Case study

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CASE STUDY FOR THE DUTCH VEAL SECTOR

Digital traceability for more transparent and inclusive agri-food trade: Industry-led data platforms and digital services for agri-food traceability and transparency systems

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Executive summary

This report provides a practical case study on the design and implementation of industry-led data platforms and digital services for agri-food traceability and transparency systems in the veal sector in the Netherlands. The Dutch veal sector is recognized for its strong integral model within the complete supply chain. It starts at the dairy farmers where the calves are born all up to the slaughterhouses where the veal is produced. The digital traceability system within the sector has been set up by the private sector itself because the entire sector noticed a need for more insight into the data of other actors. The focus was to improve animal welfare and health. Therefore, the overarching quality system Vitaal Kalf and the traceability system Kalf Volg Systeem were built.

The **institutional oversight** in the set-up and execution of the digital traceability system was and is limited. The government leaves most of the responsibility for the development and execution of the traceability system up to the private sector. Overarching organizations take the lead in this, such as the quality control actor (SKV) and the sector organization (SBK). In case measures need to be taken or laws and regulations are violated, the government steps in. The government thus takes the role of a referee, controlling the process while the sector controls each actor and calf. Another role of the government is stimulation through (1) the development of policies and regulatory frameworks and (2) subsidies and investments.

Relevant **policies, laws, and regulatory frameworks** in the Dutch veal sector come from both European and Dutch levels. On the European level, the most important policies regarding data are the Regulation on the free flow of non-personal data (Regulation 2018/1807/EU) and the Open Data Directive (Directive 2019/1024). The Dutch government has invested in ICT infrastructure regarding its physical infrastructure, research, security and integrity, capacity building, and competition issues such as transparency and access. These investments resulted in the ICT systems that are still here today and play a stimulating and enabling role in digitalizing traceability systems and therefore increasing transparency.

Each calf receives a **unique identification and registration number** which is put into a Dutch public database (I&R system). The same number is the unique number in the quality and traceability system, linked to an individual calf. Each move of the calf is notified in the traceability system, because of which you are always aware of where a calf is coming from, where it is located, and where it is going. Linked to this number are several other aspects, such as the date of birth, breed, and sex. This number stays with the calf up to the slaughterhouse where it even stays connected to the carcasses as well. At the processing stages where cuts are taken from the carcass, barcode tags are attached to each meat piece. Because of sequential barcoding, each piece of meat remains linked to the individual calf and its information. The unique barcode remains with each cut until the product is ready and labelled with a sale barcode, that adds the pricing information.

In the Dutch veal sector, most collected **data is used** for tracking and tracing the product (transparency), for food safety and quality, and animal welfare and health. Identifying problems and keeping them as small as possible is only feasible when you have enough data. In that case, you can have a clear overview of what is happening at each actor in the chain. An example where the data is used beyond these previously mentioned purposes is at products sold under the label Peter's Farm. These veal products contain a QR code on the package. When consumers scan this code, they are directed to a website containing information about the individual farmer, the farm the calf was brought-up, the feed, and unique elements of the environment. This represents not just transparency in the chain, but also towards the consumer.

Although transparency in the supply chain is considered as important, in such a chain **data privacy** is considered extra important, since most (veal) farmers work where they live. That means company data is often intertwined with personal data. Nowadays, farmers are more considerate when sharing data and with whom. The **data owner** remains the actor to which the data belongs, e.g., the feed supplier or the owner of the calves. However, there are some examples in the veal sector where this becomes a discussion. The major discussion is between a farmer and the supplier of a certain sensor or machine that automatically collects data. In these cases, the supplier might feel like the data owner, because they deliver the machine that collects the data, although the data is collected on the grounds of the farmer. This discussion might lead to a data lock-in, because when the farmer would change suppliers, often the data remains with the supplier unless the farmer pays for it. Therefore, data portability is an important topic, which makes it possible for farmers to easily transfer data in case they for example switch suppliers. Important agreements for data sharing are: (1) make responsibilities lawful, (2) set clear terms and conditions about what the shared data can be used for, and (3) ensure it is clear who is responsible in case of a data leak.

