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A simulated recall study in five major food sectors

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Abstract

Purpose – This study aims to investigate the effectiveness of current traceability systems in five food sectors: dairy, fish, red meat, fruit and vegetable, and grain. Products were bought within Norway, with national and international origins.

Design/methodology/approach – The method used structured interviews and questionnaires at each link in the production and supply chain of 30 products in order to discover the ability to identify the origin of product, the size of batches used during production, the potential product and process information available and the estimated time of recall in an emergency situation.

Findings – The results showed that it was possible to trace 53 percent of the products bought through their supply chains to their origin. The results demonstrated that mixing transformations create challenges for traceability that are more severe than other types of transformations. Company motivation is an important factor in creating the conditions for a successful tracing event.

Social implications – The study presents findings that can be used by the food producing industry and regulators that will aid in improving the ability to track and trace food effectively. This will aid the food producing industry in providing society with better food information so that consumers can make informed choices.

Originality/value – This study presents data on multi sector traceability, which is not only valuable because of its uniqueness, but also because of the possibility to use this in future studies for comparison and measurement of progress. This study is highly valuable to food producing industries, regulators and researchers as it presents new and unique data, regarding recall times and sector specific challenges.

Keywords Simulated recall, Tracking, Tracing, Traceability, Product recall, Food, Food products, Norway

Paper type Research paper

1. Introduction

Much of the food that reaches the modern consumers plate is sourced globally. Production and distribution patterns have become much more complex than was common even 30 years ago and consumer preferences have evolved to include specialist foods and foods out of season (Skees *et al.*, 2001). At the same time the number and types of food related health incidents, from Bovine Spongiform

The authors would like to thank “eSporing” the Norwegian Traceability Project for funding this study. The authors are very grateful to all the industry contributions and the contributions that were gratefully received from their colleagues. Some of the data in this paper were included in the presentation: “Simulated recalls of meat products, fruit and vegetables originating in the European Economic Community” at “TRACE in practice” the 5th TRACE conference in association with the EU project TRACE on 3 April 2009.



Encephalopathy (BSE) to Dioxins, are growing (Carriquiry and Babcock, 2007; Caswell, 2000; Elbers *et al.*, 2001; Fallon, 2001; Hobbs, 2004; Madec *et al.*, 2001; Ozawa *et al.*, 2001; Sporleder and Goldsmith, 2001). These factors have contributed to a need for greater transparency in food supply chains (Carriquiry and Babcock, 2007; Kiesel *et al.*, 2005; Pettitt, 2001; Inman, 2009). Creating this transparency requires the ability to trace and track ingredients in food stuff rapidly and precisely.

Traceability is defined as: “the ability to trace the history, application or location of that which is under consideration” (ISO, 2000) and “the ability to trace and follow a food, feed or food-producing animal or substance intended to be or expected to be incorporated into a food or feed through all stages of production, processing and distribution” (EU, 2002). However there is no requirement to record either transformations of the Traceable Units (TU’s) that take place within a company or to have internal traceability systems. Transformations in the food sector, especially mixing, have been shown to be important points of information loss (Donnelly, Karlsen and Olsen, 2009). Without internal traceability it can be difficult to connect specific products received to those delivered. In contrast to the EU the United States of America (USA) has introduced legal requirements regarding internal traceability (United States Statutes at Large, 2002).

Research carried out by Teratanavat and Hooker (2004) in the USA concluded that the number of recall incidents related to food products has been increasing since 1997, they also show that the recovery rate has not changed over time. There is little, if any, research regarding food recalls that has been presented within the EU, this paper will contribute to filling this gap. Research in this area is also important for economic reasons. Numerous studies have shown that serious recalls have a negative affect on company profits. Kramer *et al.* (2005) Skees *et al.* (2001) and Thomsen and McKenzie (2001) have shown that the most serious type of recalls reduces shareholder wealth by 1.5-3 per cent.

