of Entity
Owner or Appropriate Contact Person
Street Address
City
State
Zip/Postal Code
Contact Phone Number
Operation Type (e.g., production unit, exhibition, abattoir, etc.)
Date Activiated
Date Retired (e.g., date operation is sold, date operation is no longer maintaining livestock)
Reason Retired

Source: www.animalid.aphis.usda.gov/nais

According to the estimates of APHIS, there are two million premises, which include all locations rearing livestock and poultry in the United States. They are scheduled to be registered by 2009. The USDA has registered 235,000 premises as of March 2006 and planning to register 240,000 more by the end of 2006. Figure 2.9 and Table 2.2 is depicting the projected timelines for the premises registration:

FIGURE 2.9. Premises Registration Plan



Source: www.animalid.aphis.usda.gov/nais

TABLE 2.2. Breakdown of Premises Registration Plan

Year	% Reg./Yr.	Annual Registrations	Date	Accumulative Total
< 2006		175,000		
2006			Jan-06	175,000
	15%	300,000	Jul-06	325,000
2007			Jan-07	475,000
	50%	1,000,000	Jul-07	975,000
2008			Jan-08	1,475,000
	25%	500,000	Jul-08	1,725,000
2009		25,000	Jan-09	2,000,000

Source: www.animalid.aphis.usda.gov/nais

Animal Identification

In order to track the animal movements among premises, animals are identified either individually by Animal Identification Number, AIN or as a group if the

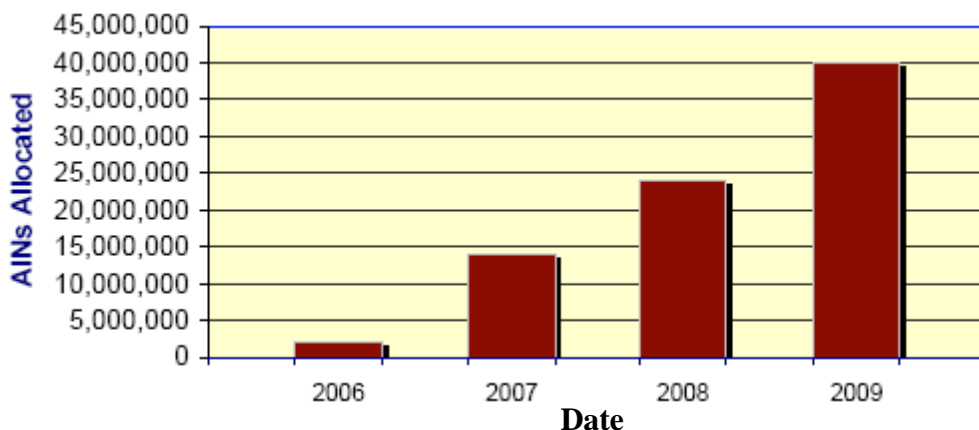
whole herd will move together from premise to premise by Group/Lot Identification Number (GIN).

As the National Animal Identification System develops, animal producers would be able to contact a reseller, animal identification number distributor to obtain officially approved tags. The reseller will send the records of the identification numbers sold to each premises to national information repository.

There are 33 million calf births every year and 7 million births of other animals such as sheep, goats. It is projected to attach AIN tags to all newborn animals by 2009.

As the animals move from premises to premises, the AINs or GIN will be linked to the premises identification number (PIN). While animals are changing location, they keep the same AIN numbers. There are a several pieces of information that must be collected and reported. This information basically consists of movement of date, AIN or GIN, if it is lot movement and PIS of the receiving premises (NAIS, 2006). Figure 2.10 depicts number of the animals identified with AINs every year by NAIS by 2009.

FIGURE 2.10. Projection of Animal AIN Distribution



Source: www.anilamid.aphis.usda.gov/nais

To identify the animals, producers can opt to use visual tags which will have the AIN imprinted on it. There are some standards that must be met by the identifiers. These standards are required by Code of Federal Regulation (CFR) and listed in the Table 2.3 at the following page.

Animal and Plant Health Inspection Service (APHIS) is in cooperation with NAIS to allow firms to use supplemental technologies such as Radio Frequency Identification System (RFID) and compatible ear tag as a part of their identification equipment (NAIS, 2006). For bison and cattle, APHIS encourages the use of Radio Frequency Identification ear tags. In order to get the AIN/RF ISO tags recognized as supplemental identification devices in the National Animal Identification system (NAIS), ISO 11784 (Radio frequency identification of animals-Code Structure) and ISO 11785 (Radio frequency identification animals-Technical concept) must be used to ensure the compatibility of the technology used across “vendors” (NAIS, 2006). For this reason, all the RFID devices must be certified for the conformance with ISO 11784 and ISO 11785 by International Committee for Animal Recording (ICAR), which “is a world-wide organization with over 40 member countries dedicated to the standardization of animal recording and productivity evaluation” (NAIS, 2006). In other words, ICAR carries out the testing of the RFIDs to ensure the compliance with the ISO 11784 and ISO 11785. The standards for RFIDs that must be met by vendors are listed in Table 2.4.

TABLE 2.3. AIN Tag-Requirements and Description

Performance Requirements	
A. One-time use	The tag must be designed for one-time use (tamper evident), making it impossible to remove and reapply the tag without visual evidence of tampering.
B. Unalterable	The printing on the tag may not be readily altered.
C. Readability	The AIN must be easily and reliably readable. The printing and color contrast of the U.S. Shield, lettering, and numbers are to be readable at a distance of 30 inches (0.75 m).
D. Tag loss rates	On average, when applied in a manner approved by the manufacturer, not more than 1 percent of tags applied may be lost in the year following application or in any year thereafter under normal field conditions over the expected life of the tag.
E. Expected tag life	The minimum time that a tag shall be expected to remain on an animal in a functional state (physically) is for the expected life of the animal.
F. Tag Toxicity and animal injury	Tags may do no harm to an animal or affect its health or well-being.
G. Tag deterioration	There may be no diffusion of colorant from tags. There may be no apparent physical deterioration (other than color) due to detrimental effects by UV light, rain, heat (45C) and cold (-30C) or other environmental influences such as chemicals, mud, urine or manure for at least 5 years of wear.
H. Tag plasticity	Devices may not split or crack under normal use.
I. Tag coupling/tensile strength	Tag coupling/tensile strength: Evaluation standards must conform to ICAR testing standards and, at minimum, should comply with ISO standards 37 and 527.
J. Tag abrasion Resistance	Tag abrasion resistance: Tags shall not exhibit damage due to wear, may be subjected to ICAR testing standards and, at minimum, should comply with ISO standards 9352.
Description of Printing	
<ul style="list-style-type: none"> • The tag must have the U.S. Shield imprinted on its surface. Two-piece tags must have the U.S. Shield and the AIN with the “840” country code imprinted on both pieces. • The tag must bear the entire 15-digit AIN. • The U.S. Shield must have a minimum width of .2 inches (5 mm). • The font for all characters imprinted on the tag must be Arial or, if different, approved by APHIS. • Print size for bovine tags must be minimum height of .2 inches (5 mm) for numbers and letters. • An indentation of the manufacturer’s unique, copyrighted logo or trademark must be easily observed on the tag. Having such information permanently imprinted on the tag is also acceptable. • The text “Unlawful to Remove” should be imprinted on the tag. • A space should be inserted between each 3rd digit of the AIN imprinted on the AIN tag; for example, 840 003 123 456 789. • Printing of other information may be authorized if it does not compromise the readability of the required information. 	

Source: www.animalid.aphis.usda.gov/nais

TABLE 2.4. Bovine and Cattle AIN/RF ISO Tag Standards

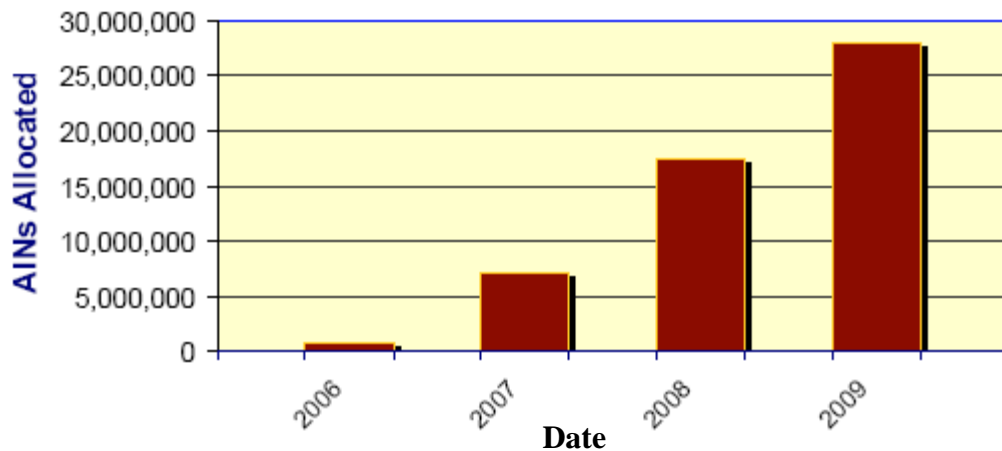
A. ISO Compliant	All transponders (RFIDs) must be certified by ICAR for conformance with ISO-11784 and 1785.
B. Electronic Read Rates and Ranges	In a laboratory with a neutral electromagnetic environment: Transponders must have a 100 percent read in best orientation at 24 inches (60 cm) in a satisfactory test and a moving test of 1 m/sec over a passage length of at least 20 inches (50 cm). In a field environment test: Transponders must be reliably machine read at a rate of 95 percent without regard to orientation by a standardized dual HDX/HDF reader, as cattle move by in a single file passage at 4 mph (1m/sec).
C. Expected tag life	The minimum time that a tag shall be expected to remain functional (electronically) is for the expected life of the animal.
D. transponder security	The official number encoded within each transponder must not be able to be altered and must be contained within the tag. Tags will be tamper-evident and impossible to unseal without visible evidence of tampering.
E. Transponder failure rate	The transponder within the tag shall be reliable and machine-readable for the expected lifetime of the animal.

Source: www.animalid.aphis.usda.gov/nais

If the requirements are met in both tables then, the USDA Approval Pending is granted. The Radio Frequency Identification Devices are not required by NAIS, but the use of them for cattle is encouraged (NAIS, 2006).

In the United States, 35,000,000 cattle are slaughtered annually. The number of the cattle having an ear tag or identifier at the harvesting point will in fact demonstrate how successful the identification system is (NAIS, 2006). By 2009, 80% of the harvested animals are planned to be identified (NAIS, 2006). Figure 2.11 depicts the annual goal for this objective.

FIGURE 2.11. Projection of Animals Slaughtered With AIN



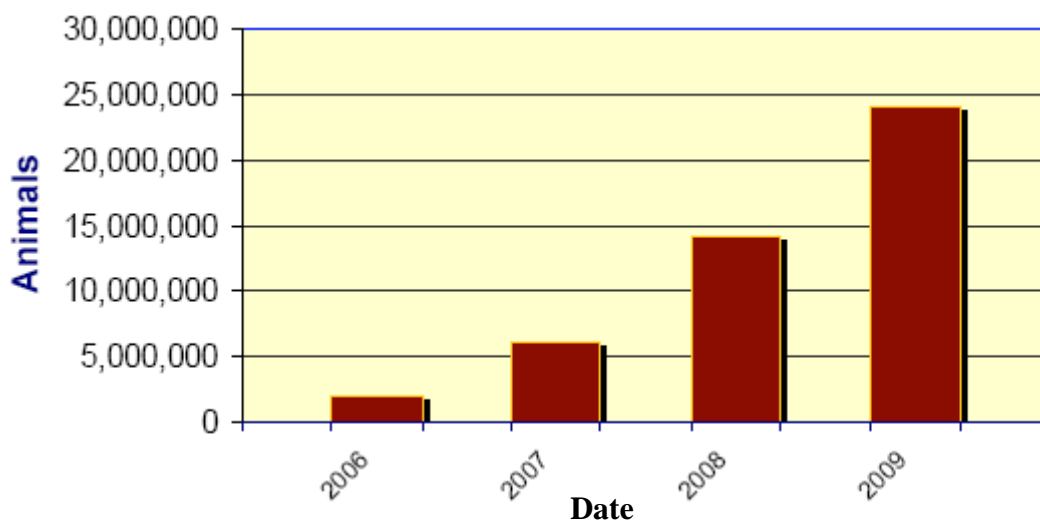
Source: www.animalid.aphis.usda.gov/nais

Animal Tracking

In order to have reliable traceability, a substantial amount of animal movements and related information must be recorded and electronically available. For this purpose, Animal Tracking Processing System (ATPS) is being developed and will be under development in 2006.

