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Report

Traceability of hides through the supply chain

- Norilia Hide Case

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ABSTRACT

Abstract heading
This study is a part of iProcess project funded by the Research Council of Norway (NFR 255596). The aim of this study was to evaluate various data capture technologies for traceability of hides in a pilot setting. The RFID enabled hide tags provided best readability while there were challenges with the other technologies. RFID tags were used for tracking between the slaughterhouse and Skjeberg. Hides which had dot peening and laser engravings went through the tanning process and the hides returned still had hair on them which made it difficult to read the markings. The UHF and LF RFID tags could not be located in the hides after the tanning process. In theory, all tags and markings tested in the study should be readable, but the tanning process is the main challenge for the available technology. Traceability from the farm to the raw hide processor (Skjeberg) is possible with the technologies available and RFID tags provide promising results. If the machine-readable requirement is not essential, laser engraving can be used for traceability also including the tanning process.

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1 Introduction

Hides are one of the most important rest raw materials or plus-products produced by the meat industry as they are further processed and used in leather production. The hide supply chain consists of a producer (farm), slaughterhouse, hide processor and a tannery and is visualized below in Figure 1. A lot of data is generated in this supply chain but a full electronic traceability system from the farm to the tanneries does not exist. There is a need to develop such a system that will improve the overall quality and product differentiation as well as improve the process efficiency.

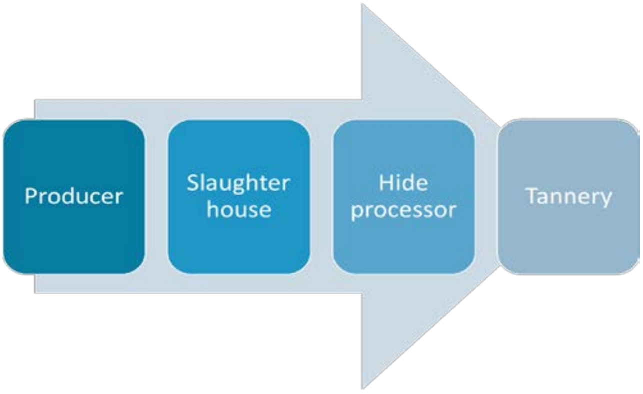

Figure 1. Typical supply chain of cattle hides.

Norwegian farmers use a great deal of time to make sure that their animals are doing well[1]. Farms are small, and farmers have a lot of knowledge about animal husbandry, with a focus on animal health. Barbed wire is banned in Norwegian fences because this can potentially damage the animal's skin. This, together with the general absence of horns on Norwegian cattle, is one of the main reasons that Norwegian cattle hides have fewer defects. Norwegian cattle hides are world-class and are used in the luxury market for the production of handbags, belts, shoes, and upholstery. Hide production in Norway was about 2.1 thousand tonnes in 2015, declining by an average annual rate of 15.3 % from 2008 [12]. In 2017 a total of 293 371 cattle hides were produced in Norway. Norwegian hides are known for their high quality and farmers earn up to 30 euros per animal when sold to international tanners. This hide is turned into luxury handbags each costing up to 4700 dollars by big brands [20].

Many international as well as Norwegian brands, like Gucci, Bolia and Dressmann [4, 7, 11] are concerned about the impact of leather production and ethical sourcing and are demand higher levels of traceability. Leather supply-chains are multi-step and globalized, making it challenging to define criteria for sustainable leather and study the whole supply chain. Traceability can be used as a tool to drive leather sustainability. Traceability methods and systems for animal hides is an emerging field driven by a customer demand for sustainable and ethically sourced leather.

2 Background for the study

The current study has been conducted as a task in the project *iProcess – Innovative and Flexible Food Processing Technology in Norway*, funded by the Research council of Norway (NFR 255596). The project was awarded 34.1 mill NOK through the BIONÆR programme, and work started in 2016 and will run until 2020. The hide case is one of two case studies in Work Package 4 in the project, and is a collaboration between SINTEF Ocean, Norilia, Nortura and RFID Solutions. Norilia handles 90% of Norwegian cattle hides and 80% of skins from Norwegian lamb, sheep and goats [1].

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[1] https://www.norilia.com/feature-articles/from-norwegian-cow-to-luxury-handbag

3 Objectives

The hide case study has the following objectives:

1. To map the current hides supply chain in Norway to identify the status of traceability.
2. To identify the data capture technologies that can be used for traceability of hides.
3. To identify and test various traceability agents (RFID tags, sensors) and make an efficient industrial implementation plan.
4. To test and evaluate various data capture technologies for traceability of hides in a pilot setting.

4 Traceability

4.1 Traceability and consumers

Traceability and identification are extremely important for manufacturing companies, not only for ensuring safety to the customers and comply with regulations, but also for optimizing logistics [6]. Several consumer surveys and studies show that customers are concerned about the genuineness of leather products and often relate the manufacturing country with the quality of the product [5, 14]. In an assessment based on consumer survey and secondary sources for leather labelling at EU level, consumers expressed preferences for products with a particular country of origin and limited environmental impact, as well as expressed their willingness to pay higher prices for these products [8]. The results from another survey show that, in the 16-34 age group, ecological impact, ethics, and the country of origin of goods are important determinants in the consumer's decision process when he or she buys apparel. Leather products often being at the higher price end of the apparel/accessories segment, consumers are all the more concerned with ensuring that they have the quality of product that they pay for [5]. A research paper investigating the awareness of Romanian consumers towards ethical leather footwear highlights that consumers are interested in ethical footwear, but the knowledge and information they have are limited [15]. To be able to assist consumers in making a sustainable choice, trade rules should enable the tracking of manufactured articles by providing consumers with information on product origin and by assisting in counterfeit control [21].