For actors to share data, there should be clear **incentives** present. In the Dutch veal sector, the main identified incentive for data sharing is to become a transparent chain in which everyone has insight into their supply chain partners. Because of that, actors that are causing problems can be easily identified and the actors that are performing well are able to showcase this. Both a strong shared collective need and a strong individual need are required. The collective need in the sector is the desire to guarantee animal welfare and animal health and decrease the use of antibiotics. This resulted in a shared desire to increase insight into each other's data to ensure that in case of any problems, only the actor that is responsible is affected. The individual need is related to money since having more data on other actors enables you to optimize operational decisions and therefore increase profits or decrease costs and losses.

The major incentive to improve the digital traceability system and therefore transparency is changing market demands. Currently, sustainability is increasingly demanded by consumers and therefore focus has shifted more towards plant-based products. Therefore, the Dutch veal sector has the incentive to reflect their products as well as possible, to be able to compete with these plant-based products.

Although the traceability system is working very well in the Dutch veal sector, some **limitations** can be identified. The major identified limitation by the interviewed stakeholders was that most data goes to the end of the supply chain and not so much is going back into the chain. Calf husbandries often only hear when something is wrong with their calf, which limits them in continuous improvement management. Also, the quality of data, in combination with a lack of ICT capacity in the sector, in terms of skills and manpower is perceived as a limitation. Dynamic data, coming from sensors, is collected in high volume and mostly unstructured. Transforming this data into interpretable data costs a lot of work and skills, which is not largely present in the sector.

Finally, this case-study revealed several **best practices** that can be learned from the Dutch veal sector. The first one relates to the role of the government as they should find the right balance between not forcing a system on the actors and being able to provide specific rules and regulations that can be further detailed by the sector. The second one is a shared common need of the actors, in which each actor also has a clear individual incentive. This common need was observed throughout the interviews with the stakeholders and was mentioned to be the reason for the current digital traceability system to exist in the first place. It also helps in terms of splitting the costs of the set-up of the digital traceability system, since individual initiatives turn out to be very expensive. Also crucial is a unique key during communication and sharing of information. In the Dutch veal sector, this is the identification and registration number linked to each calf. Without that, data integration is very complex and a standardized flow of data cannot be reached. A learned solution for possible distrust among actors is to have a

cooperation data actor who functions as an intermediate party and is responsible for setting the terms and conditions for data sharing.

For a digital traceability and transparency system to function there should be enough resources available, such as skills and ICT systems. That is where the government can play a role by investing in ICT infrastructures, investing in research in digitalization, and subsidizing projects with a practical focus such as living labs. That way, actors will be stimulated and enabled to contribute to a digital world, opening possibilities for digital traceability and transparency systems.

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List of acronyms

BI	Business Intelligence
Covid	Centraal College van Deskundigen / Central college of experts
EPC	Electronic Product Code
EPCIS	Electronic Product Code Information Services
ERP	Enterprise Resource Planning
EU	European Union
FI-PPP	European Future Internet Public-Private Partnership
GDPR	General Data Protection Regulation
GS1	Global System of Standards
NVWA	Nederlandse Voedsel en Waren Autoriteit / Dutch food-watching authority
IKB	Integrale Keten Beheersing / Integral chain control
I&R	Identificatie & Registratiesysteem / Identification & registration system
KvK	Kamer van Koophandel / the Netherlands Chamber of commerce
KVS	KalfVolgSysteem / Calf tracking system
LTO	Land- en Tuinbouw Organisatie Nederland / Agri- and horticulture organization the Netherlands
RFID	Radio Frequency Identification
RVO	Rijksdienst voor Ondernemend Nederland / Netherlands Enterprise Agency
SDa	Autoriteit Driesgeneesmiddelen / Netherlands Veterinary Medicines Institute
SBK	Stichting Brancheorganisatie Kalverensector / Foundation sector organization calf sector
SKV	Stichting Kwaliteitsgarantie Vleeskalversector / Foundation quality assurance veal sector
TRACES	TRAde Control and Expert System
UBN	Uniek Bedrijfsnummer / Unique company number
VKI	Voedsel Keten Informatie / Food chain information
VVK	Vereniging van Kalverhouders / Association for calf husbandries
ZLTO	Zuidelijke land- en Tuinbouw Organisatie / Southern agri- and horticulture organization