As it is stated earlier, there are 40,000,000 new animal births annually and only 60% of this amount is planned to have complete movements records by 2009 (NAIS, 2006). Figure 2.12 better depicts the annual goal of this purpose by 2009.

FIGURE 2.12. The Projected Complete Movement Records of Animals by Year



Source: www.animalid.aphis.usda.gov/nais

The firms that are willing to manufacture or distribute AIN tags have to apply for approval from USDA. In order to apply for an approval from USDA, companies first must obtain a nonproducer participant number (NPN) through the premises registration system. Once the NPN is obtained, the firm can get a level-2 USDA authentication account to have access to the AIN Management System which will enable the firms to have online transaction with USDA and some other USDA web applications and services through internet such as electronic surveys, checking the status of USDA accounts (NAIS, 2006).

AIN Management System

The AIN Management System is a web-based program that is used to administer AINs. USDA allocates the AINs to companies that manufacture official devices or technologies. There are three parties in the initial “roll-out of” the AIN Management System which are manufacturers, managers and resellers (NAIL, 2006).

Manufacturers, managers and resellers are also known as nonproducers and each of the nonproducer gets an identification number in the registration system called nonproducer participant number (NPN) from the State in which the company's headquarter is located. The NPNs are 7 digits very similar to premises identification numbers (NAIS, 2006).

In order to be authorized either to manufacture or to distribute the AIN tags, companies must apply for an approval from USDA. To apply, firms have to get a NPN and obtain a 2 level eAuthentication account. The process of obtaining an APHIS eAuthentication will be explained in detail in the subsequent part of the study.

AIN Tag Manufacturers

AIN manufacturer are companies that are authorized to produce official identification devices, which will have the given AIN numbers on them by (APHIS). There are some requirements of the identification device producers that are listed in Table 2.5.

TABLE 2.5. Requirements of AIN Tag Manufacturers

<p>AIN tag manufacturers must:</p> <ol style="list-style-type: none"> 1. Abide by the terms and conditions set forth in the AIN tag manufacturer agreement; 2. Complete the AIN tag manufacturer training program provided by USDA; 3. Imprint the “840” AINs allocated to them with the U.S. Shield on identification devices approved by APHIS. 4. Maintain the uniqueness of the AINs allocated to them; 5. Imprint approved tags according to the specifications listed in Table 2.3 6. Report the shipment of all tags to the AIN Management System within 24 hours of shipment; 7. Have an operational computerized system that communicates with the AIN Management system and is computable with NAIS standards to maintain the Necessary information, including a database of the manufacturer product codes for all devices that contain an AIN; 8. Furnish official identification devices to AIN tag managers; 9. Have a means to support the distribution of AIN devices through marketing Agreements with AIN tag managers or be AIN tag managers themselves; 10. Provide a record to APHIS of all “transitional” AINs produced with a “USA” prefix and their ICAR manufacturer number; 11. Agree to discontinue the printing of any identification numbering system as directed To do so by USDA if USDA terminates and phases out an official numbering System; 12. Maintain a record of inventoried AIN tags and have such records available to the USDA upon request; and 13. Enter the names of nonproducer participants that wish to utilize as AIN managers Into the AIN Management System, advising them that such designation requires Participation in AIN manager training provided by USDA.
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Source: www.animalid.aphis.usda.gov/nais

AIN Tag Managers

Tag managers are companies that provide the AIN tags to another manger or reseller. The tag managers must have a distribution agreement with an AIN tag producer and must abide by the conditions listed in Table 2.6.

TABLE 2.6. Requirements of AIN Tag Managers

<p>AIN tag managers must:</p> <ol style="list-style-type: none"> 1. Complete the AIN tag manager training provided by USDA; 2. Distribute AIN tags only to a premises or entity that has either a PIN or NPN and Validate the accuracy of the PIN or NPN; 3. Provide the validated PIN or NPN to the entity that ships the AIN tags when not Completing the delivery themselves; 4. Maintain a record of inventoried AIN tags received from an authorized AIN tag Manufacturer or another authorized AIN tag manager or returned from a premises, And have such records available to the USDA upon request; 5. Submit to the AIN Management System within 24 hours (or close of next business Day), in accordance with the prescribed protocols, a record of all AINs shipped or Delivered; and 6. Educate producers receiving AIN tags on the proper use of official animal \ Identification devices.

Source: www.animalid.aphis.usda.gov/nais

AIN Tag Resellers

Tag resellers do distribute the AIN tags from managers to the premises and report the tags they shipped to premises. As managers do, AIN tag resellers also make sure that the premises identification number (PIN) is valid (NAIL, 2006). The tag resellers have a marketing agreement with an AIN tag manager and have to abide by the conditions listed in Table 2.7 in order to be an authorized reseller:

TABLE 2.7. Requirements of AIN Tag Resellers

<p>AIN tag resellers must:</p> <ol style="list-style-type: none"> 1. Complete the AIN tag reseller training provided by USDA; 2. Distribute AIN tags only to a premises or entity that has either a PIN or NPN and Validate the accuracy of the PIN or NPN; 3. Provide the validated PIN of NPN to the entity that ships the AIN tags when not Completing the delivery themselves; 4. Maintain a dated record of inventoried AIN tags received from an authorized AIN Tag manager or another authorized AIN tag reseller, or returned from a premises, And have such records available to the USDA upon request; 5. Submit to the AIN Management System within 24 hours (or closes of next business Day), in accordance with prescribed protocols, a record of all AINs shipped or Delivered; and 6. Educate producers receiving AIN tags on the proper use of official animal Identification devices.

Source: www.animalid.aphis.usda.gov/nais

E-Authentication

USDA agencies use the eAuthentication to allow individuals to open online accounts to have access to certain USDA web services. There are two types of eAuthentication accounts, which are level 1 and level 2 (NAIS, 2006)

Level 1 account provides limited access to USDA web services. It does not enable the holder of this type of account to have electronic transactions.

AIN tag manufacturers, AIN tag managers and AIN tag resellers use level 2-account. This type of account does enable its holders to have electronic transactions with USDA and uses the services provided electronically by USDA. The transactions that can be conducted by USDA include application for permits, registering premises for the National Animal Identification System (NAIS) and checking the status of the documents.

Tracking Databases

During the time of a single animal tracking database establishment, USDA received a lot of comments to have several different animal tracking databases instead of a single database (NAIS, 2006). Therefore, USDA is supporting the establishment of private animal tracking databases. The main role of the USDA is to establish a portal called *metadata* (NAIS, 2006). The *Metadata* will not be submitted any movement records of animals, instead, it will have the list of the Animal Identification Numbers that each participating animal tracking database has in its system and the participating animal tracking databases will submit a list of the Premises Identification Numbers to *metadata* that they have in their systems. In case of a need for the records of an animal, the animal health officials will ask for the records through *metadata* to the participating databases that have those (NAIS, 2006)

“USDA administers the metadata portal and the system that processes the information from participating Animal Tracking Databases (ATDs) within the Veterinary Services (VS). The metadata portal or system and related functionality for processing the animal movement records returned to VS are referred to as the Animal Trace Processing System (ATPS)”(NAIS, 2006).

APHIS will take the initiatives to integrate the State and Private animal tracking databases and is developing the complete requirements that State or Private animal tracking systems must meet or exceed to be “NAIS Compliant Animal Tracking Databases”. The requirement for compliance with NAIS is estimated to be completed by late 2006 and actual integration with the ATPS will take place in early 2007 (NAIS,

2006). Table 2.8 displays the minimum amount of information that must be stored in an animal-tracking database.

TABLE 2.8. Information Stored in the Animal-Tracking Database

Filed Description	Data Type	Size	Reqd.	Example
Event	Numeric	2	Y	Movement in, out...etc.
Sighting/reporting	Character	7	Y	
Premises Identification				
Source/Destination	Character	7	N	
Event Date & Time	Date		Y	
AIN	Character	15	Y	
Species	Character	3	N	
Iden. Elect Read	Boolean	1	Y	0(False default)/1(True)
Animal Date of Birth	Date	8	N	YYYYMMDD
Age of Animal	Character	3	N	(M)onth, (D)ay, (Y)ear e.g. M11 (Zero fill if less than 10)
Gender	Character	1	N	(M)ale, (F)emale
Breed of Animal	Character	2	N	
Remarks	Character	50	N	
Status	Character	1	N	(C)correction
Alternate Animal ID	Character	17	N	Alternate official identification number if 840 AIN not available. Group/Lot identification number if animal has AIN and was moved out of a lot; old AIN if tag replaced
Alternate Animal ID Type	Character	1	N	

Source: www.animalid.aphis.usda.gov/nais

Since there will be more than one Animal Tracking Databases (ATD) to keep the records, it is a bit confusing to understand how the system is going to work.

Whenever, the animal changes its premises, this change must be recorded in the ATD to find out all the premises the cattle had been in the case of an investigation. When the cattle leave the farm, say, for market auction, at the entering and leaving, the movements of the cattle will be recorded (Lawrence and Martin, 2004).

Comparison of National Animal Identification System (NAIS)
and Country of Origin labeling (COOL)

As the name of the two systems implies, NAIS is able to trace back the individual cattle from slaughterhouse to the farm of origin and all the premises the cattle had been. However, COOL does not enable officials to trace back individual cattle; it only provides information about the origin of the cattle where the animal was born, reared, slaughtered and packed. As Umberger (2004) states, the implementation of COOL at producer level will be simplified by NAIS and it would be complementary to the COOL program. In addition, since the NAIS does provide little or no information about the origin of the cattle at the retail level, COOL will inform the customers about the country of origin of the product they buy (Umberger, 2004).

DNA Based Traceability

Each animal has a distinct DNA code except twins. This characteristic of DNA enables the animal and its products derived from that to be matched and identified (Loftus, 2005). In order to apply DNA-based traceability, DNA samples would need to be collected and stored in a database to enable the animal to be identified in case of need by comparing the DNA samples from the products (Loftus, 2005). Currently, the biggest obstacle preventing the traceability from farm to fork is the break in the slaughterhouse. By the application of NAIS there will full traceability from farm to slaughterhouse allowing the animal health officials to track every step of the cattle up to slaughterhouse. To overcome the “*break*” in the slaughterhouse and allow full traceability DNA samples will be taken from the carcasses at slaughterhouse and stored in a database. When a product from a retailer is needed to be traced back, the DNA sample from the products will be matched with the stored samples.

CHAPTER 3

METHODOLOGY AND RESULTS

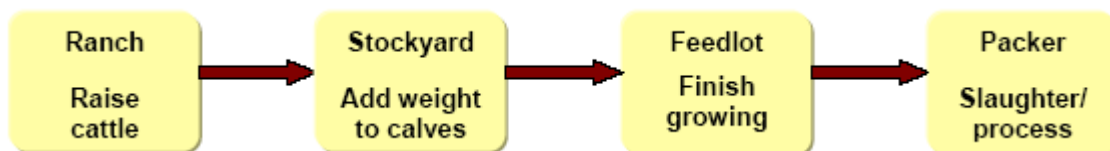
This research focuses mainly on the cost-benefit analysis of traceability for SMEs. Since SMEs are not as financially strong as large enterprises, the cost of traceability application is a very sensitive issue for them. The cost, therefore, must be computed in advance and compared with the benefits it will bring to enterprises. This research will also focus on the benefits of traceability. Both qualitative and quantitative approach will be carried out to provide the perfect fit.