4.2 Use of traceability as a feedback

A problem is bridging the gap between the tanner who can evaluate the quality of hides and skins, and the farmer who is in the best position to influence that quality. It is difficult for example, to persuade a farmer to use expensive chemicals or techniques if they do not receive any reward in return. Traceability systems can help bridge this gap and result in a better product itself as well as a more environmentally sound process [3]. Benefits of this level of traceability can also help in monitoring of animal health and growth (by monitoring and reporting skin diseases back to the farmers) [17].

In a collaborative research by Gibson and Bass and some international business partners, a physical stamping mechanism was used to grade hides based on their quality and visible damage and to provide feedback to improve hide quality. The numerical stamp used on animal hides could be used to track the source of the hide and other information from a database [13].

4.3 Challenges in traceability

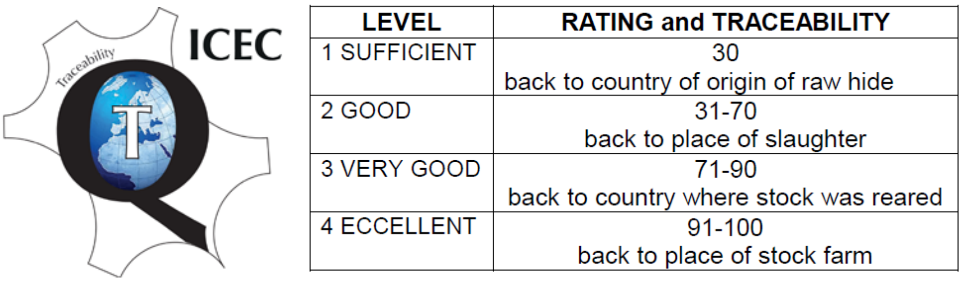
In the textile and leather industry, traceability still represents a tough challenge as the material undergoes severe mechanical, thermal or chemical processes in its production chain [6]. Hide quality is difficult to link to production systems because of the lack of traceability of hides and the fact that the meat/dairy & leather goods industries are currently progressing separately on sustainability issues [17].

4.4 International standards and available methods

There are a few regulations and standards for leather produced from wild animals and reptiles such as CITES reptile leather, however there are not certifications and standards for bovine leather. Here are a few certifications and labels.

4.4.1 ICEC

ICEC is the only Certification Institute specialized exclusively for the leather sector. Established in 1994, the Institute of Quality Certification for the Leather Sector has developed a Leather Traceability Certification that assesses the tanneries in terms of the geographical traceability of the upstream phases of the raw materials (slaughterhouses, breeding farms). The certification will define such product with a pertinent rating. This rating specifies the traceability degree regarding the process upstream of the tanneries. The best rating can trace the raw hides to the location of the breeding farm (Figure 2).



LEVEL	RATING and TRACEABILITY
1 SUFFICIENT	30 back to country of origin of raw hide
2 GOOD	31-70 back to place of slaughter
3 VERY GOOD	71-90 back to country where stock was reared
4 ECCELLENT	91-100 back to place of stock farm

Figure 2. ICEC traceability.

4.4.2 OEKO-TEX

The LEATHER STANDARD by OEKO-TEX® is a worldwide consistent, independent testing and certification system for leather and leather articles of all levels of production. This standard targets manufacturers of leather materials and leather articles along the entire supply chain, traders and brands/retailers. *Made in Green* by OEKO-TEX is a labelling system for all types of textiles, although not particularly for leather, that gives access to information like the production facilities and the country in which the product was manufactured. The OEKO-TEX association is a union of 18 independent textile research and test institutes in Europe and Japan and their worldwide representative offices. Their label *Made in Green* has a unique product ID or QR code, which provides full traceability and transparency for the consumer. This *Made in Green* label contributes to product safety from a consumer's point of view [18].

4.4.3 Nordic Ecolabel

For the Nordic countries, products certified under the Nordic Ecolabel must be able to document traceability of the hides/skins and leather for all the stages of the production chain incl. the slaughterhouse, hide distributors and tannery. The production chain shall be described, and the name and telephone number of the slaughterhouse, hide distributor and tannery shall be given. The Nordic Ecolabel also requires documentation on the environmental aspects such as chemicals used, effluents, energy and water consumption during the treatment of hides/skins [16] (Figure 3).

Figure 3. Nordic Label

5 Tagging and labelling methods

Physical tags like plastic and paper labels or RFID tags for animal hides cannot withstand the tanning process hence there is a need to develop a tagging system that can carry information all the way through the supply chain until the leather product is sold to a customer [6]. There are a few new methods under experimentation. As a part of this study, possible labelling and tagging methods were reviewed and described in Table 1. Stability of the taggants throughout the tanning/production process is a challenge, and only chemical marking by a tattoo pen [6] and DNA-tagging (see next chapter) have been proposed for leather traceability.