Effective tracking and tracing systems improve the speed and precision of recalls both in life threatening food contamination issues and also in less serious food quality issues (Karlsen *et al.*, 2010). One important factor affecting speed and precision of tracing and tracking is the batch size. The smaller the recorded batch size the greater the precision that is possible in the traceability process (Bertolini *et al.*, 2006). Methods for improving traceability are a central area for research and ever increasing information is available however this study aims not to investigate the most advanced methods but rather look at the current real world situation.

One theory, put forward by Sherri McGarry at the Joint Institute for Food Safety and Applied Nutrition (JIFSAN) conference 2009, is that the shorter and simpler the supply chain the quicker and more effective recall would be. Data from a broad range of supply chains would enable this to be examined further. The effect of import activities on the traceability of products raises questions as to whether it is more difficult to trace an imported product than a “local” product. In McGarry’s experience from tracing food through food supply chains in America following food safety incidents it appeared to be easier to obtain information where the product was “local.”

The aim of this study was to investigate the current reactions in the food production sectors to a possible recall of products, purchased in Norway, but originating from Europe and beyond. This was to allow comparison between geographic origins

(local/national and international) and different food sectors. This is an important extension to work, which has previously been carried out in the fish sector. The result of this work should enable more focused and appropriate research, both for the authorities and for the various food sectors, into improving both precision of and time taken for food recall.

2. Material and methods

A modified version of the method described by Karlsen and Senneset (2006) and Randrup *et al.* (2008) was used and is outlined in Figure 1. Food products were bought at selected larger supermarkets. In order to guard against bias in the results randomised decisions were made with regards to which sectors should be represented (dairy, red meat etc) exactly which products should be bought and where. An overview of the products finally purchased can be found in Table I.

Three large populated areas spread across the geographic area under investigation were chosen, these were: the Norwegian cities of Oslo, Trondheim and Tromsø. Five supermarkets were visited at each location. In each supermarket two products were bought, with care taken not to buy identical products in the same chain of supermarkets, at the different locations. This was to avoid the study replicating results in the same supply chain. The investigation was carried out in five food sectors representing the most common consumer products:

- (1) dairy;
- (2) fish;
- (3) meat;
- (4) fruit & vegetables; and
- (5) grains.

These products were also of particular interest as part of a larger national project related to traceability of food stuffs. The authors carried out a structured interview in each shop followed by a telephone interview with each business involved in the supply of the product. The interview questions can be found in Tables II and III. The same protocol with regards to instructions to shop employees was followed in each supermarket. In each case the focus was on tracing back the main sector ingredient in question, i.e. fish, meat etc. For example with fish pie the emphasis was on tracing the fish through the supply chain.

Following the initial purchase of products the researchers immediately began contacting each link of the supply chain through which the products had travelled, using the structured supermarket interview together with additional questions (shown in Tables II and III). All contacts were recorded and registered in a database for analysis. In each case the company was informed about the nature of the research and that individual company information would be confidential.

The additional questions, which were used in the telephone interviews can be seen in Table III.

The data collected was analysed using Microsoft Excel and SPSS (Statistical Package for the Social Sciences). Simple analyses were carried out.