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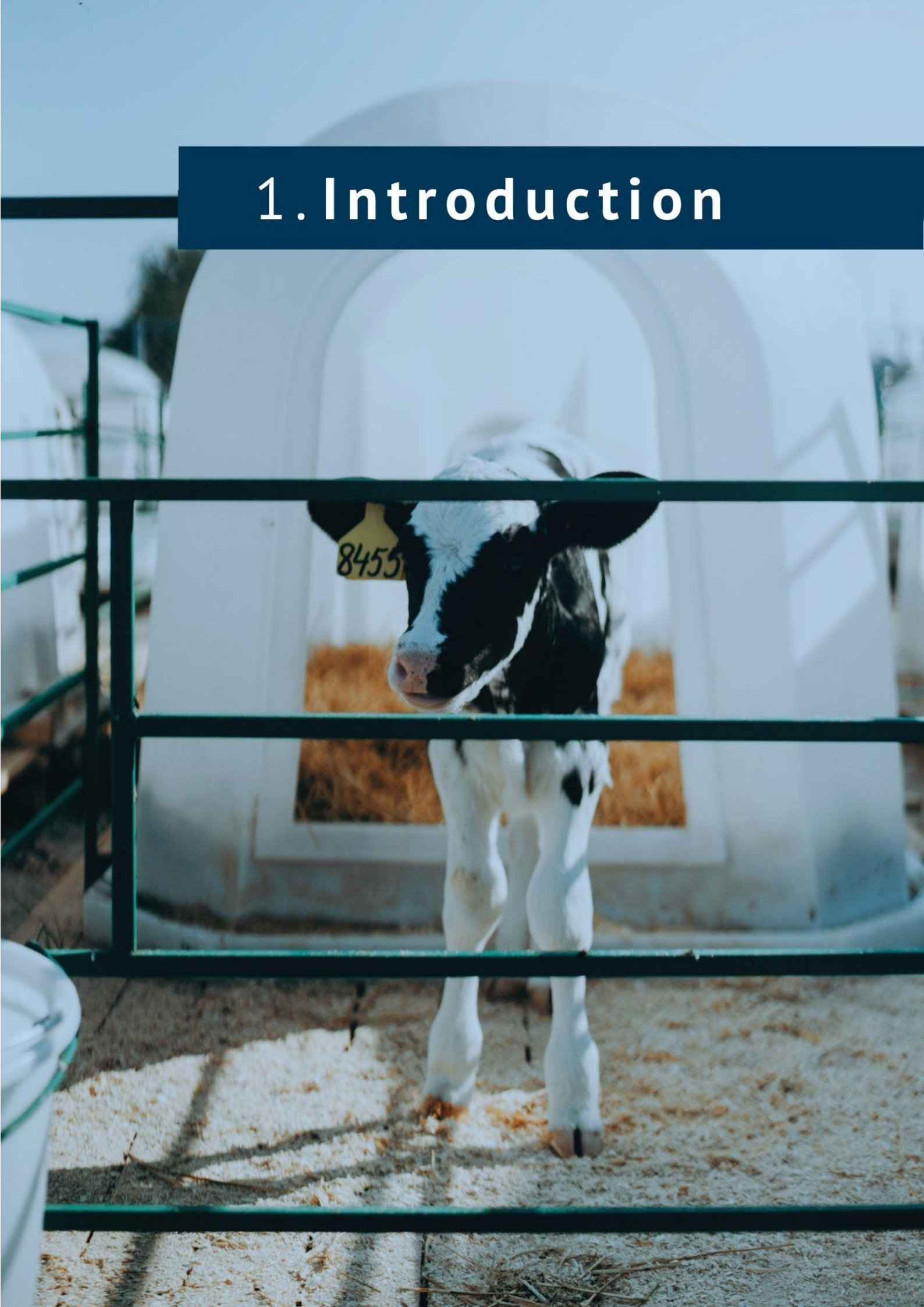
Tables

1. Introduction



This report provides a practical case study on the design and implementation of industry-led data platforms and digital services for agri-food traceability and transparency systems in the veal sector in the Netherlands. The report will provide an executive summary and is complemented by a PowerPoint presentation summarizing the key findings of the report. The report covers the following topics:

- institutional oversight,
- policy and regulatory frameworks that enabled the system,
- the design and implementation of the data platform,
- arrangements for data use and re-use,
- data privacy and ownership,
- the incentive structure for participation,
- limitations of the system, and
- best practices and lessons learned from the digital traceability/transparency system.