Taggant materials have been widely used to mark objects for the purpose of identification [10]. Different kind of taggants can be used, such as physical, spectroscopic, chemical and DNA taggants – and these can be applied to or incorporated within an object. The speed, simplicity and accuracy of analysing the coding components is an important factor when it comes to the overall efficacy of taggants [10]. It is also highly important that the taggants are impossible (or extremely difficult) to duplicate.

5.1 Marking by using a tattoo pen with metallic paint or Barium titanate

An innovative method under experimentation for hides is using chemical markers applied to the hides by a tattoo pen [6]. The chemical markers tested was metallic paint and the chemical Barium titanate that can be traced by X-Ray or Microwave reflectometry (MR), respectively. X-ray instruments are used to detect metals, while the MR is an electromagnetic measurement technique that measures variation in dielectric permittivity (dp). Barium titanate has a dp of more than 40 while hides have a dp of 3-4 (at room temperature). The results showed that X-ray was the most promising technology, since it can "re-construct" the pattern of the markers (as a 2D code) [6]. The reading of the code can be automated by using software for image processing, and the X-ray has the possibilities of being implemented in the process line. However, X-ray machines are expensive – and prices for secondary market instruments of relevant instruments (24 kV and 8 mA settings) could be in the range of 65 000 USD- 95 000 USD. For the MR there is a requirement for physical contact between the probe and the material, and interference from the environment could also influence the MR results. In addition, the localization of the markers could be challenging.

5.2 DNA tagging

Storage of "non-genetic" data within DNA molecules have large potential since the arrangements of the 4 digits (A, C, G and T) gives a near unlimited number of codes [19]. Recent years, several approaches of using DNA-based authentication for product tracking and tracing have been designed [19].

According to Gooch et al., (2016) there are five manufacturers of commercial forensic DNA taggants, and several of these are used for property marking. E.g. applied DNA Sciences (ADNA) has developed authentication technology for different products, and industry solutions to tag, test and track raw materials, critical components and finished products[2]. Challenges in using DNA for traceability is that it requires some effort in analysing the taggant (typically extraction of DNA and PCR – analyses or sequencing), and also that DNA is a relative sensitive molecule [9].

Recently ADNA issued the patent "Alkaline Activation for Immobilization of DNA Taggants " (US20140256881A1). This patent describes the process for enhanced binding affinity of the SigNature®T molecular tags, and the resulting DNA- taggants are proposed to withstand extremely harsh manufacturing processes. The DNA taggants were, in example, recovered after cotton and wool yarn processing (US20140256881A1). A research project with BLC Leather Technology and ADNA with the aim to provide full traceability throughout the leather supply chain has been performed. This project investigated the feasibility of generating unique botanical-based synthetic DNA markers that have a strong affinity to collagen (the principle protein within skin and therefore leather). The markers are reported to be unique to a specific operation or facility and were reported to be recovered and detected throughout the leather production process, even in finished leather/product (pers. comm. Tony Benson, ADNA).

Applied DNA are also providing a service called SigNify authentication services – which consist of three options. Full forensic authentication at their laboratory (NY), on-site authentication at a customer´s certified lab, or in-field DNA authentication. The latter comprise a portable DNA reader where one can do tests for specific marks, but this should require DNA extraction (2 hours) and analyses (unknown time). For tracing back an unknown DNA code – there is probably a need for sending sample results to a laboratory for comparison with a database (with relevant producers/batches).

These special tags called the SigNature T DNA tags are already used for cotton to track the authenticity of cotton through the entire supply chain (Figure 4) [2]. This method is claimed to be not only robust and durable but also cost effective [3].

Figure 4. SigNature label.

5.3 Chemical tagging

In example, unique elemental fingerprint such as rare-earth elements are applied, and usually analysed by mass spectrometry (LA-ICP-MS) but also laser-induced breakdown spectroscopy has been used [22]. SmartWater$^{\text{TM}}$ is using this technology to prevent crime. Here a water based, inorganic traceability liquid with unique forensic signature is used. The code embedded here is a mixture of metal salts and

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[2] http://adnas.com/technology/

non-biological DNA. The liquid can also contain fluorescence dyes. The customer registers the unique code in a database.

Another innovative method under experimentation is using chemical markers to tag the hides. These chemical markers can be metallic paints or chemicals like Barium titanate that can be embedded in the skin and traced through X-Ray or Microwave reflectometry [6].

5.4 Spectroscopic taggants

Molecules with differing optical qualities are combined in a mixture with a unique spectral signature [10]. Such taggants are usually identified via the analysis of overall emission signature by simple spectrophotometry techniques. Non-toxic organic dyes that fluoresce in different regions of the visible spectrum are commonly used. Advantages of this technique is the low cost and good availability of organic dyes. However, there is a possibility of illegal reproduction of such taggants if the fluorophores are recognized by dishonest players. In addition, there are disadvantages of spectra emission overlapping, short fluorescence lifetimes and sensitivity to photobleaching [10]. We have not found any literature using spectroscopic taggants for hide traceability.

5.5 Physical taggants

Includes e.g. microdots, that are small polymer disc with unique numeric code imprinted. The code is not visible for the naked eye but is analysed by optimal microscopy and code can be compared to a database. Also, for physical taggants, there is the challenge of durability during the production process of leather.