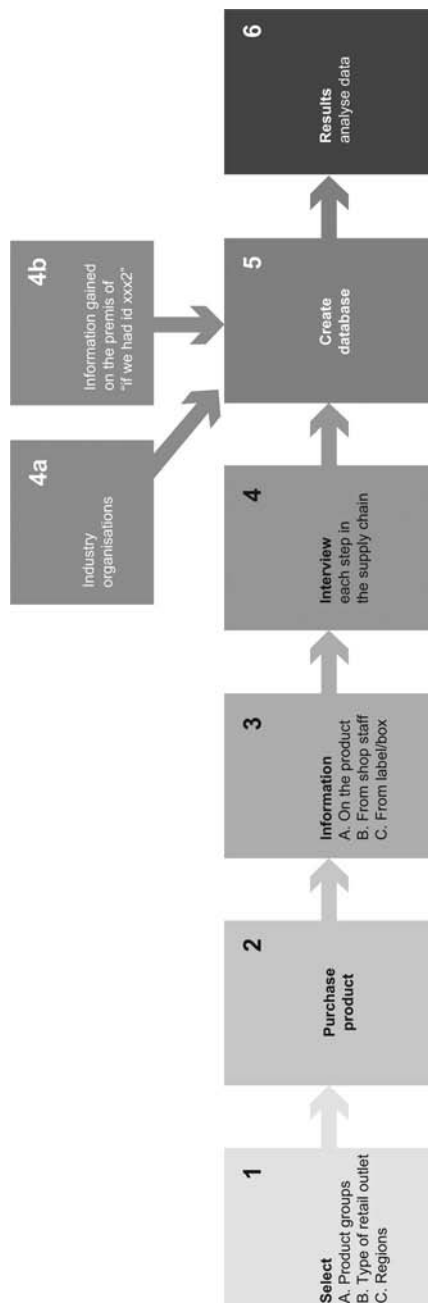


Figure 1.
The method used during
this study

Table I.
List of products tested

Region	Fruit and vegetables	Grain products	Dairy products	Fish products	Red meat products
Oslo	Banana Pepper	Rice cakes Bread	Cheese Yoghurt	Wolf fish cakes Fish cakes	Neck cutlets Salami
Trondheim	Apple Yellow tomatoes	Breakfast cereal White flour	Skimmed milk drink Sour cream	Salmon "biff" Frozen salmon fillet	Entrecote Ham
Tromsø	Apple Broccoli	White flour Bread	Semi skimmed milk Yoghurt	Fish pie Fresh salmon fillet	Steak Minced meat

Notes: This list is generic and apparent duplication is caused by purchase of the same type of product at different supermarkets. Brand names and supermarket names are not identified due to confidentiality

Information about the purchase

1. Date of purchase
2. Place of purchase

Information about the product both on the packaging and gained in the shop

1. Describe the product
2. Does the product have any special certifications such as MSC, KRAV, Organic?
3. Who owns the brands?
4. What is the name of the producers? (contact details)
5. What is the authorisation number?
6. What is the origin of the product? (country and region)
7. In which land was the product processed?
8. What is the GS1 code on the product?
9. Is the product marked with any other identifying numbers?
10. What is the production date?
11. What is the 'best before' date?
12. Is there any other information on the product?

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Table II.
Questions asked during the purchase of the product

1. Which part of the value chain is this?
2. What is the name of the company and the contact person?
3. How is the information collected (in person via email, via fax via telephone)?
4. When was the information collected?
5. What was the time taken to collect information?
6. How was the information collected?
7. Have you delivered product (specific) X to the customer Y?
8. What kind of information can you give me about the product?
9. Can you tell me exactly where the raw ingredients have come from?
10. Can you tell me who delivered the raw ingredients to you?
11. How large was the delivery, which included the ingredients for this product?
12. How do you communicate with your customers?
13. What is the size of a batch at your company?
14. What is the estimated time needed to trace back through your company?

Table III.
Questions asked as part of the structured survey

3. Results

The results are summarised in Table IV. It can be seen that the dairy sector had the greatest number of products with known origin. The grain sector had the least number of products with known origin.

Although the longest individual supply chain, with ten links, was encountered in the dairy sector on average the fisheries sector had the longest supply chains.

Type	Known origin	Unknown origin	Not reporting	Total investigated	Known origin (%)
Dairy	5	0	1	6	83
Fish	4	0	2	6	67
Red meat	4	1	1	6	67
Fruit & veg	3	3	0	6	50
Grain	0	5	1	6	0
Total	16	9	5	30	53

Table IV.
Summary of the results

None of the grain products were fully traceable. Very often the grain was traceable back to a grain silo but at this point there were either no records kept or the companies were not prepared to make their records public.