In order to compute the traceability cost from farm to fork, I will first explain the beef supply chain and then shed light on the technical components needed to establish traceability system

Beef Supply Chain

In the U.S. beef supply chain there are four basic segments; they are the cow-calf producer, the stockyard, the feedlot, and the packer. Figure 3.1 illustrates the animal flow between segments

FIGURE 3.1. Beef Value Chain



Source: Donnelly, Deines & Katz, 2002

The cattle market demonstrated a moderate growth rate more than 20% from 109 million head in 1965 to 132 million head in 1975; however, the total cattle population declined to 97 million head since 1975 (Weaber & Miller, 2004). Since the mid 1960s the efficiency per head increased about 70% from 375 lbs in 1965 per head to 641 lbs in 1975 (Weaber & Miller, 2004).

Since the growth phase ended in 1970, businesses in the beef industry either merged or bought other firms to benefit from economies of scale or to cut operational costs. For example, the largest four packing plant increased their market share from 40% in 1980 to 70% in 1990 (Weaber & Miller, 2004). As Donnelly, Deines and Katz (2002) stated, the beef segment of the red meat industry alone constitutes 18% of farm sales in terms of cattle used in the production and the beef consumption represented 56% of red meat consumption with 64.4 pounds (boneless weight) per capita consumption in 1998.

Cow-Calf Producer (Ranch)

The first player in the beef supply chain is the cow-calf producer. The cow-calf producers are relatively small-scale operators. In 2003, according to USDA estimation there were 792,050 cow-calf producers and 32.8 million head of beef cow (Mark, 2004), which gives us the average herd size 41. The breakdown of the herd size according to States has been depicted in Table 3.1.

TABLE 3.1. Number of Beef Cows Operations, By Size and Beef Cow Inventory, Selected States, 2003

State	Beef Cow Operations					Beef Cow Inventory
	Total	1-49 Head	50-99 Head	100-499 Head	500+ Head	
Arizona	2,000	1,350	200	380	70	175,000
California	12,000	9,300	810	1,600	290	720,000
Colorado	10,400	6,700	1,670	1,800	230	612,000
Idaho	7,500	5,100	930	1,300	170	488,000
Kansas	28,000	18,500	5,300	4,020	180	1,550,000
Montana	11,800	5,400	2,050	3,900	450	1,472,000
Nebraska	21,000	11,800	3,900	4,800	500	1,848,000
Nevada	1,300					244,000
New Mexico	6,400	4,400	820	1,000	180	455,000
North Dakota	11,000	4,600	2,920	3,400	80	937,000
Oklahoma	50,000	38,500	7,200	4,100	200	1,970,000
Oregon	12,300	9,900	950	1,200	250	603,000
South Dakota	15,500	6,300	3,490	5,300	410	1,711,000
Texas	132,000	104,000	15,600	11,500	900	5,483,000
Utah	5,200	3,400	750	950	100	351,000
Washington	9,200	8,100	520	530	50	270,000
Wyoming	4,900	2,000	900	1,700	300	756,000
Other States	451,550	381,200	47,815	22,865	970	13,215,300
United States	792,050	620,550	95,825	70,345	5,330	32,860,300

Source: Mark, 2004

The cow-calf producers typically raise the cattle up to 6 to 10

(<http://www.beef.org/nbbaeconomics.aspx>) months and then sell them to stockers for extra weight before they are sold to a feedlot to be fattened for slaughter. The return on the cattle per head for cow-calf producers is directly affected by supply conditions and the return pattern on cattle per head fluctuates. For example, the annual per head return was \$78.29 in 1991, \$148.05 in 2004, which was \$141 and \$63 more than the estimates for 2002 and 2003 respectively. In 2005, the estimated annual per head return was \$139.11 that was lower than 2004.

(<http://www.ag.ndsu.nodak.edu/aginfo/lsmkt/docs/ac022406.pdf>)

Auction Market (saleyard)

Auction markets are the places where numerous cattle sellers and relatively few buyers meet. There are 815 fixed auction facilities in the United States, according to the USDA Packers and Stockyards Administration. The annual number of the cattle sold by an average U.S. saleyard is 10,000 (Wahl, 2006).

Stocker

Stockers are the second producing segment in the US beef supply chain. They graze the cattle until they are about 12 months old. The cattle usually gain about 200-300 pounds of weight at the stocker (Mark, 2004).

Feedlot Operator

Feedlot operators buy cattle from stockers at around 900 pounds and feed them up to 1,200 to 1,400 pounds keeping them on feed from 110 to 250 days to reach target weights (<http://www.beef.org/ncbaeconomics.aspx>) The size of feedlot operator ranges from a couple of hundred head to 100,000 head, and they are mostly located in the Southwest and the Pacific Northwest (www.beefusa.org). The annual number of cattle raised by an average feedlot operator is about 10,000 (Wahl, 2006). The annual return at the feedlots is relatively stable and does not fluctuate too much (<http://www.ag.ndsu.nodak.edu/aginfo/lsmkt/docs/ac022406.pdf>). There are approximately 2,205 feedlot operators having 1000 or more cattle and Table 3.2 depicts the feedlot operator sizes in details.

TABLE 3.2. U.S. Feedlot Number, Inventory, and Marketings, By Size, 2003

Feedlot Capacity	Lots	Inventory	Marketings
<i>head</i>	<i>number</i>	<i>1,000 head</i>	<i>1,000 head</i>
1,000-1,999	852	467	925
2,000-3,999	552	704	1,403
4,000-7,999	347	944	1,915
8,000-15,999	195	1,442	2,958
16,000-31,999	139	2,343	4,757
32,000+	120	5,353	11,509
Total	2,205	11,253	23,467

Source: Mark, 2004

Packer/Slaughterhouse

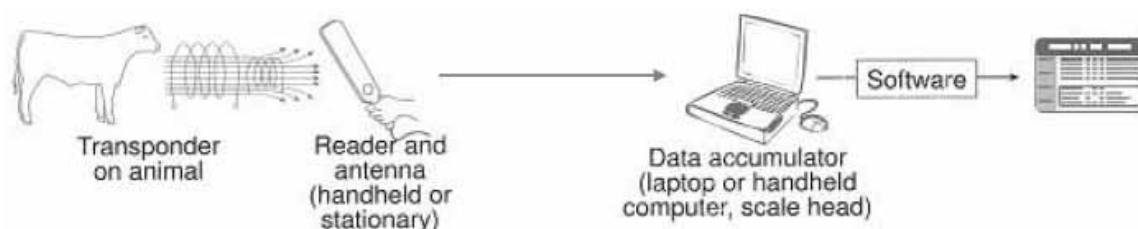
The Packer/slaughterhouse is the last segment of the beef supply chain before the final consumers. Packing plants typically buy cattle from feedlot operators at around 1,000 to 1,250 pounds (www.beefusa.org). There are 64 major packing plants and the four largest of these packing plants are Tyson Foods that owns IBP Inc; Cargill owns Excel Corp; ConAgra Foods Inc, and Farmland National Beef (www.beefusa.org), which account for 80% of the total US beef market. The annual average number of cattle and calves harvested is about 33 million in the US. In 2005, 32.5 million cattle and 770.4 thousand calves slaughtered (www.nass.usda.gov). The four largest packing plants account for approximately 26.6 million of the animals slaughtered in 2005.

Radio Frequency Identification

United States Department of Agriculture (USDA) aims to fully implement NAIS by 2009 and it is neutral about the technology that will be used for the NAIS. However, Lawrence and Martin (2004) state, "Cattle will likely use individual animal IDs with a radio frequency ear tag." RFID tags are capable of carrying identification

information that can be read by a reader and transformed into an understandable format via software. Figure 3.2 illustrates how the RFID system works.

FIGURE 3.2. RFID Equipment



Source: Blasi, Dhuyvetter, Spire, Epp & Barnhardt et al. 2003.

Since the NAIS is newly being designed and planned to start being implemented in 2007, the cost of implementing this system is not known precisely from farm to fork. In this part of the study, the cost estimates of the NAIS will be proposed for various cattle operators in the beef industry and in the subsequent parts, the cost for the technology or system needed for complete traceability from farm to fork will be provided. In order to apply the RFID system, there are a number of pieces of equipment needed as shown in the Figure 3.2: a transponder (Electronic Tag), an electronic reader, a data accumulator, a software/web-based analysis and storage (Blasi et al., 2003). I will elaborate on the components of RFID in detail in the next section.

Components of Radio Frequency Identification System (RFID)

Transponder

The transponder is also known as electronic tag, which provides the automated data on the individual animals. An electronic tag is read by using a reader (electronic reader). The electronic tag is passive; therefore can last throughout the life of

the animal. The following pictures show the electronic tag and how it is attached into the ear of cattle.

FIGURE 3.3.RFID Tag and its Appearance on Cattle



Source: <http://agnews.tamu.edu>



Source: www.cattlestore.com

Electronic Reader

Readers are used to read the electronic tags on each individual cow. There are different types of readers for different purposes. Some of the readers are hand held and some of them are stationary. In Figure 3.4, the handheld and stationary types of readers are depicted.

FIGURE 3.4. Handheld and Stationary Readers



Source: <http://www.allflexusa.com/eid/readers.php>

Data Accumulator

Data accumulator is usually referred to a computer. This can be a laptop, personal computer or handheld computer.

Software/Web-Based Analysis and Storage

To transfer the data from reader to computer, there must be a compatible program with the reader installed in the computer. In addition, the program is also needed to upload the data to the database to report the movement of the cattle.

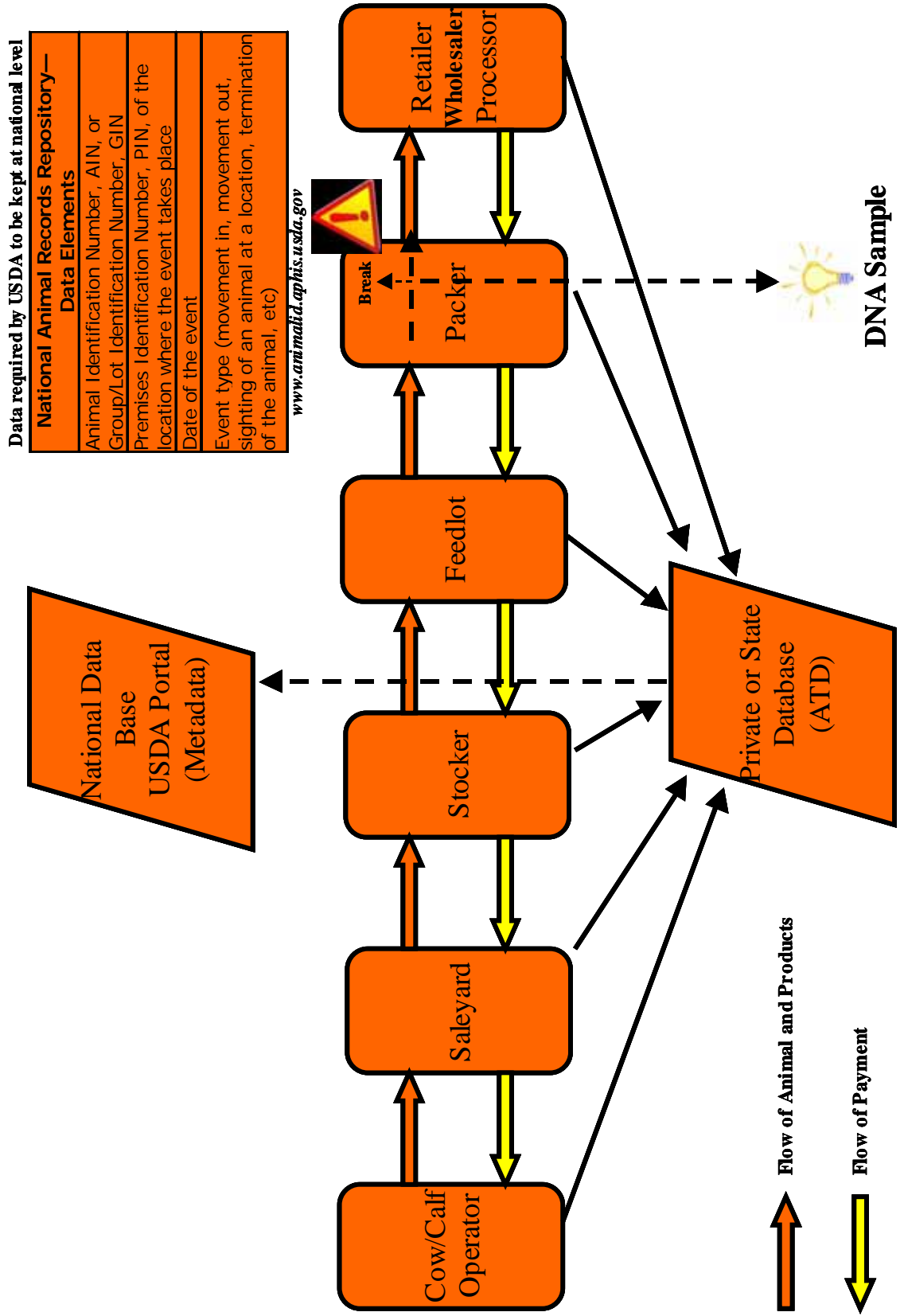
Other

In this category of the cost segmentation Internet access, subscription/upgrade fees and labor are included.