5.6 Gibson Bass stamper

The Gibson Bass Stamper, developed by Joe Gibson in 2001 is a computer controlled stamping system which stamps individual letters, numbers or codes onto a hide or skin at any stage of the tanning process. The stamps last through the finished leather and information about the source of hide can be found in a database (Figure 5) [13].

Figure 5. Controlled stamping by the Gibson Bass Stamper.

Table 1. *Methods for marking and tagging of hides.*

Marking/ tagging method	**Does it survive the tanning process?**	**Equipment requirements**	**Feasible in industrial setting?**	**Unique code?**	**On individual hides?**	**Tested in iProcess**	**Relevance**
Tattoo							
Subsurface tattoo with metallic paint [6]	Yes, 2D shape	X- ray instrument	Yes, but high cost	Yes	Not known	No	Method is relevant for brand protection and authentication
Subsurface tattoo with Barium titanate (high permittivity) [6]	Could identify marker, but not shape	Microwave-reflectometry instrument	Not very cost-effective			No	
Taggants (may also be used in combinations) [10]							
DNA - taggants[3]	Applied DNA claims to have tested it with success	DNA extraction, PCR amplification instrument (portable DNA – reader)	*Validate* specific code: yes *Identify code: need laboratory*	Yes	No	No	This is currently used for different textiles and claim to have tested on hides.
Chemicals (like metals)	No information		Requires advanced analytical instruments			No	
Fluorescent / phosphorescent substances	No, these should not come in contact with bleaching materials					No	
Physical taggants (microdots etc)	No information					No	
Other labelling methods							
Laser	Tested once in iProcess without success			Yes		Yes	
RFID	Tested without success			Yes		Yes	Better way of attaching the RFID to the hides is required. Check the possibility of a fastner + RFID solution (e.g. Avery Dennison solutions)
Stamping							
Dot peening	Tested without success					Yes	Could conduct further tests after shaving the hair on the hides
Gibson Bass Hide[4] Stamper	Claim to be lasting through tanning		The label seems quite large			No	Have contacted the company to check if it is possible to stamp the hides with a data matrix code instead of large letters.

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[3] http://adnas.com/2018/05/01/apdn-leather-tagging-farm-finished-products/#1521759792861-493c67bc-0ada

[4] http://www.gibsonmanagement.com.au/how%20traceability.htm

6 Case study

Using hides from Norilia as a case study, several data capture technologies for traceability of hides through the supply chain were tested in an industrial pilot setting. A general overview of the five different technologies tested are shown in Table 2 below. The technologies tested included three different RFID solutions, dot peening and laser marking.

6.1 Process Mapping of the Norwegian cattle hide supply chain

Process mapping of the cattle hide supply chain was conducted with input from the industry partner Norilia. The AS-IS process maps of the slaughterhouse and the hide processor are shown in Figure 6. The process maps indicate the current data capture points.