The results regarding batch size are interesting and yet challenging to compare sector to sector. The results from the fisheries fell into two groups some originating from “farms” and some from the wild. The farmed fish had the smallest batch size with around 100,000 fish. The wild caught fish sector, with a batch size of, ‘the catch from three fishing boats over three days’ gave the largest (estimated) batch size. The dairy sector batch sizes demonstrated the wide range that it is possible to find. The range found was from 1,163 collections from farms (the same farm maybe included more than once) in a soured cream product to 124 collections in a simple milk product. A similar pattern was seen in the red meat sector, a processed product could have come from one of 3,499 animals whilst an unprocessed product could have come from any of 30 animals.

4. Discussion

This study provides new insights into tracing in five food sectors covering typical food stuffs that consumers currently purchase. Some of the most interesting points are highlighted here:

- Red meat was a sector with the longest possible recall times (Figure 2). As red meat is a sector which has often been the focus of food safety incidents one might expect that the motivation for fast, precise traceability leading to short recall times would be very high in this sector. This was not the case.
- The mixing transformations, for instance those at the silo, which are used in the grain sector in order to improve quality are an inherent problem for traceability (Table IV). Though researchers have recently demonstrated solutions for this

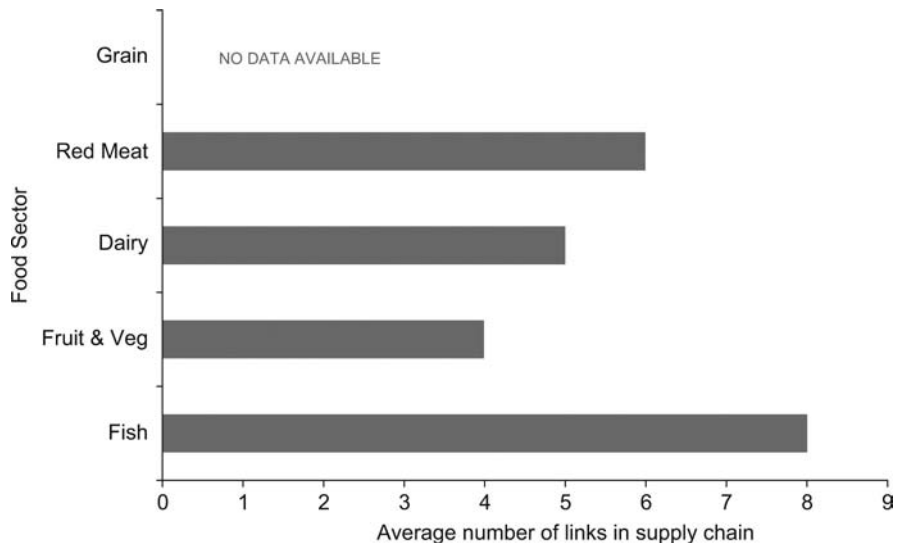


Figure 2.
Average links in the supply chain

problem through appropriate use of registrations and databases (Thakur and Hurlburgh, 2009).

- Sectors with long (in context of this study) supply chains such as fish, particularly when it was farmed, demonstrated the fastest estimated recall times (Figures 2 and 3). This shows that factors other than supply chain length are more important for recall times. Such factors may include strategic company factors and motivation.
- The dairy sector demonstrated a successful recall rate (i.e. full identification of known origin) of 83 per cent, which was the best of any of the sectors in the experiment; it demonstrated middle values with regards to supply chain length and recall time. But although they have proved, through the high recall rate, an excellent awareness of, and access to appropriate recordings, the batch sizes (number of milk tanker collection visits to farms) were in some cases large. So we can conclude that throughout traceability, consistent registration of ID's, does not necessarily mean small batch sizes. What affect this would have in a food safety incident would have to be considered by an expert in food safety and diary products.
- The origin of national i.e. "local" product was more often found than the origin of imported products (Figure 4).
- The data gathered during the phone and personal interviews during the experiment pointed to the fact that human factors and motivation within a company are some of the most important factors in determining the ability trace once sufficient technological solutions are in place.