The diagram in Figure 3.5 depicts the players taking part for the complete traceability from farm to fork and break in the slaughterhouse. Arrows going from cow producer toward retailer direction show the flow of products or animals in the beef value chain and the other arrows show the flow of payment. In addition, the diagram also depicts the break in the system for traceability from farm to fork.

The important assumption at this point is the flow of animals in the supply chain. It is assumed that all the cattle slaughtered follow the arrows in the following diagram depicted in Figure 3.5.

Figure 3.5
Flow of complete traceability from farm to fork as a combination of pending National Animal Identification and DNA



Cost Computation of Traceability from Farm to Fork

In order to obtain the per pound cost of the traceability all the way through the value chain, per head cost of the traceability incurred at every point of the chain will be summed up and divided by the average beef productivity of an individual animal.

Dhuyvetter and Blasi developed a model (www.beefstockerusa.org/rfid) to compute the cost of RFID systems for different sizes and players in the supply chain, and I used their model to compute the cost of RFID for various players in the beef value chain.

The Dhuyvetter and Blasi's model takes into account the following variables to provide cost estimation of RFID system for various players in the beef supply chain.

D = Annual Depreciation

I_v = Initial Value of the Equipment

S_v = Salvage Value

E_L = Expected Life of the Equipment

R = Annual Interest Rate

r = Monthly Interest Rate

t = Time (Month)

T = Time (Year)

A.I.C. = Accured Interest Cost

S_H = Size of Herd

P = Percentage Use of the Equipment Goes to RFID

M = Monthly Cost of the Operational activity

The equipment used in the model for cost computation is depreciated over a number of years depending on the expected life of the equipment. Equation 3.1 can be used to compute the annual depreciation of the equipment.

$$(3.1) \quad D = \frac{I_V - S_V}{E_L}$$

Depending upon the equipment the model divides the cost into investment and operational costs. The scope of the investment in this model includes the reader, accumulator and software. In order to find the interest cost of the equipment used in the model, the equation 3.2 can be used to provide it. In the Equation 3.2, for example, $T_0 = 0$, $T_1 = 1$ and so and fourth.

$$(3.2) \quad A.I.C. = \sum_{i=1}^N (I_V - D * T_{i-1}) * R$$

In order to find the total cost of the equipment per head annually Equation 3.3 takes into account the interest cost as well as the initial value of the equipment. By using Equation 3.3 the cost of the equipment for various sizes of herds for different players can be computed.

$$(3.3) \quad \text{Cost of the Equipment per Head} = \frac{\left[\left(\frac{A.I.C. + I_V}{E_L} \right) * P \right]}{S_H}$$

As stated earlier, the cost RFID in the model is split into investment and operational cost, which includes ear tags, internet access, subscription fees and labor. The Equation (3.4) can be used to find per head operational cost. The way the computation works is very similar to the computation of the annuity.

$$(3.4) \quad \text{Operational Cost per Head} = \frac{\left[\left(\frac{(1+r)^t - 1}{r} \right) * M \right] * P}{S_H}$$

The sum of the results of Equation 3.3 and 3.4 will provide the annual per head cost of the RFID system.

In order to take into account the interest on the investment and operational cost of the system, a 5%¹ annual interest rate has been used.

It is assumed that the animal flows from cow/calf producer to saleyard, from saleyard to stocker, from stocker to feedlot and from feedlot to packing plants and from packing plants to retailers in the diagram above. In fact, some of cow/calf producer will sell their animals directly to feedlots and some will sell to stockers for additional weight. For simplicity, this assumption is made that animals flow in the beef supply chain as depicted in Figure 3.5.

Cow/Calf Producer

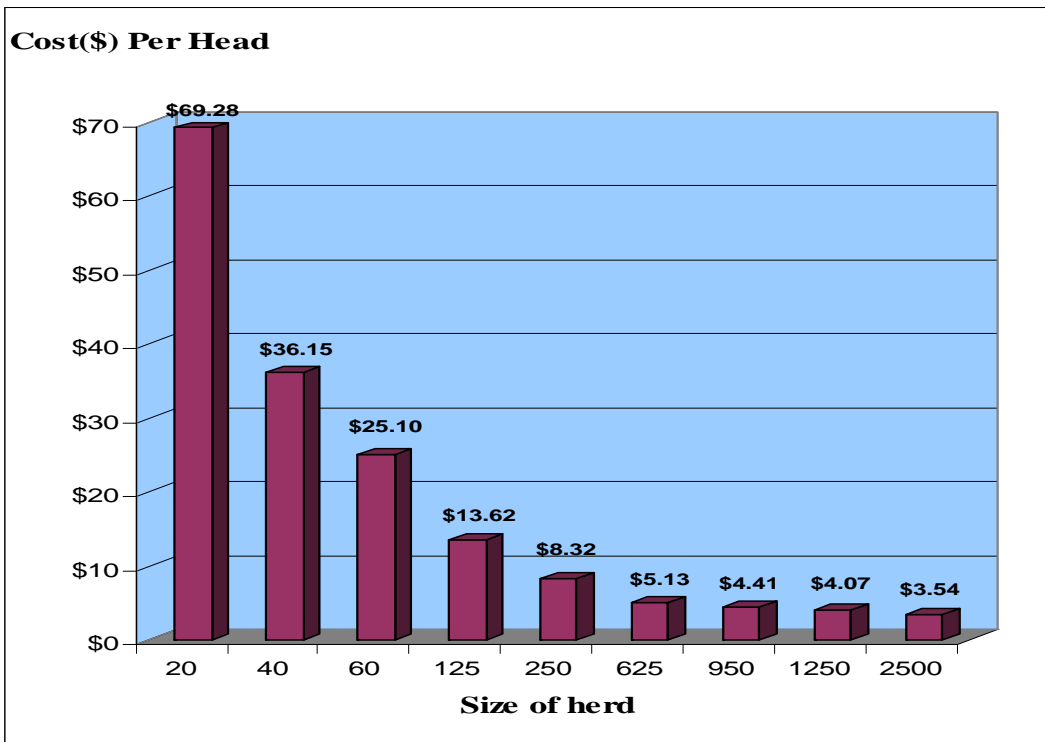
TABLE 3.3. Breakdown of RFID Cost for Various Cow/Calf Producers

RFID Components	Number of Head								
	20	41	60	125	250	625	950	1250	2500
EID Transponder (Tag)									
Allflex FDX EID/Visual	3.01	3.01	3.01	3.01	3.01	3.01	3.01	3.01	3.01
Electronic Reader									
Allflex Stick Reader	8.30	4.05	2.77	1.33	0.66	0.27	0.17	0.13	0.07
Data Accumulator									
HP Laptop	5.30	2.58	1.77	0.85	0.42	0.17	0.11	0.08	0.04
Software/Web-based analysis and storage									
Computer software	8.08	3.94	2.69	1.29	0.65	0.26	0.17	0.13	0.06
Other									
Internet Access	6.15	3.00	2.05	0.98	0.49	0.20	0.13	0.10	0.05
Subscription fees	12.81	6.25	4.27	2.05	1.03	0.41	0.27	0.21	0.10
Labor	25.63	12.50	8.54	4.10	2.05	0.82	0.54	0.41	0.21
Total (\$)	69.28	35.34	25.10	13.62	8.32	5.13	4.41	4.07	3.54

¹ Federal Reserve Interest Rate for Open Market Operation, retrieved from <http://www.newyorkfed.org/markets/statistics/dlyrates/fedrate.html>, May 22, 2006.

The Allflex FDX EID/Visual ear tag (www.cattlestore.com), which is \$2.94/tag, is assumed to be used (See Figure 1 in Appendix). The Allflex Stick Reader is used for cost computation (See Figure 2 in Appendix) with 3-year average expected life. Software cost, annual internet access, subscription fees and annual labor cost are taken as stated in the model by Dhuyvetter and Blasi (www.beefstockerusa.org/rfid). Table 3.3 displays breakdown of the cost structure of RFID for various calf/cow producers. The annual cost per head for an average-size cow/calf producer is highlighted in the Table 3.3. Figure 3.6 demonstrates the economies of scale for cow/calf producer.

FIGURE 3.6. RFID Cost for Cow/Calf Producers



Auction Market (Saleyard)

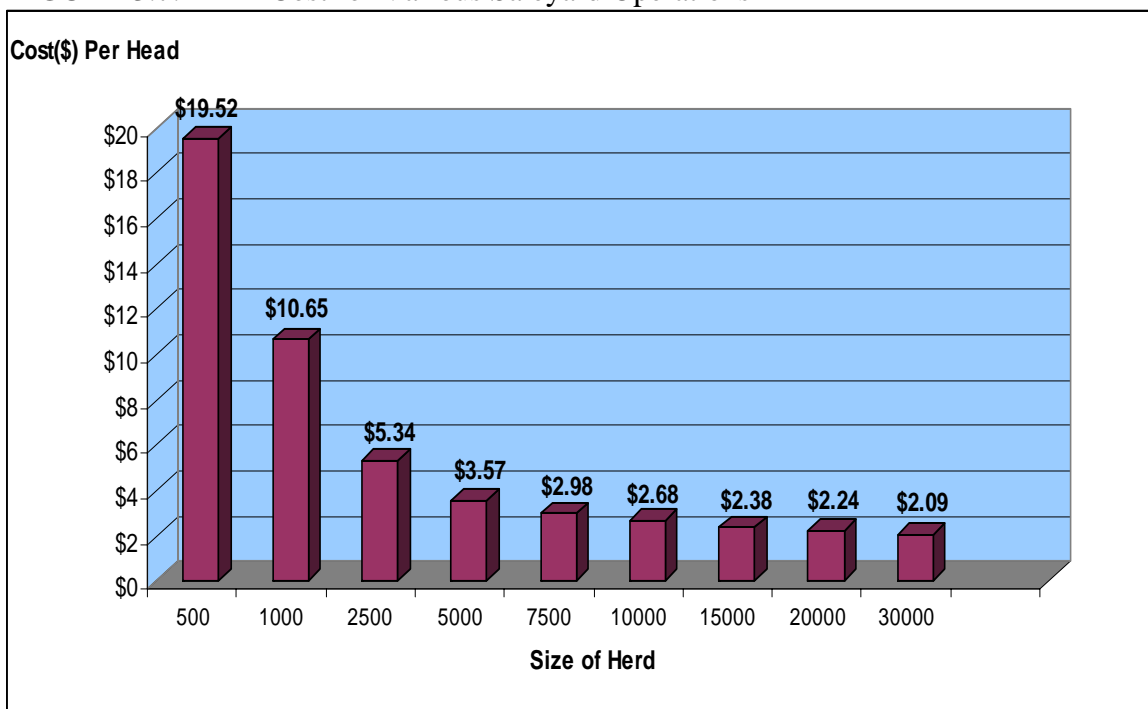
TABLE 3.4. Breakdown of RFID Cost for Various Saleyard Operations

RFID Components	Number of Head								
	500	1000	2500	5000	7500	10000	15000	20000	30000
EID Transponder (Tag)									
Allflex FDX EID/Visual	0	0	0	0	0	0	0	0	0
Electronic Reader									
2 Allflex Stick Readers	0.66	0.33	0.13	0.07	0.04	0.03	0.02	0.02	0.01
Data Accumulator									
2 HP Notebooks	0.97	0.49	0.19	0.10	0.06	0.05	0.03	0.02	0.02
Software/Web-based analysis and storage									
Computer software	0.46	0.23	0.09	0.05	0.03	0.02	0.02	0.01	0.01
Other									
Internet Access	0.25	0.12	0.05	0.02	0.02	0.01	0.01	0.01	0.00
Subscription fees	1.79	1.79	1.79	1.79	1.79	1.79	1.79	1.79	1.79
Labor	15.38	7.69	3.08	1.54	1.03	0.77	0.51	0.38	0.21
Total (\$)	19.52	10.65	5.34	3.57	2.98	2.68	2.38	2.24	2.09

Two Allflex Stick Readers are used for cost computation (To see figure and technical features of the reader, refer to Figure 2 in Appendix) with the assumption of 3-year average expected life and amortization. The computer software, internet access, subscription and labor are retrieved from Blasi et al (2003, p.12) and same values have been used for stocker and feedlot operators. Table 3.4 depicts the cost of RFID of various sizes of herd for saleyards operations.