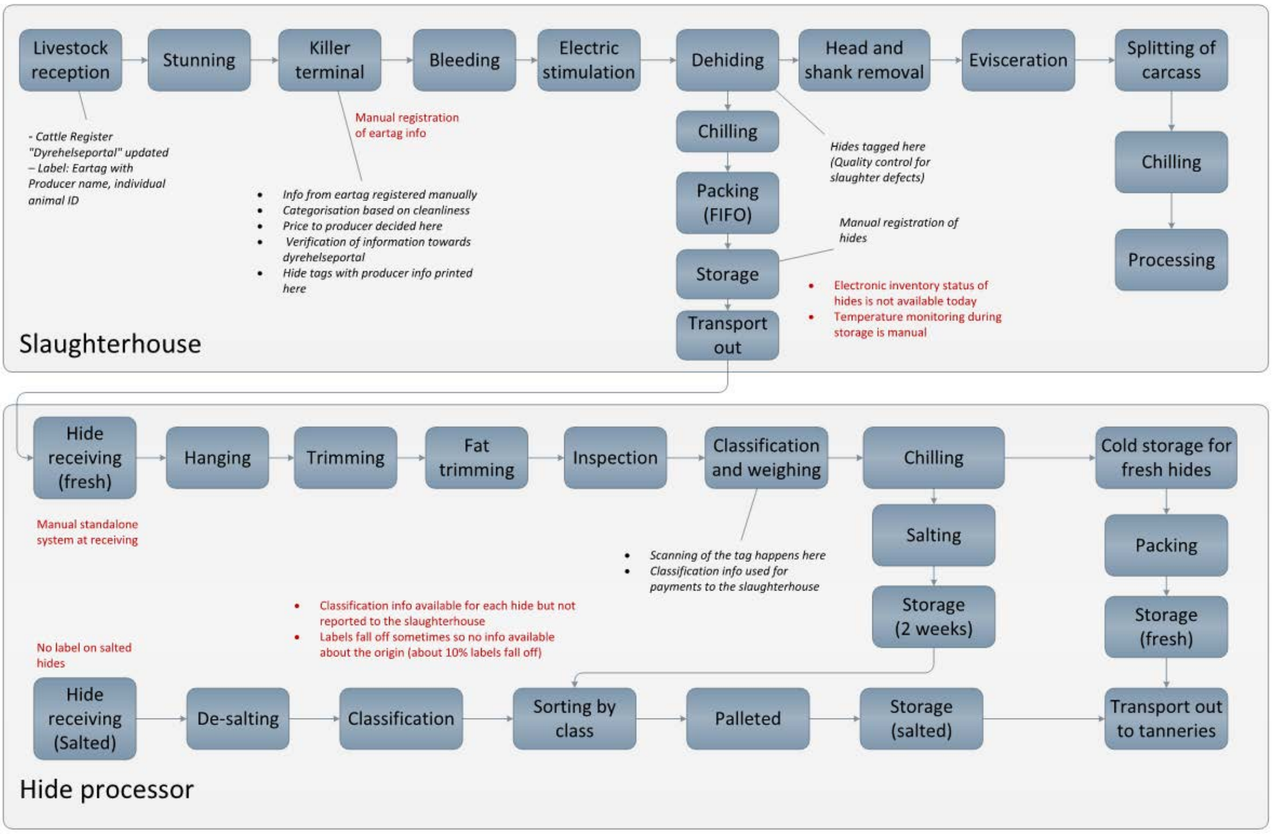

Figure 6. Process Map of the slaughterhouse and the hide processor.

Table 2. Tagging/marking experiments carried out in the hide case.

Tagging technology	Equipment used	Raw material tested	Benefits	Challenges	Tracking	Did the tests work?	Date of test
Ultra-high Frequency (UHF) RFID	RFID tags from Smartrac and Trap NF Nordic ID Stix reader to confirm readability.	Fresh hides (n=2)	• State of the art technology • Individual tagging • Batch reading • Cheap tags	• The process needs automation • Does not operate well in or close to aqueous fluids • Large size	Tracked hides from Skjeberg, to the tannery and back.	No, the tags were lost or unreadable after the tannery. Readability: 0%	Tested spring 2017
Low Frequency (LF) RFID	Tags from Dyreidentitet AS, used for microchipping of pets.	Fresh hides (n=10)	• Made for hide tagging. • Adhesive that bonds to organic materials.	• Very close-range readability • Difficult to inject the tag	Tracked hides from Skjeberg, to the tannery and back	No, the tags could not be found after the tannery. Readability: 0%	Tested autumn 2018
Dot Peening	SIC Marking E1 123 Marking system	Fresh hides (tested both QR-code and text) (n=4)	• Readable after the tannery • Portable device with fixed mount • Simple technology • Low operating cost • Wide marking window • Robust and lightweight (2kg)	• Not possible to read markings on hides with hair • Mainly used for marking metal • The needle was rough on the material • Need to shave the area used for marking	Tracked hides from Skjeberg, to the tannery and back	No, could not read the markings (the hides were not shaved) Readability: 0%	Tested autumn 2017
Laser engraving	30 W MACSA laser and Godex GD550 2D barcode reader	Fresh and salted hides (tested both QR-code and text) (n=2)	• Handheld equipment	• Hard to read markings on hides with hair • Hard to scan the markings • The process needs automation • Availability of equipment	Tracked hides from Skjeberg, to the tannery and back	Yes partly, the text was readable after tanning. The QR code was unreadable. Readability: 0% for QR and 100% visibility.	Tested autumn 2018
RFID enabled hide tags	Reader Impinj R440, 4G-router, antenna, Raspberry Pi or Logistic IOT platform.	Fresh hides (preliminary test n=649, main test 1 n=750, main test 2 n=550)	• There is already such a process in place. • Standard off the shelf RFID process • Ensures the track is kept	• RFID tags are only as secure as its fixation to the hide	Tracked fresh hides only until first processes of tannery	Yes, the hides were tracked between Malvik and Skjeberg. Readability: 80% and 100%.	Tested spring 2019

6.2 RFID

Several different RFID technologies were tested for tracking of the hides. These were Low Frequency (LF) RFID tags similar to those used for microchipping of pets, coupled ultra-high-frequency (UHF) RFID tags, and RFID tags that were glued onto the traditional hide tags used at Norilia.

6.2.1 LF RFID Tag

Low frequency RFID was tested to investigate the possibility of injecting tags into biological material. Tags similar to those used for tracking of pets like cats and dogs was injected manually as shown in Figure 7 using a standard syringe between the outer layers of the hide. Tags were injected into two hides to test the technology and sent to the tanneries. After coming back from the tannery, the hides were scanned. No traces of the tags were found after the tanning process. The tags were probably lost or destroyed during the rough tanning process.

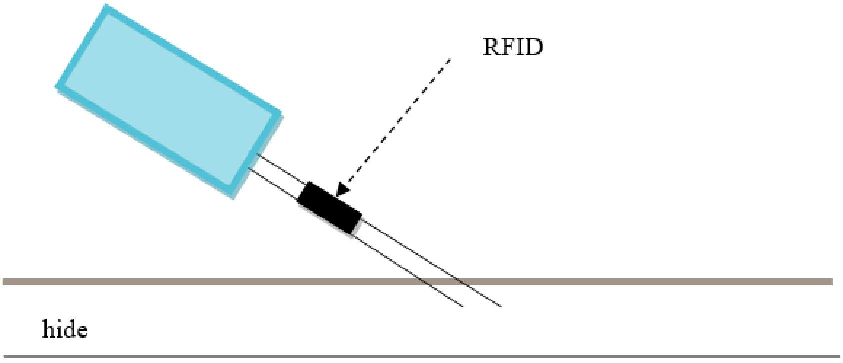

Figure 7. Injection of Low Frequency RFID tag, usually used for tagging of animals like dogs, into hides. Illustration: Geir Vevle.