The international food supply chain, including its actors, is experiencing stronger pressure to deliver safe, healthy, and attractive food with additional pressure from a highly competitive environment (Bunte et al., 2009). One way to monitor compliance with quality, environmental, and other consumer demands related to the food product is traceability. Traceability is part of information technology and plays an important role in increasing transparency, and digitalizing production chains (Bunte et al., 2009).

The Dutch veal sector is recognized for its strong integral model within the complete supply chain, including actors such as dairy farms, feed suppliers, calf husbandries, transporters, slaughterhouses, veterinarian inspections, and processors of veal skins (Berkhout, van der Meulen & Ramaekers, 2022; Berkhout et al., 2011). An overview of key actors in the Dutch supply chain of veal is given in Figure 1 below.

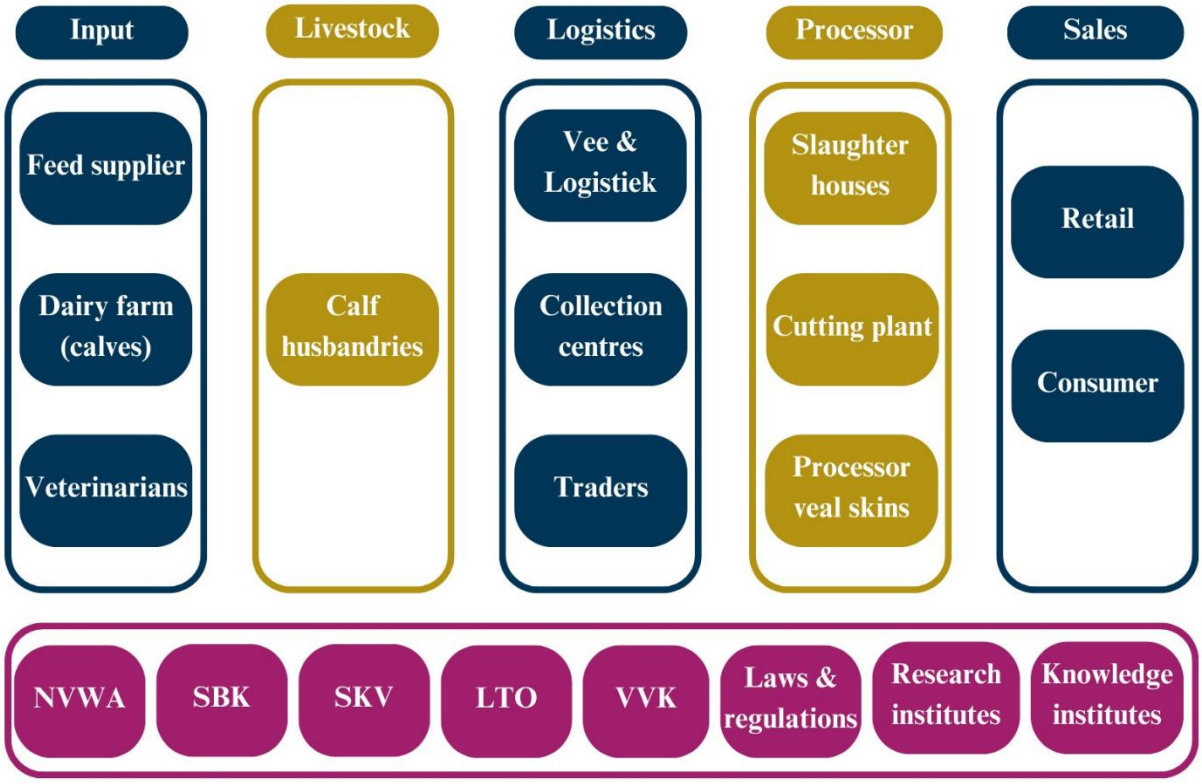


Figure 1. Most important actors in the Dutch supply chain of veal.

To show the capacity of the Dutch veal sector, the amount of veal produced is illustrated in Figure 2. About half of the calves in the sector are of Dutch origin and half are from abroad. As can be seen, most of the veal produced is intended for the export market (Wageningen Economic Research, 2022).