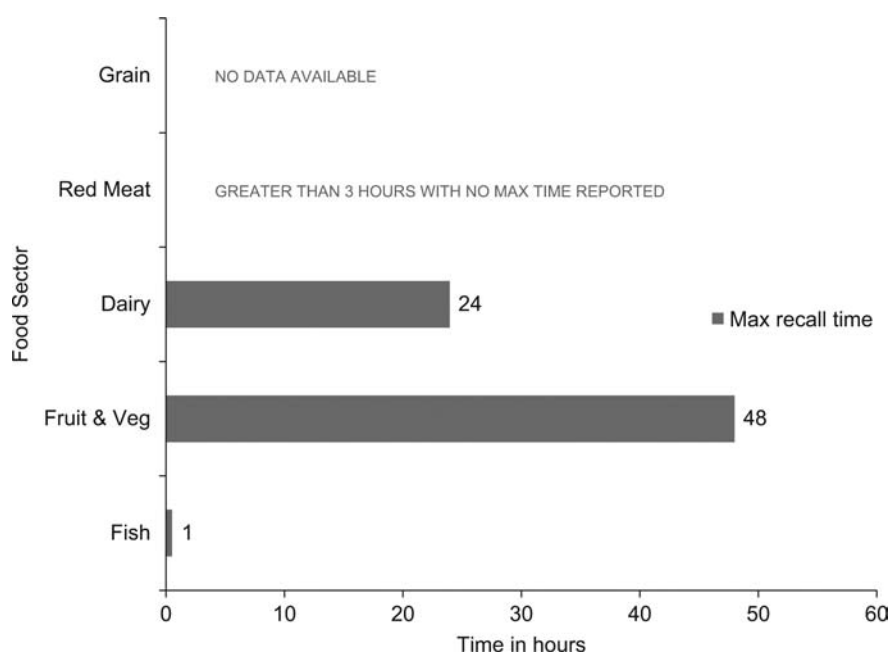
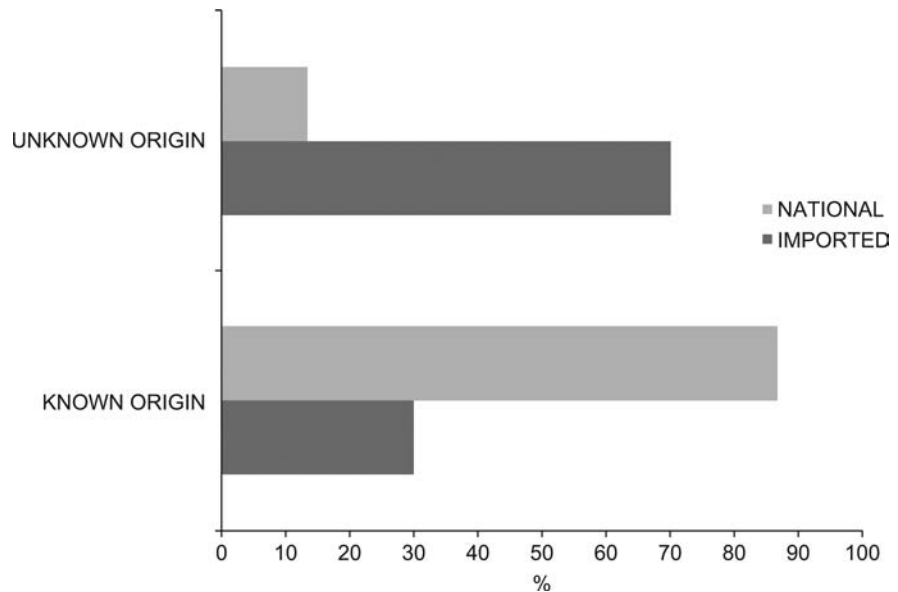


Figure 3. Illustrates the estimated maximum recall time. The "estimated time" is that estimated by the companies involved

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Figure 4.
Imported compared to local products this is from the supply chain included in the category reporting and excluding those counted as not reporting



As far as the authors are aware this is the first data set which presents a systematic comparative study of recall times for commonly bought consumer food stuffs. The above points are further elaborated below.