6.2.2 UHF RFID

Conventional radioactively coupled ultra-high-frequency (UHF) RFID tags were tested using commercial off the shelf labels with Near Field UHF capabilities to overcome the challenges of saltwater and conductivity in hides. UHF RFID was tested as a possible technology for full chain traceability. Thus, fresh hides were tagged, allowing the tag to follow the hides through the entire supply chain before checking for the presence of the tags when the hides come back after the tannery. UHF RFID tags were injected into ten fresh hides and sent to the tannery (see Figure 8). Coming back test showed that the none of the tags survived the tanning process. Most likely they were lost during the handling or in the tannery.

Figure 8. Tagging with RFID UHF. Photo: Geir Vevle.

6.2.3 RFID enabled hide tags

Preliminary test

In January 2019 preliminary tests with RFID tagging using Nortura's existing hide tags were conducted at Nortura Malvik. The equipment tested were traditional hide tags with RFID tags on glued to one side as shown in Figure 9.

Figure 9. To the left is the hide tag used in production today. The right shows labels with glued RFID tag on one side. However, due to production errors the tags were glued to the wrong side of the labels. Photo: SINTEF Ocean.

During the preliminary test, 1231 hides were tagged at Malvik and sent to Skjeberg where they were scanned during their arrival at the facility. The preliminary test showed that only about 50% of the tags (616 tags) were registered at Skjeberg. The low readability of the tags could be linked to several issues, but the most likely explanation was obstruction of the signals from the RFID chip through the hide, or that the antennas were mounted too far away. Using today's hide tags, Norilia has estimated that about 1% of the hides lose their tags between the slaughterhouse and Skjeberg. Sometimes there are also some incorrect registrations done at the slaughterhouses meaning that the hide tag is invalid. During the preliminary trial several potential causes of the low readability were identified (Table 3).

Table 3. Potential causes for low readability of RFID enabled hide tags, their likelihood and how these can be confirmed.

Potential cause	Likelihood?	How to confirm
Tag was destroyed in the process	Low	Remove a tag not read at Skjeberg for test.
Tag degradation due to ex. moist	Medium	Test tag that is proven not to work.
Hide obstructing the RF	High	Antennas will be mounted on both sides of the movement path (both for hides and tags).
Antennas too far away	Medium	One antenna close, one antenna further away. Compare results.

Main experiment

After the preliminary tests the main experiment with RFID enabled hide tags was done later in spring similar to the preliminary test. The tests were conducted on different types of cattle, both calf, cow and ox in the slaughterhouse in Malvik. The RFID labels were glued onto the hide tags after killing and bleeding but before dehiding. The labels were placed about 10-20 cm below the sternum close to the head and neck. Traditionally hide tags have been placed in the throat; however, the placements of the labels have been changed to an area higher up (while the carcass in hanging upside down) to ensure better EHS for workers doing the handling.

The test setup at Malvik consisted of two waterproof and washable antennas that were mounted with an angle of 70 - 80° at a height of about 2,5 meters. This was done to enable the antennas to cover a larger area as shown in Figure 10. Additional equipment included a 4G-router and a reader which was placed in a nearby closet.

The test setup for reading the tags during arrival at Skjeberg was similar to the one at Malvik and also consisted of one reader and two antennas pointing towards the passing hides (shown in Figure 10).

Figure 10. Antennas used at Skjeberg during the tests with RFID tagging of hide tags. Photo: Geir Vevle.

The main experiment consisted of two separated tests where the RFID tags were glued onto the hide tags at Malvik and transported to Skjeberg. The first test was conducted using 750 tags, while during the second test 550 tags were used.

The first test showed good readings after attachment of the RFID where data and signals from the tags were registered on site and sent to the IOT platform for storage (Figure 11). After tagging the hides continued along the processing line. The hides were read again after arrival at the Skjeberg facility. After arrival here 649 of the 750 marked hides were read indicating a readability of about 80%. This was found to be suboptimal. It is probable that the low readability was due to one of the two following reasons; 1) hides obstructing the RFID or 2) the antennas were mounted too far away. To improve the readability the antennas were moved closer to the hides on the processing line, and there were also personnel at the site facilitating the readings to identify other possible obstacles. Thus, for the second test all of the 550 tags were read at both Malvik and Skjeberg ensuring a readability of the RFID enabled hide tags of 100%.