The annual cost per head for an average-size auction market is highlighted. Figure 18 illustrates how the cost per head decreases as the size of number of cattle sold increases. In other words, it depicts how the economies of scale occur as the size of heard increases.

FIGURE 3.7. RFID Cost for Various Saleyard Operations



Stocker

TABLE 3.5. Breakdown of RFID Cost for Various Stocker Operations

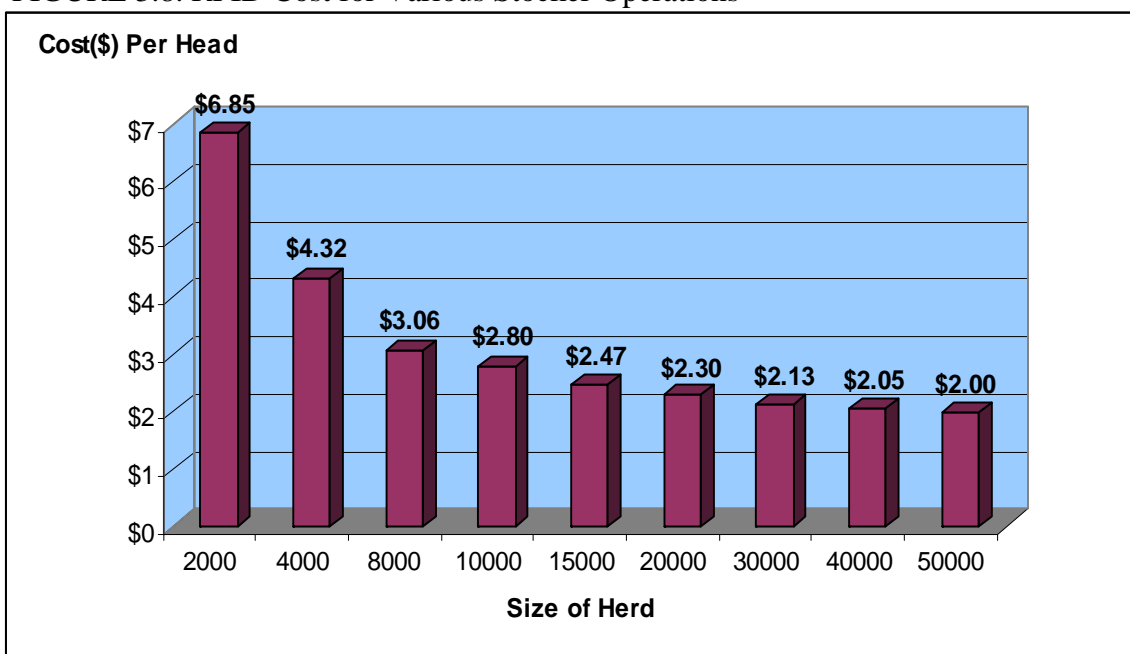
RFID Components	Number of Head								
	2000	4000	8000	10000	15000	20000	30000	40000	50000
EID Transponder (Tag)									
Allflex FDX EID/Visual	0	0	0	0	0	0	0	0	0
Electronic Reader									
Destron Walk-Thru Reader	0.73	0.37	0.18	0.15	0.10	0.07	0.05	0.04	0.03
Data Accumulator									
Dell Precision Comp.	0.30	0.15	0.07	0.06	0.04	0.03	0.02	0.01	0.01
Software/Web-based analysis and storage									
Computer software	0.12	0.06	0.03	0.02	0.02	0.01	0.01	0.01	0.00
Other									
Internet Access	0.06	0.03	0.02	0.01	0.01	0.01	0.00	0.00	0.00
Subscription fees	1.79	1.79	1.79	1.79	1.79	1.79	1.79	1.79	1.79
Labor	3.84	1.92	0.96	0.77	0.51	0.38	0.26	0.19	0.15
Total (\$)	6.85	4.32	3.06	2.8	2.47	2.30	2.13	2.05	2

For a stocker there is no need for ear tag. Therefore, the cost of ear tag is zero.

The reader used for stocker is Destron Walk-Thru (To see the figure, refer to Figure 3 in

Appendix) and amortized over three years. The annual RFID system cost per head of an average size of stocker is highlighted in the above Table 3.5. Figure 3.8 depicts how economies of scale for stockers occur as the size of herd increases.

FIGURE 3.8. RFID Cost for Various Stocker Operations



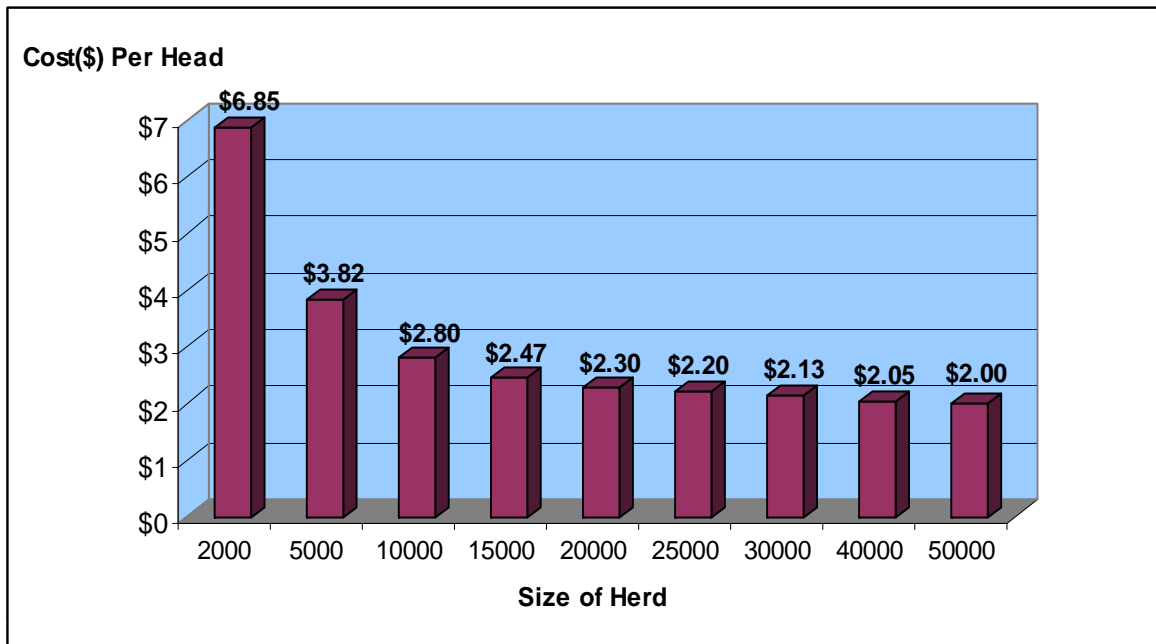
Feedlot Operation

TABLE 3.6. Breakdown of RFID Cost for Various Feedlot Operations

RFID Components	Number of Head								
	2000	5000	10000	15000	20000	25000	30000	40000	50000
EID Transponder (Tag)									
Allflex FDX EID/Visual	0	0	0	0	0	0	0	0	0
Electronic Reader									
Destron Walk-Thru Reader	0.73	0.29	0.15	0.10	0.07	0.06	0.05	0.04	0.03
Data Accumulator									
Dell Precision Comp.	0.30	0.12	0.06	0.04	0.03	0.02	0.02	0.01	0.01
Software/Web-based analysis and storage									
Computer software	0.12	0.05	0.02	0.02	0.01	0.01	0.01	0.01	0.00
Other									
Internet Access	0.06	0.02	0.01	0.01	0.01	0.00	0.00	0.00	0.00
Subscription fees	1.79	1.79	1.79	1.79	1.79	1.79	1.79	1.79	1.79
Labor	3.84	1.54	0.77	0.51	0.38	0.31	0.26	0.19	0.15
Total (\$)	6.85	3.82	2.80	2.47	2.30	2.20	2.13	2.05	2

The equipment used for a feedlot operator is identical to the equipment used for stocker. The cost structure of both operations is identical, too. The only distinction between two operations is the functions they perform in the supply chain. The annual cost of RFID application for an average size feedlot operator is highlighted in Table 3.6. The Figure 3.9 depicts the decrease in the cost per head as the herd size increases for feedlot operations in the US beef supply chain.

FIGURE 3.9. RFID Cost for Various Feedlot Operations



Packing Plant

Since National Animal Identification System is not yet fully operational and there is not any source that can provide the actual application cost of the RFID system for packing plants that can meet the minimum requirements of NAIS, I make a number of assumptions to find out the annual cost per head for a packing plant.

1. The equipment used for feedlot operation can be sufficient to implement RFID not more than 50,000 head of cattle (computer, reader and labor).
2. Enrollment in a data management company is assumed to be \$1.75/head annually (Blasi et al., 2003, p.12) as it is used for feedlot operations.

Under these assumptions, maximum per head cost of RFID is going to be \$2/head as illustrated in the last column of Table 3.6. Since the size of packing plants is not small, the computed cost per head will be lower than that because of the economies of scale. However, I cannot provide an exact estimation how much lower it will be due to lack of data. In addition, the four big plants account for 80% of the market and overwhelmingly large in size relative to the other packing plants in the market; therefore, per head cost for these packing plants will be lower than those packing plants which are relatively smaller.

Traceability Cost from Slaughterhouse to Retailers

The cost from cow/calf producer to slaughterhouse estimated above is based on the information in the model (www.beefstockerusa.org/rfid). However, for the traceability from farm to fork, the cost should be computed from slaughterhouse to retailer and added on top of the traceability cost from farm to slaughter.

The technology that will enable us to overcome the *break* in the slaughterhouse as mentioned in the earlier sections of the study is *Deoxyribonucleic Acid* (DNA) testing. In order to provide full traceability in compliance with the proposed National Animal Identification System (NAIS), the RFID and DNA will be combined. In other words, RFID system will enable us to record all the movements of the animal and DNA will enable us to find out the source or more specifically the cattle from which the

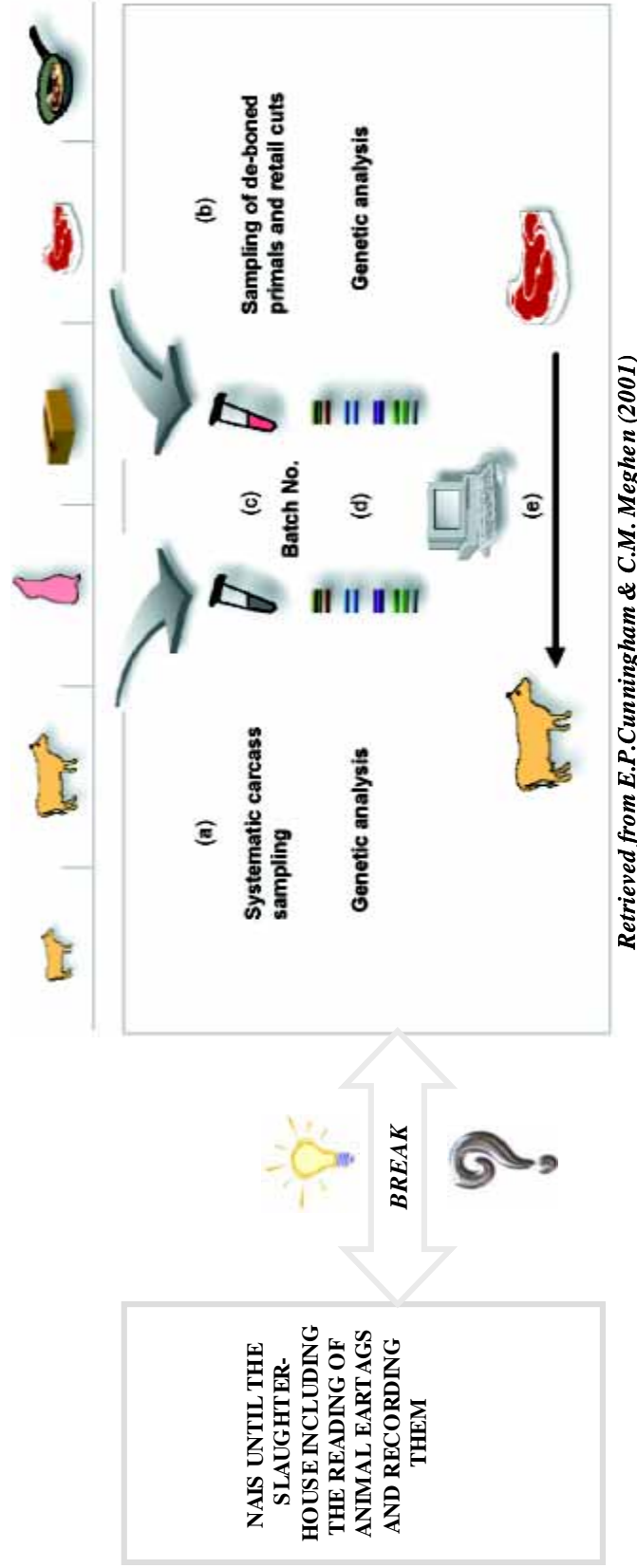
beef derived. The following diagram illustrates how the system will be merged and how the DNA based traceability will work.