4.1 Bulk products

There are a number of similarities between grain and milk, such as collection and mixing of products from a number of farms and both being bulk products. However there are important differences, for example grain is delivered by farmers into silos whereas milk is more usually collected, and the route driven by the collection truck forms an excellent initial traceability log. Due to the nature of the product milk tankers must be regularly cleaned forming natural “stop” points, this is not the case with grain. Many deliveries are made to a grain silo in a short period of time with no requirement or other particular need to separate one delivery from the next (Thakur and Hurlburgh, 2009). This means there is no cut off point or natural “stop” at which registrations of contributing farmers can be made. The dairy sector generated the best traceability in this study (83 per cent). The authors believe that this is due both to the previously mentioned “stop” points (caused by hygiene regulations) and also to the fact that the supply chain for dairy products moved outside the country of investigation in only one case. Additionally the attitude of managers and employees in the dairy sector, measured by their level of response, generally seemed to be positive to the idea of tracing and electronic systems were in place and well integrated.

4.2 Compliance with current regulations

Each of the sectors investigated comply, as far as we are able to ascertain, with the current “one up one down” EU regulation (EC, 2002). This regulation requires, as a minimum, the ability to establish what type of product is supplied from which

suppliers and what type of product is sold to which customers. The current regulations within the EU require one up one down traceability but does not require detailed internal traceability. The results show that the fastest and most precise tracing activities were achieved when a supply chain has addressed both internal and chain traceability and had clear connections between internal traceability data and chain traceability data. For instance in the farmed fish supply chains many of the companies could access both internal and external connections within the same electronic data base system.

4.3 Effect of supply chain length

The hypothesis that the shorter and simpler the supply chain the quicker and more effective recall would be, has been tested using the data from this study. From the evidence in this study (Figure 3) we can see that there was no such trend towards shorter supply chains leading to faster recall. For example the results for the fish products show that although on average they had one of the highest numbers of links in a supply chain (varying from 7-9 see Table IV) the fish sector was also characterised by a relatively high percentage of known origins (67 per cent). Unprocessed products such as the fruit and vegetables had fewer links in the supply chain (3-4 links) and a lower percentage with a known origin (50 per cent).

4.4 Batch size

Batch size is an important factor in relation to traceability (Karlsen *et al.*, 2011). If no internal traceability information is registered, such as date of use, it can lead to apparently extremely large batch sizes of possibly a whole year or more. The red meat sector reported possible batch sizes ranging from 30 animals to over 3,000, that is not to say that all 3,000 animals contributed to a product but that, that was the smallest number of animals identifiable which could have contributed to the product. Apples for example could be marked individually using small labels allowing for detailed information on individual products to be maintained independently of actual packaging. An example taken from Donnelly and Karlsen (2010) is that of a company having a single large delivery of salt which is used in small quantities in production without registering either the date when they start or stop using it, the batch size can only be calculated from the date of delivery of the salt which maybe months different from its date of use. If there is the need for a recall of products containing this salt all products from the date of the initial delivery of the salt to the present must be recalled. Such examples as this, often concerning ingredients used in very small quantities, will be found throughout the different sectors. This lack of registration of all resources used, will, in the case of a recall, have much greater economic consequences for the company due to the information being homogenous and imprecise. In the event of a food safety incident at any point in the supply chain there would be no possibility of carrying out a swift precision recall. During this study it was often observed that companies with multiple registrations, and therefore usually smaller batch sizes within production, could trace more precisely.

4.5 Other important factors affecting tracing and tracking observed in this study

Observations, resulting from the interviews with companies in the study associated with successful tracing of food products, showed that traceability was either demanded

by their customers (at many points in the supply chain) or as a vital part of ensuring food safety. This indicates that the internal attitude of the company may be considered an important factor with regards to traceability. The authors suggest that factors, such as these, i.e. company motivation and customer demands, play an important role in the amount of effort put into effective tracing and tracking systems. A certain degree of caution must be used since the sample is not large enough to carry out statistical tests on.