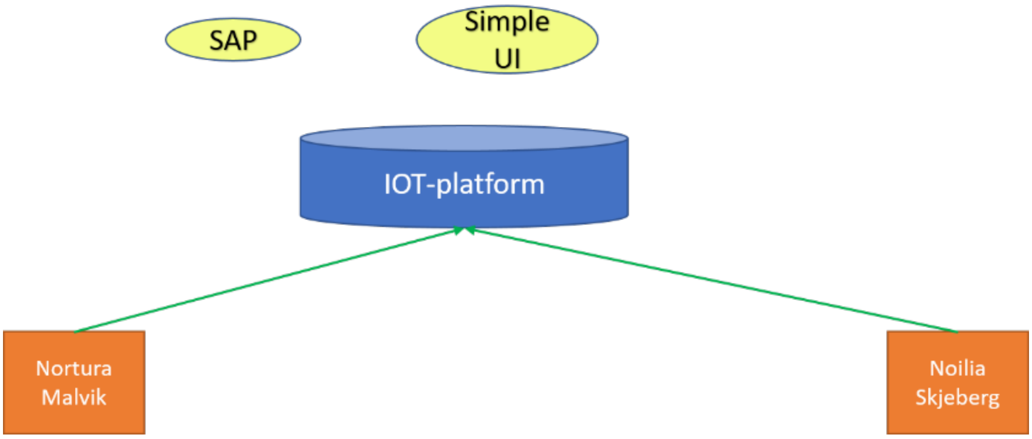

Figure 11. Test setup for RFID tags glued to hide tags. The RFID reader supplying data to the cloud via 4G and GUI to visualize data. Illustration: Geir Vevle.

6.3 Marking with Dot Peening

Tests with Dot Peening using a portable SIC Marking E1 123 Marking system[5] which is particularly suitable for creating 2D data matrix codes, was conducted at Nortura's facility at Rudshøgda October 2017.

In the tannery the hides are stretched using clips in the outer areas of the skins which leaves clearly visible marks on the hides (1-3 cm inwards from the ends of the hides). Thus, the best areas for markings are one of these two areas: 1) the neck or 2) the tail. Some tanneries also end up removing parts of the neck, to ensure the markings are not lost during this process. The tail or farther in the neck area are the best areas for markings. Thus, the neck area was used for marking of the hides with Dot Peening. Also, only hides from large cattle were used for this test (see Table 4).

Table 4. Hides used for the tests with Dot Peening.

Animal origin	Slaughter weight	Weight of hides*	Classification
Cow	180 kg	17+	Q17+
Bull	330 kg	33+	33+

* Weight of hides are usually estimated to about 10% of the carcass weight.

The Dot Peening tests were conducted in the production line right after where the fresh hides were transferred down from the slaughter line to the basement (Figure 12). During the test only 4 hides were within the right weight class and were used for tests with Dot Peening. The marking was done in the neck area right by the hide tag so that it would be easier to locate and read the markings later. All hides were marked with the same letters and a QR-code as shown in Figure 13. In addition to the Dot Peening and white strips, the fresh hides information from the hide tag was collected by photographing the markings so that the information could be linked to the identification numbers, animal id as well as the time of the marking. While marking the hides it became clear that visibility could become a problem later, as it was impossible to read the markings due to too much fur and blood.

Figure 12. To the left: The stationary SIC Marking's e1 controller of the Dot Peening machine. To the right: The handheld part of the Dot Peening machine while testing on fresh hide. Photo: SINTEF Ocean.

After the Dot Peening process, the hides continued online to a chilling step with cold water (ca. 2°C) on an underwater conveyor belt covered with plexiglass (max 18 hides at the time). After chilling, the hides were

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[5] https://www.sic-marking.com/e1-p123-marking-system

placed in big grey plastic boxes (10 hides in each) for storage and transportation to the hide plant in Skjeberg by chilled trailers.

When the hides returned to Skjeberg after tanning no marks on the hides were found. This was largely due to the fact that the hides still had hair when they returned from tanning, making it impossible to find the markings. The hides were shaved to try and locate the markings, but they could not be found. This could be due to how the structure of the skins (especially the collagen layer) changes during the tanning process where the hides undergo scraping, warming/drying, stretching and sanding. This could mean that the holes made during the Dot Peening process could become sealed or blocked. A possible improvement for testing with Dot Peening could be to shave the areas before marking of fresh hides at a suitable step in the processing line. However, delaying the marking to a later stage in the process means missing some of the information generated at the slaughterhouse. Also, shaving the hides before marking adds another processing step that will be time-consuming and add costs.

It should be noted that before testing the equipment online in the factory with the final product hides (both crude and smooth hide skin), the equipment was tested to see what programme settings would work the best, and to determine the best placement of the markings. Several different QR-codes were printed, but reading the codes using mobile phones with QR-scanners was unsuccessful (Figure 13).