The proposed traceability system from farm to fork in the US will work according to illustrated Figure 3.10. There will be two parts of the system: an electronic identification system (RFID) and a DNA-based traceability system.

At point A or when animals are killed, samples from the carcasses will be taken and these DNA samples will be linked to individual animal identity (for the proposed case, the DNA samples will be linked to Animal Identification Number) and samples will be analyzed and then the DNA profiles will be stored into the database. To find the source of a pack of meat, the DNA sample will be taken at point B as depicted in the diagram above and matches with the previously stored DNA profiles in database.

Once the cattle is identified by comparing the DNA samples, the movement records of the animal can be accessed by using the animal identification number and all the premises the infected animal had been and all other cattle it commingled with can be determined. This process will provide a great opportunity to stall all other animals from going into marketplace that are found to commingle with the infected animal without taking steps to find out whether these animals are also infected.

FIGURE 3.10 Connection of National Animal Identification System and DNA



Estimation of Traceability Cost from Farm to Fork

There are two ways of DNA testing implementation “in practice, implementation of DNA-based traceability requires the collection of DNA samples (reference samples) from animals/ carcasses to enable the DNA code be read. Samples can either be archived for subsequent analysis or analyzed and the resultant DNA profiles stored in a database along with information on animal origins.” by (Loftus, 2005, p.235) The cost of DNA sampling, analyzing and storing the resultant profiles into a database costs 1 cent per pound (Loftus, 2006) for a big plant capable of slaughtering about 6.5 million cattle annually. The cost includes everything needed to implement DNA traceability (i.e. equipment, software, labor cost, testing, storing etc).

To find the cost of RFID per pound, the cost incurred by the players in the supply chain is summed up and divided by the average meat productivity that can be derived from cattle which is 522 pounds (www.beefusa.org). On top of the provided cost of RFID in the previous parts of the study, an additional 50 cents/head (Sehoenseld, 2006) will be added for keeping the animal movement records. This 50 cents/head will be paid by every player in order to keep the movement records of animals in a database.

Cost of Traceability

$$\begin{aligned} \text{from Farm to Fork} &= (\text{Electronic Identification Cost}) + \left(\begin{array}{l} \text{DeoxyriboNucleic Acid (DNA)} \\ \text{Testing cost} \end{array} \right) \\ (\text{Per Pound}) & \end{aligned}$$

$$\begin{aligned}
& \left(\begin{array}{l} \text{Cost for Cow/Calf Operator +} \\ \text{Cost for Saleyard Operator +} \\ \text{Cost for Stocker Operator +} \\ \text{Cost for Feedlot Operator +} \\ \text{Cost for Packing Plant} \end{array} \right) + \left(\begin{array}{l} \text{Database} \\ \text{cost for each} \\ \text{player in the chain} \end{array} \right) \\
= & \frac{\hspace{10em}}{\text{Average pound of beef derived from cattle}} + \left(\begin{array}{l} \text{DeoxyriboNucleic Acid (DNA)} \\ \text{testing at Packing Plant per pound} \end{array} \right) \\
= & \left(\frac{35.34 + 2.68 + 2.8 + 2.8 + 2}{522} \right) + \left(\frac{2.5625}{522} \right) + (0.01) = \$0.102 = 10.2 \text{ cents / pound of beef}
\end{aligned}$$

Economic Interpretation of the Results Found in Section 3.4

The significant amount of the cost per pound computed above is caused by cow/calf producers because of their small size relative to other players in the supply chain. As it is depicted in the tables and graphs above, the cost of RFID is decreasing as the size of the operations increases.

For an average size of cow/calf producer the average cost of raising cattle is going up by \$35.34 and as the size of herd increases the cost decreases to \$3.54 for 2500 head of herd. The same is true for other players.

The cost calculated 10.2 cents for traceability from farm to fork is the worst scenario. However, the cost will be lower if the beef comes from a relatively larger calf producer or instead of installing this system in business, they can take their caws to fixed stations for tagging and for other work to be done for RFID. By assuming the caw will come from a big producer for example from a producer having 1250 caw, the cost will be about 4.2 cents per pound.

Depending on the size of the players in the value chain, the cost of traceability from farm to form will range from 4.2 to 10.2 cents per pound.

CHAPTER 4

WELFARE IMPLICATIONS

The core question by this study addressed is what consumers will gain by having traceable products in their food supply chain. Before going to benefits of consumers from traceability, I would like to elaborate on the foodborne disease related death and the cost of the foodborne diseases.

In 2000, 2.1 million people died from diarrhea and a significant number of these 2.1 million is attributed to tainted food and drinking water (www.who.int/mediacentre/factsheets). Every year in the United States, there are 76 millions foodborne diseases cases caused by pathogens such as E.coli 0157, Listeria monocytogenes and Salmonella and 325,000 of these cases end up in hospital (www.researchandmarkets.com). About 5,000 of the 76 million cases end with death every year in the United States (www.who.int/mediacentre/factsheets)

The Welfare of Traceability for Consumers

Traceability is a unique system that encourages a strong interaction between consumers and producers and provides a positive impact on both of the players.

Traceability is becoming a tool for consumers to ensure safety of food products and increase the profit for firms.

It is true that the consumers have diversified economic behaviors, which are well explained by their incomes or endowments. Because food products are most needed in human life, and therefore, every consumer prefers safe and healthy product from a reliable source of production. Why? Because consumers want to prevent any of the following cases during or post consumption:

1. Consumption of contaminated food
2. Food borne illness
3. Future Medical expenses

The following incident is about Kevin Kowalcyk demonstrates the risk of consuming contaminated food:

(http://www.safetables.org/Policy_&_Outreach/Speeches/speech_barbara_kowalcyk_2004.html)

“Good afternoon, my name is Barbara Kowalcyk. I am a biostatistician from Mount Horeb, Wisconsin and a Board Member of Safe Tables Our Priority. I would like to thank the U.S. House of Representatives’ Food Safety Caucus for sponsoring this important event and taking the time to really listen to consumers about the costs that they face from contamination in America’s food.

Three years ago, my oldest child, Megan started Kindergarten. One night, as I was putting our 2 ½ year old son, Kevin, to bed, we talked about how Megan – his best friend - would be going to Kindergarten in just a few weeks. As I kissed him goodnight, Kevin said, proudly, “When I grow up, Mommy, I’m going to Kindergarten too.” This month Kevin should have started Kindergarten, but foodborne illness robbed him of that chance.

On Tuesday, July 31, 2001, Kevin awoke with diarrhea and a mild fever. By Thursday morning, Kevin was much sicker and was hospitalized for dehydration and bloody stools. Later that afternoon, we were given the diagnosis: E. coli O157:H7. My husband, Mike and I were distraught – we had heard of E. coli and knew that it could kill. The doctors, however, reassured us that Kevin would be ok...as long as he didn’t develop Hemolytic Uremic Syndrome (HUS), a condition we had never even heard of.

The following day Kevin’s kidneys started failing and he was transferred to the Pediatric Intensive Care Unit at the University of Wisconsin’s Children’s Hospital. Kevin had developed HUS. My husband and I will never forget sitting in this tiny waiting room while grim-faced doctors informed us that this was one of the worst things that could have happened to our child. The best they could do was keep Kevin alive while the disease ran its course and hope they could fix everything when it was over.

Our family spent the next eight days living in that hospital – watching our beautiful child slip away from us. Kevin spent the first three days crawling around a crib in agony. He threw up black bile. He became drawn and his eyes were sunken. He looked like a malnourished

third world child. And he smelled – a horrible and overwhelming smell – a smell that you could never forget. During those three long days, Kevin begged us to give him water or juice, but the doctors said it would only make him worse. Kevin finally convinced us to give him a sponge bath and, as soon as the washcloth came near his mouth, he grabbed it, bit down on it and sucked the water right out of it. It broke our hearts.

On Tuesday, August 7th, Kevin was placed on a ventilator and continuous dialysis. In hopes of preventing Kevin from remembering this horrible ordeal, doctors heavily sedated him. As the medication would wear off, Kevin would try to pull the tubes out so braces were put on his arms. His body began to swell. Doctors inserted tubes to drain fluid off both of his lungs. By the end of the week, he was receiving more medications than we could count to stabilize his blood pressure and heart rate. He had received eight units of blood. Then, on the evening of August 11th, those same grim-faced doctors ushered us back into that tiny waiting room. Kevin's heart had stopped but they were able to resuscitate him. Kevin had a 10% chance of survival – if they could get him on a heart and lung machine. Did we want them to proceed? Yes, we said. Those same grim-faced doctors came back to the waiting room a second time. Kevin's heart had stopped again and they had been able to resuscitate him. Did we still want them to proceed? Yes, we said. Those same grim-faced doctors came back to the waiting room a third time. Our beloved Kevin had died. He was only 2 years, 8 months and 1 day old.

What about the hidden financial costs of foodborne illness? My husband and I were lucky because we have good health insurance and a life insurance policy on our children. Even so, Kevin's life insurance did not cover the entire cost of his funeral, and despite our good medical insurance, neither myself, my husband or my daughter, Megan, were entitled to grief counseling which we all desperately needed. Because of Kevin's death, my marriage is statistically more likely to end in divorce and my surviving children are at risk of developing eating disorders. It is now three years since Kevin died and we continue to spend money every month on grief counseling to help ensure that our family does not incur yet another loss. The price of foodborne illness is too high.

And what about the losses you can't put a price on? The parents of a four year old are informed that their child will likely need a kidney transplant before she is fifteen. A perfectly healthy six year old loses her pancreas, becomes a diabetic and has to take 40 pills a day in order to eat. A nine year old is terrified to go to sleep for fear she will never wake up again. An active twelve-year-old girl is easily winded. A college freshman loses her hair and is told that her kidneys would never survive a pregnancy. A two-year-old child dies. The price of foodborne illness is too high".

Due to contaminated food, Kevin lost his life. The medical cost the family incurred was more than \$100,000 (www.safetables.org) and even though the family had good insurance package the insurer did not cover all of the cost. In addition, the family incurred unquantifiable emotional cost by losing their child.

In 1997, major food-borne pathogens such as Salmonellosis, Campylobacteriosis, E.coli O157, Cholera, naturally occurring toxins, unconventional agents, persistent organic pollutants and metals, caused nearly \$35 billion medical costs

and productivity loss in the United States

(<http://www.who.int/mediacentre/factsheets/fs237/en>). These statistics demonstrate how costly the foodborne disease can be to society.