The data in this study is limited by the fact that it was, of necessity, conducted from Norway meaning that the results cannot be said to be representative of the whole of Europe. Over 30 per cent of the products studied here were imported into Norway before sale. This presented some problems when gathering data as companies became less inclined to cooperate with the research once we moved outside Norway. In order to compensate for this the study was designed with the possibility to report that the product was either of known, unknown origin or not reporting thus preventing the results from being skewed by the lack of responses from certain industry actors. However it did mean that we were able to get an indication about whether nationally produced food is easier to trace than internationally produced food. The highest percentage of products with a known origin, without a restricted batch size, was found to be in the dairy sector (Table IV). Of the 83 per cent tested dairy products could be traced back to a known origin with this same percentage being produced and processed nationally. This theory of nationally produced food being easier to trace is also supported by the results from the fisheries sector where three of the four traceable products were also nationally produced and processed. In order to investigate this further a cross national study would need to be carried out in order to limit the bias towards national products experienced in this study.

4.6 EU vs USA

A comparison of the results from this study with those from a USA study (Levinson, 2009) was also carried out. The one major difference between the two studies, however, is that the USA study stops at the USA border. This means that products were only studied up to the point where the traceability moved across that border.

Figure 5 shows an overview of the results from the USA study and from the current study where the products were purchased in Norway with no restriction on origin. The two studies were carried out using a very similar method, at around the same time 2007-2009 and with a similar number of products. The American study addressed product bought within the USA with no indication of origins outside the borders of the USA while the current study addressed products bought, without any origin restriction, in Norway. Within the limited scope of these two studies Figure 5 would seem to indicate that there is a much greater chance of locating the origin of a Norwegian purchased European food stuff than an American one. The results in the USA study did show one similarity to the study carried out in Norway this being that in both cases most traceable products were found to be in the dairy sector.

One interesting comment made by Levinson (2009) is that although they were able to trace only five of the 40 products to their origin, for 31 of the products they were able

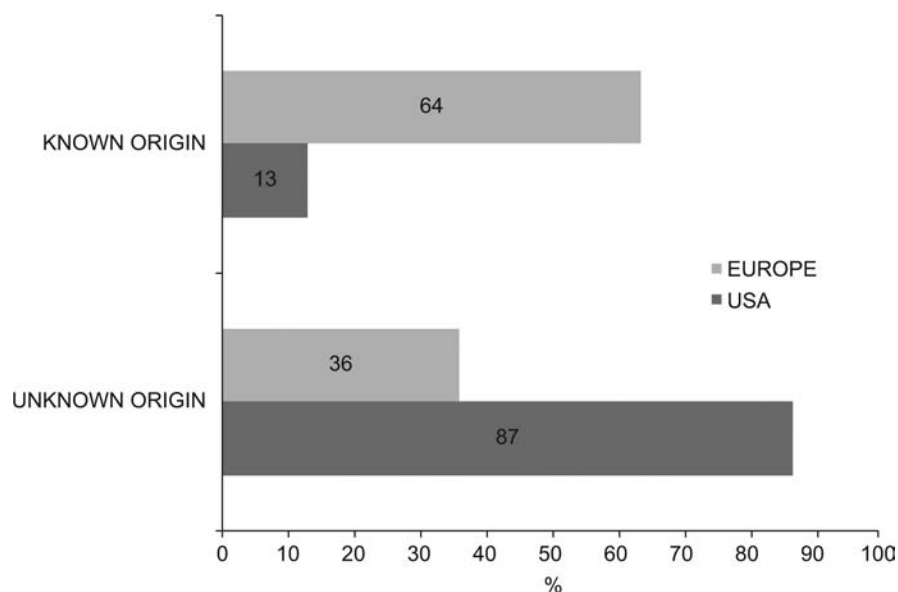


Figure 5. Comparison of data from this study with data from an American study (Levinson, 2009)