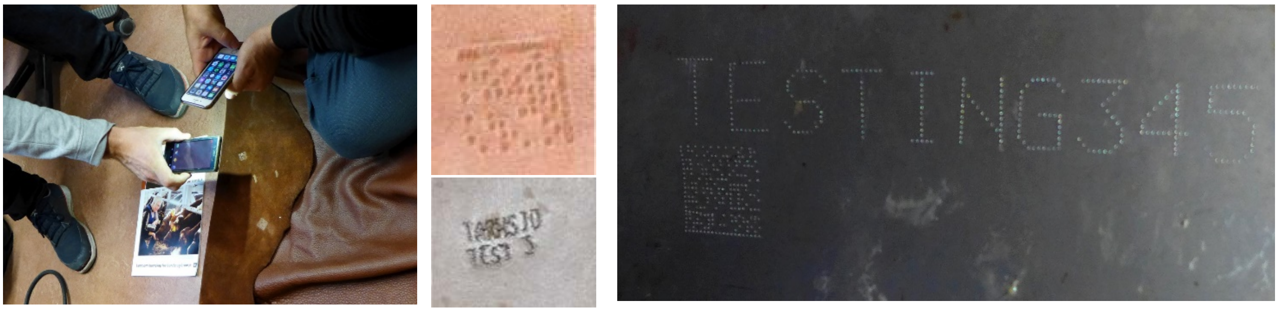

Figure 13. To the left: Hides were tested in the office prior to entering the facility and tagging fresh hides. Middle: Dot peening on hides after the tannery. Right: Text and QR code printed on the hides using Dot Peening. Photo: SINTEF Ocean.

6.4 Laser engraving

A state of the art 30W MACSA Laser was used for marking of both fresh and salted hides. The hides were engraved with a variation of POWER and DURATION as well as the prints and lettering on the hides. The ultimate goal was to get a machine-readable ID onto the hide, like a QR or Datamatrix code. Secondly, an Alphanumeric ID could be introduced. The hides were engraved at Norilia's facility at Skjeberg, prior to the tanning process.

Coming back to Skjeberg after the tanning process the hides had visible markings (Figure 14). However, the QR code or the Datamatrix code was unreadable. This was most likely due to deformation of the skins during the tanning process. Despite the difficulties with machine reading of the marks, the laser engraving showed positive results with markings that were still readable after the tanning process. This technology could also show potential for usage in other parts of the supply chain other than what was tested during this trial (e.g. after the tanning process).

It should also be noted that a hurdle for this technology is the availability of equipment. No handheld equipment has been identified suitable for this job, and an industrial setup is considered to be too cumbersome to use. Another challenge would be to automate the process, as this process was done manually during the current study.

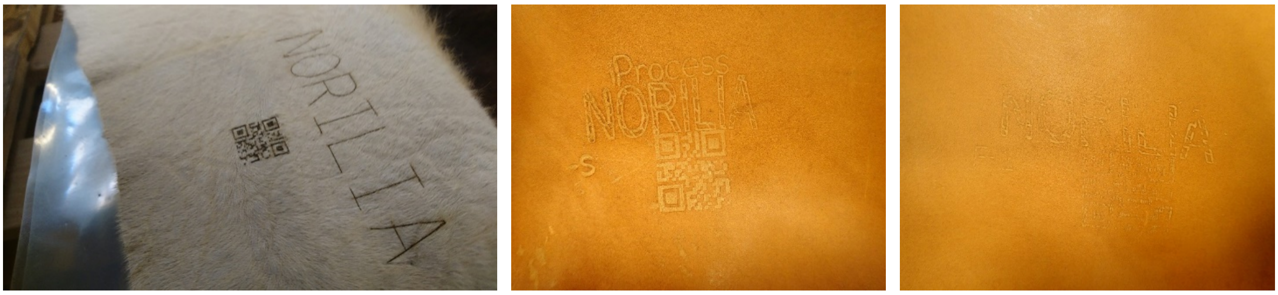

Figure 14. To the left: Finished hide with markings, the middle and the left shows examples of hides with readable but deformed laser markings after coming back from the tannery. Photo: Geir Vevle.

7 Conclusions and further work

Several data capture technologies for traceability of hides were tested in this study. Two of the tested RFID technologies, The UHF RFID and LF RFID tags, could not be located in the hides after the tanning process, and were presumed to be lost or destroyed during handling or processing. Further, the hides used for testing dot peening came back after the tannery with hair, which made it difficult to read the markings. Hides marked with laser showed promise, and despite distortion the engraved text was still readable after the tannery. However, of all the different technologies tested the RFID enabled hide tags provided best readability before tanning while there were challenges with the other technologies. The RFID tags were used for tracking between the slaughterhouse and the hide plant (Skjeberg). In theory, all tags and markings tested in the study are readable, but the tanning process is the main challenge for the available technologies.

In any case, more reliable traceability from the farm to the hide plant is possible with the technologies tested, of which the RFID tags showed the greatest promise. Also, if the machine-readable requirement is not essential, laser engraving can be used for traceability also including the tanning process. Thus, the best current solution would be to employ RFID enabled hide tags from the slaughterhouse until the tanneries. From there on laser engraving of the hides with an alphanumerical code could be used. This enables tracking of the hides up to the tanneries or customers, that can get all the information captured through the supply chain and can use this information in several ways, for example, differentiating their products in the market by providing origin information to the customers.

Traceability system would be useful in authentication of hides by linking them to a specific farm. The data generated through the supply chain from the quality inspections can also be used as a feedback to the producers and can be used to improve the handling practices on the farm as well as during the transport and slaughter of the animals. Additionally, tracking of the hides and online readings can help with providing an overview of the contents of, for example, cold storage rooms, and prevent hides being stored too long. Introduction of a traceability sysem like the one introduced above will also enable for data collection and further possibilities related to BigData. Temperature monitoring using RFID-enabled tags could be used in combination of traceability for quality control. Further follow-ups after completion of iProcess will include discussions with Matiq on how to include the suggestions for data capture in the existing SAP framework for Norilia.

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