The best way to protect ourselves from foodborne diseases and from the related costs is to have safe food. The key instrument that will enable us to do this is “*traceability from farm to fork*”. The cost of having traceable food, for example, beef will range from 4.2 cents to 10.2 cents per pound. Traceability in the food value chain will allow health authorities to easily determine the source of the tainted food and prevent it from going into market or to gradually recall products already in the market before they are consumed. The cost of foodborne disease, to society can be reduced and will increase the welfare of the society. The proposed NAIS system, planned for full implementation by 2009 will enable trace back to find all the premises the infected animal had been and the cattle it commingled within 48 hours. Other cattle that commingled with the infected animal would be found and prevented from going into market and the source of the contamination will be fixed. The combined EID+DNA will enable determination of cattle from which the beef was derived and trace it all the way back to the herd of origin.

Traceability itself alone cannot assure quality but it can enable authorities to find out the liable player in the value chain and make firms in the value chain invest sufficient resources to combat against food contamination. As Buzby, Frenzen and Rasco (2001, p.1) state, “Economic theory suggests that firms that make or distribute food products will invest fewer resources in reducing disease-causing contamination if they expect not to pay for injuries due to contaminated products.” Therefore, traceability is the

key tool that will make firms invest sufficient resources to reduce disease causing contamination and produce “*due diligence*”.

The Benefits of Traceability for Firms

In competitive environments firms always strive to innovate and develop new marketing and production mechanisms to successfully position or survive the existing pressure in the market place. The competitive U.S. beef industry is also continuously developing its technology and marketing strategy with the regard to maximizing its ability of satisfying consumer needs and striving to remain a sustainable industry. Along those lines U.S. beef industry has adopted multiple strategies for beef products in domestic and export markets. One of the recent marketing strategies for the beef industry as well as for other food industries has been the traceability, which has been comprehensively described in previous sections. Recent contaminated beef outbreaks caused consumers to lose confidence on the quality and safety of beef products and to change their consumption patterns. Therefore, some of food industries players e.g. beef firms developed and started to apply traceability as a mechanism of providing very valuable information e.g. the origin of product to the consumers to avoid their concerns and doubts. It is important to remember that traceability also provides information on the quality of the product, because the traceability system allows players to observe all points of an entire production process. The system has the ability to build trust and confidence of the consumers over the quality and safety of the food products. hAnluain (2001, p.1) states that:

“Trust is central in meat purchases, because you cannot judge what’s important by looking at the product, so you have to believe in the product you are getting. The only time you discover that your trust is broken is when a scare occurs,” said Mary McCarthy, a lecturer in food

economics at University College Cork in Ireland. "Traceability reassures the consumer and protects the supplier or retailer."

In addition to many other favoring characteristics and benefits the traceability system is also extensively applied by some firms as an efficient tool to differentiate beef products. The differentiability of beef products contributed to the sustainability and competitiveness of the given firm in the market place and also generated sufficient profit margins.

The most important and crucial point is the ease of adopting traceability into the production process by any player in the beef value chain. For example, it will only cost \$2.68/head annually to a saleyard operator handling 10,000 head of cattle and \$2.8/head annually to a feedlot operator having 10,000 head of cattle. The traceability application cost per head makes it relatively easy for the beef chain players to implement traceability to differentiate their beef produce.

Since there is no legal barrier or financial constraint, the first applicant will enjoy of benefits of traceability by charging premium prices or increasing sales. For example, in Ireland a supermarket chain, Superquinn uses DNA traceability for the beef it sells and as a result was able to increase its sales. hAnluain (2001, p.2) states "Our beef sales have increased steadily over the past number of years, and in 2000 were 11 percent ahead of 1999, the CEO of Seperquinn, Quinn said". The increase in the beef sales experienced by Superquinn draws much more attention than usual, because the total beef consumption was estimated by European Officials to be 18% below the consumption rate of 2000 towards the end of 2001 (hAnluain, 2001).

Firms that introduce traceability into their production practices can reap the benefits of traceability by setting premium prices for the differentiated products.

Consequently, the differentiability of beef products will enable the firm not only to participate in premium markets but also in non-premium market by setting different prices. Clemens (2003b, p.3) state, “Results from consumer focus groups indicate that Japanese consumers will pay 20% more for domestic foods with specific safety assurances and production information. This response is generally supported by price differences at retail outlet.” Therefore, the major commercial motivation for the firms in the beef industry to implement traceability is to have the ability of differentiating their products and maximizing profit from premium price setting in the short-run since the firms in beef value chain operate in a monopolistically competitive environment.

The following will provide details about the economic benefits of traceability in the case of the product differentiation and premium pricing strategy. To illustrate the economic effects of the traceability for an individual firm in beef value chain, a monopolistically competitive market model is used. The model constituted by the following combination of assumptions from both monopolistic and perfect competition market environments:

- There are many identical firms that produce and supply beef products to the consumers;
- This model may apply to all but identical players of the same status in the beef value chain e.g. beef producers, processors, and retail outlets. Basically, the model illustrates economic behaviors of the producers or processors as key players. The mixture of different players e.g. processors and retailer is beyond the focus of the model as they may have different marketing strategies.

- In the short run case, one of beef firms differentiates its products with the use of traceability to target the premium beef market. This part of the model captures a monopolistic effect, which allows only one firm to exist in the marketplace and to price its beef products monopolistically. The model enables us to let other firms of the producer or processor type to enter into beef market to lessen the existing monopolistic or market power or to completely reduce it to the zero level. In the short run, only one firm has market power to affect the price but other firms do not have this advantage. In the long run other firms enter the premium market by using traceability and produce at the price that is equal to average cost where marginal revenue (MR) = marginal cost (MC).
- In the long run, other U.S. beef firms e.g. producers, processors and retail outlets will realize the economic benefit of the traceability from targeting premium market. In addition, consumers will increase demand for traceable beef products that will urge other firms to apply traceability.
- Obviously, the monopolist will promote the specific benefits of traceable beef products to the consumers, which will increase their awareness of the importance of the system. Other firms will strive to apply the same traceability technology to reposition their presence in the market place or to be able to target the premium beef segment. It is likely that the broad application of the traceability across many firms will reduce the premium pricing strategy and reduce abnormal profits. Abnormal profits will be replaced by zero economic profit in the long run due to the application of the

same technology, traceability and marketing services associated with product forwarding.

- Though the market structure and environment constitutes some assumptions of the monopolistic power and pricing, it also allows free entry and exit for all firms e.g. producer and processor because, the cost of traceability is affordable. It does not require millions of dollars to incorporate it into production process (see the cost provided in the previous part of the study for various size and types of businesses in beef value chain).
- Differentiated products can be substituted with the products of other firms in meat industry. The substitution depends on the prices and other features of the substitutable products. Therefore, the demand curve is downward sloping, which indicates that the price decrease is followed by the increase in the quantity sold. However, consumer preferences over quality and safety factors of the products will explicitly segregate the same type of beef product into different market plots.

Figure 4.1 details a clear picture on short run effects of traceability on the firm's economic behavior. The primary objective of the firm is to profit by differentiating in Figure 4.1.

FIGURE 4.1. Short Run Case of Traceability Effect and Abnormal Profit

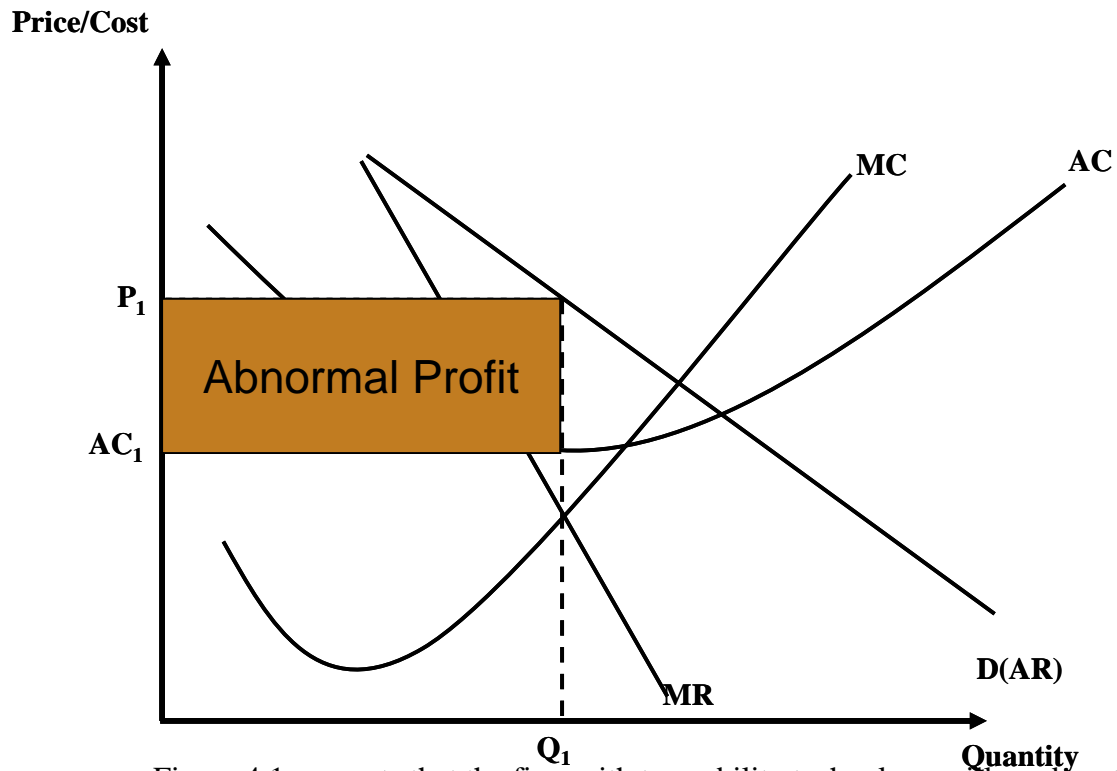


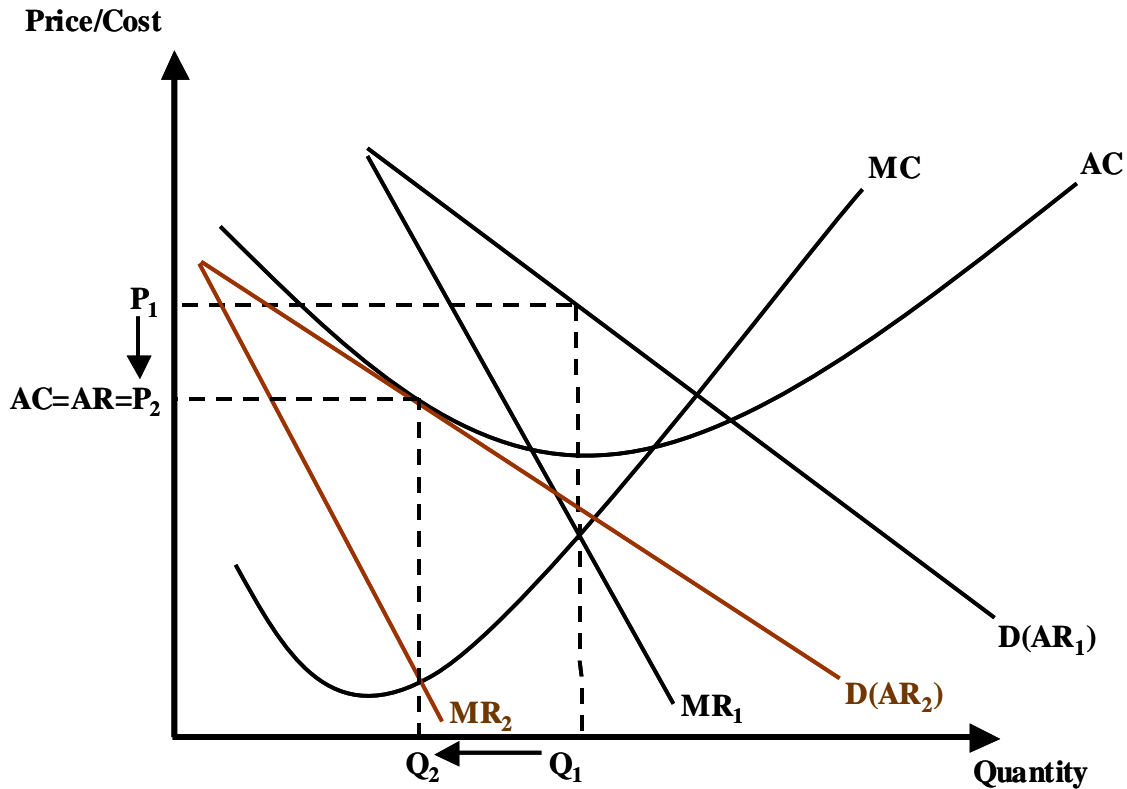
Figure 4.1 suggests that the firm with traceability technology will produce the quantity Q_1 and priced P_1 where $MR=MC$. The given quantity is considered to be an optimal level of output for the firm to sell in the beef market, which significantly depends on the consumer preferences as well as ability of the firm to successfully promote its products. In the short-run, it is also possible for the firm to continue to increase the quantity of the products if it obtains the confidence and trust of an existing pool of clientele. However, the assumption of the model does not allow the increase of the quantity with the increase of price due to the downward slope of demand for the firm's beef products. The firm will follow the strategy of choosing quantity by charging the price where $MR=MC$. Beyond this point, the additional increase in traceable beef product will bring less additional revenue than additional cost, which will lead to lower profit margins compared to the point where $MR=MC$. Therefore, by the application of

traceability, the firm will maximize its profits in the short- run at the point where MR and MC intersect. It also concludes that the firm is the monopolist in short run with unique market power.