to identify which facilities were “most likely” to have handled the product they failed to trace. In our study there was only one of the products (in the fruit and vegetable sector) where the “most likely” route was identified, this being by means of the fact that the packaging identified the origin of the fruit. However in order to identify it on a batch and farmer level one extra identifying code was needed. This was lost because the consumer containers of the fruit were not kept in the larger cardboard box in which they were delivered. In this particular case the inability to trace back to origin was due to a lack of identification at lot and batch level. This meant that the unique identification of the Trade Units (TU), necessary for successful traceability were not locatable. These two factors highlight the need for two important things. First: companies need to be aware of how to maintain the traceability of a product – by recording all transformations and secondly: the importance of internal traceability in a “trace back” situation.

4.7 Methodological considerations

The method used here has been developed over time and through several projects. A very similar method has been used in recent governmental studies carried out in the USA (Karlsen and Senneset, 2006; Randrup *et al.*, 2008; Levinson, 2009). The method has weaknesses which must be highlighted, these are: lack of a sense of urgency as companies are aware that this is a simulation; lack of actual evidence for the claims made by the companies, (it was outside the scope of this study to physically check each company’s documentation however since details were often passed from one company to the next it is thought that the likelihood of the companies misleading the researchers is negligible). As previously mentioned, 30 per cent of the products studied here were imported into Norway before sale, and companies in these supply chains were more disinclined to cooperate with the research.

4.8 Further work

Analysis of all the data collected in this study provides some useful pointers towards further study for both improving and assessing the optimal levels of traceability or information flow. These include the need for greater clarity in both identifying what is the correct information and then recording this in order to maintain identity of products (Creedle, 2007). For example one company in the study had recorded large amounts of internal data but had no connection to the external suppliers of ingredients making the data of little use in chain traceability. The study data also includes confirmation of optimal methods for harmonisation of infrastructure (TraceFood, 2007) for example electronic systems for registration of food product movements and compatibility of information in chain traceability systems. Supply chains where each company was aware that there was a standardised way of identifying goods along the supply chain were able to demonstrate how this information could have been used to trace through an external electronic database. Knowledge of such external identifier could in an emergency situation eliminate the need to contact each individual link in a supply chain. The data also points to the increasing need for industry standards so that multiple information technology (IT) solutions can be provided with systems that can “talk to” each other (Senneset *et al.*, 2007). Research related to this has already identified it as an important area for improved and effective information flow, for example the TraceFish standards (European Committee for Standardization, 2003a,b; Denton, 2003) International Organization for Standardization (ISO) work and in the honey, potato and chicken sectors (Haverkort, 2007; Haverkort *et al.*, 2006; Donnelly *et al.*, 2008; Donnelly, van der Roest, Höskuldsson, Olsen and Karlsen, 2009). The final pointer, noted by Levinson (2009) is that of the importance of human factors and education of employees in such things as how to maintain traceability information.

5. Conclusion

The traceability challenges identified in this study are mainly shown to be sector specific for instance, the apparent lack of need or regulation for identifying origin prior to mixing many deliveries of grain to gain a desired quality level. It would seem that the most successful traceability systems in this study are not due to any traceability regulations but rather other regulations such as the hygiene requirements in the dairy sector. As previously discussed there are similar tracing challenges in the grain and dairy sectors, e.g. both being bulk products, but with differing traceability outcomes due in part to non-traceability related regulations. The study also confirms some key features for successful tracing events in all sectors, for example the registration of the specific identification of lots at reception and dispatch of food products, the marking of the smallest unit or trade unit (TU) and not least the need for companies to be aware of these basic principles of traceability. The work presented here shows that in order for sector wide traceability to be effective companies must have some degree of both internal and chain traceability. Many of the interviews carried out for this work also highlighted the fact that the development of industry or sector standards for exchange of traceability information would be beneficial. Research regarding the effects of country of purchase is limited in this study and similar multinational studies would provide greater insights into amongst other things the importance of place of purchase in a trace back scenario. Further research is required on assessing the cost and benefits for individual sectors of implementing varying levels of traceability.

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