Since there is no barrier to entry, other firms will be attracted by the abnormal profits and will apply the same or similar traceability systems in their production practices to obtain a share of the abnormal profit.

The key question to be answered is what will be the effect of the new entrants on the early applicant of traceability system? What will happen to the abnormal profit that is generated by differentiability of beef products? The new entrants will increase the supply of the traceable products, which will reduce the price charged by the first firm acting as a monopolist and will gain some of its clients. Figure 4.2 explicitly illustrates the dynamics of monopolistically competitive market model in the long run case, where other identical firms enter into the premium market.

FIGURE 4.2. Effects of New Entrants on the First Firm

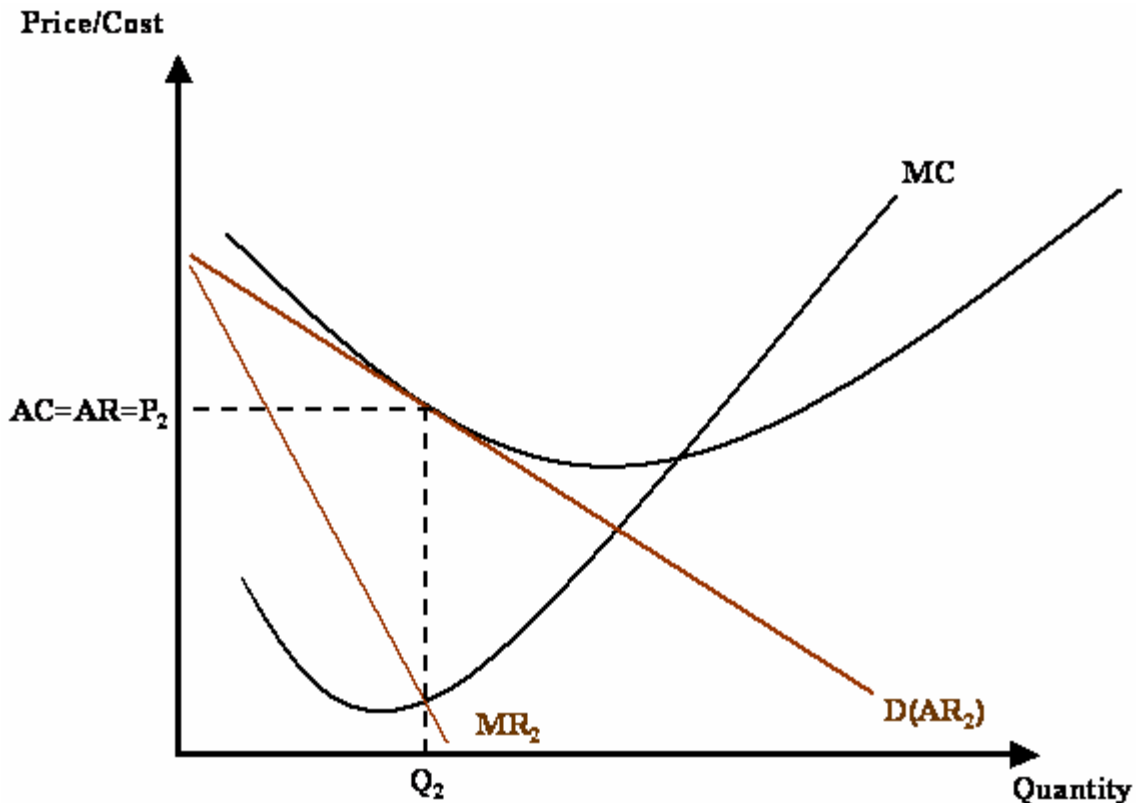


There will be pressure of additional supply by other identical entrants that will keep price of short run case P_1 to decline to P_2 at which point $AC=AR$. In the monopolistically competitive market $AC=AR$ point generates a zero economic profit for the firm. When the firms observe that there is no more possibility of gaining abnormal profits by applying the traceability they will stop entering into the market. Due to the decrease in the price the demand marked as $D(AR)$ and MR will shift inward for the individual firms. In terms of demand increase and decrease for an entire market versus an individual players two interesting cases will come out; a) an overall quantity demanded will increase due to the price decrease, b) an individual share of the firm may decrease due to the number of the entrants in the market place.

Consequently, firms that differentiate their products by applying traceability will make zero economic profit in the long run. Therefore, an initial applicant will be the only one that will reap the benefits of traceability before the price they charged gets equal to AC. The monopolistic firm or initial applicant will maintain its market power by the product differentiation until other firms understand the importance and benefit of traceability. This timeline is considered to be a short run case in the model. In addition, Figure 4.2 illustrates that the first firm will sell less quantity, Q_2 , of traceable beef products at a lower price, P_2 versus Q_1 , demand at price, P_1 in the short run case before sharing the market with other identical entrants.

Figure 4.3 clearly depicts the long run case of an individual firm operating in beef value and differentiated its products by using traceability.

FIGURE 4.3. The Long Run Case of an Individual firm in the Premium Market



The unique characteristic of this model is that it merges two market models into one by a single marketing strategy, the differentiation of beef products, initially by one player and then, by other identical players.

The model suggests that any beef firm may apply traceability as marketing strategy to differentiate its beef products. This opportunity will enable that firm to obtain an extreme level of profit in short run that is known as an abnormal profit in the economics. In other words, that firm will become a monopolist with a unique market power. But the monopolist has to share its market, which is a premium beef market segment with other entrants in the long run. Because other entrants e.g. beef producers, processors and retail outlets will also apply the traceability to be able to differentiate their products in the market place. As a result, the monopolist firm will lose an abnormal profit advantage and share it with other entrants. The number of entrants will increase until price of the beef product reaches to average cost to generate zero economic profit. It is also true that the implementation of traceability as a successful marketing strategy and food safety technology across the players in the value chain will generate safer and quality beef supply. Consequently, the medical and productivity cost to economy will be reduced.

It is beyond the scope of the current research to test the applicability of the marketing mechanism by applying the traceability in the real world. A more comprehensive analysis of traceability for the U.S. beef industry would be required to better understand what challenges and successes have been achieved after the integration of the traceability system in the production practices and willingness of consumers to pay and to purchase traceable products.

CHAPTER 5

SUMMARY AND CONCLUSIONS

In this study traceability has been explored in detail. Necessary technical information for application of traceability system has been provided. In addition, the different traceability applications in different countries have been studied and compared. The study also provides information on current trend in the United States and proposes a way for farm to fork traceability in the US livestock industry as well as the implementation cost of it per pound of beef.

It seems so far that the traceability is one of successful ways of obtaining the confidence of consumers. Gradually, traceability will become an integrated part of every firm in the USA that supplies food items to the market place. In fact, not only in the US, but all over the world firms in the food industry will incorporate traceability into their production systems to meet consumers' expectations as well as government's expectations.

We know from previous chapters that the traceability enables firms to overcome any costs related with product recall. The detailed and professionally organized traceability will provide sufficient information to the interested parties to avoid any disputes arising from the suspected food contaminations. The ability of tracing back all the way to the very origin of product or product supplements is unique and important for

the firm to be able to differentiate sufficient suppliers of raw material from insufficient ones.

Due to different types of foodborne contamination outbreaks, firms are having a difficult time convincing their customers about the safety of their products. Also, to be more competitive and capture more market share, exporting like Australia, EU, Japan and New Zealand are implementing thorough traceability system. Unfortunately, the United States lags far behind its competitors and gradually having hard times to protect its competitiveness. Therefore, it has become a crucial issue for the U.S.beef industry's outlook.

The study concludes that by differentiation of products, firms will have the ability to set their own price and make abnormal profit in the short run. In fact, the first applicant of the traceability will act as a monopoly before any other firm enters into the differentiated product segment. In the long run, however, due to introduction of traceability by other firms the supply of the traceable products will increase and price the first applicant used to charge will decline. Also, the new entrants will draw some of the customers of the first applicant. Due to these two major reasons, in the long run the firms providing traceable products will make zero economic profit.

Traceability contributes positively to the economic welfare of consumers in short run and long run. In addition, the study found that the traceability cost from farm to fork will range from 4.2 to 10.2 cents per pound; however, the willingness of consumer to pay extra 4.2 cents per pound of beef is not measured. Therefore, it is strongly suggested the research focus on those issues is a doctoral level of commitment.

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APPENDIX A

FIGURES

Figure A.1 Allflex Electronic Ear Tag



Price: \$2.94/tag

Figure A.2 Allflex Handheld Readers

Allflex Stick Reader - Curly Cable Allflex Stick Reader - Curly Cable



Price: \$452.00

The Allflex Stick Reader is designed predominantly for use by cow/calf, stocker and small feedyard operators. It reads FDX-B and HDX tags.

Features and Benefits:

ISO 11784 & 11785 HDX and FDX-B compatible

45cm, portable, ruggedized hand-held reader

Can be operated off standard 120V power supply or from an external 6V or 12V battery

Weighs 22 ounces including the cable. Cable either straight (3m in length) or curly (1m)

Read range minimum of 20cm with data storage capacity and RS232 port

Figure A.3 Destron Walk-Thru Reader

Destron Walk-Thru Reader**Price: \$4,000**

Large, lightweight portable tarp antenna. Designed to for use in cattle processing areas to read groups of animals as they walk through the antenna field. Will read all ISO compliant RFID tags when used with a Destron Technologies reader FS2001-ISO. Requires an external tuning box to allow the user to compensate for environmental factors encountered during installation. The system can be easily transported from one processing area to another or rolled up and stored for occasional use. The antenna is constructed within a high-strength, industrial grade poly-tarp. The structure needed to support the antenna may be built by the user per Destron specifications or purchased from Destron® Technologies.

Specifications

Performance: For 100% accuracy the cattle must be restricted to a single file as they pass through the antenna.

Approvals: FCC part 15 class A (when used with an FS2001 reader, IEEE STD C95.1 1999 Edition.) Safety levels with respect to human exposure.

Construction: Two layer stitched industrial grade poly tarp. Cleans easily.

Frequency: 134.2 kHz

Read range: Up to 4 ft. at optimal tag orientation and 2 ft. for ALL tag orientations. User environment may affect read range.

Temperature

Range: -25C to +50 C

Dimensions: 12ft L x 44 in

Temperature Range:

-25C to +50 C

Dimensions: 12ft L x 44 in W (laid out)

Weight: 15 lbs

Pass-through

Dimensions: 6ft. h x 4ft. L x 2.5 ft. W (*W is the width of the pass through and may be adjusted to accommodate for the size of the animals being read.*)

Installation: Up to 28 mounting holes available. Should NOT be mounted directly on a solid metal plate.

Interface: NEMA 6P watertight connector with shielded cable to FS2001 external tuning box. Optional Armorfast cable is available for severe environments. Panel may be hardwired by special order and used with up to a 30 feet of cable.