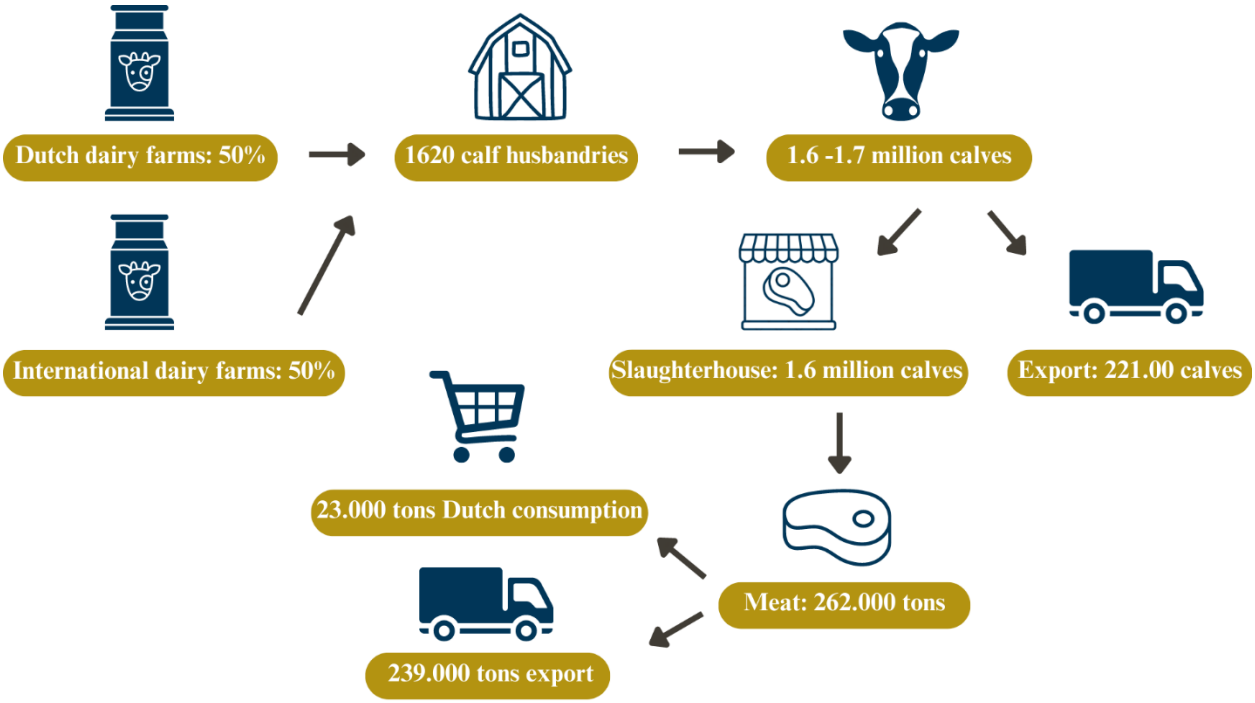


Figure 2. The Dutch veal sector illustrated in facts in figures, referring to numbers from 2020 (Wageningen Economic Research, 2022).

Most of the Dutch veal sector is in the hands of four integral companies: VanDrie Group, Denkavit Group, Pali Group, and the Gebrs. Fuite group (Berkhout et al., 2022; Berkhout et al., 2011). Denkavit Group is an important player with an international focus on the production and sales of fodder and has contracted calf husbandries in the Netherlands. The Pali Group is active in the chain with calf husbandries and one of the two slaughterhouse companies. Gebrs. Fuite group is mostly active in the chain with the production and sales of fodder and calf husbandries. The VanDrie Group is an international integrated chain of companies that is active as multiple actors in the veal supply chain and contains the second slaughterhouse company of the chain (Berkhout et al., 2022).

Since the VanDrie Group is the most integrated chain in the Dutch veal sector, some more information is given about this company. The VanDrie Group is namely world leader in the veal sector and produces up to 25% of all European veal (Bunte et al., 2009; Pompe, 2012). Its yearly revenue is about 1.5 million euros. The VanDrie Group is also well known because of its unique integral supply chain approach and the overarching quality system called Safety Guard. Of the 23 companies that the group consists of, there are 1100 veal farmers owned by four companies, eight fodder production companies, five dairy producers, five veal slaughterhouses, and one processor of calf skins. To produce dairy, lactating cows are needed and therefore leading to a lot of calves, which is the input for the VanDrie Group. The output, processed veal, is sold to retailers in the Netherlands and abroad. In Figure 3 on the next page, an overview of the supply chain of the veal sector, and more specifically that of the VanDrie Group can be found.

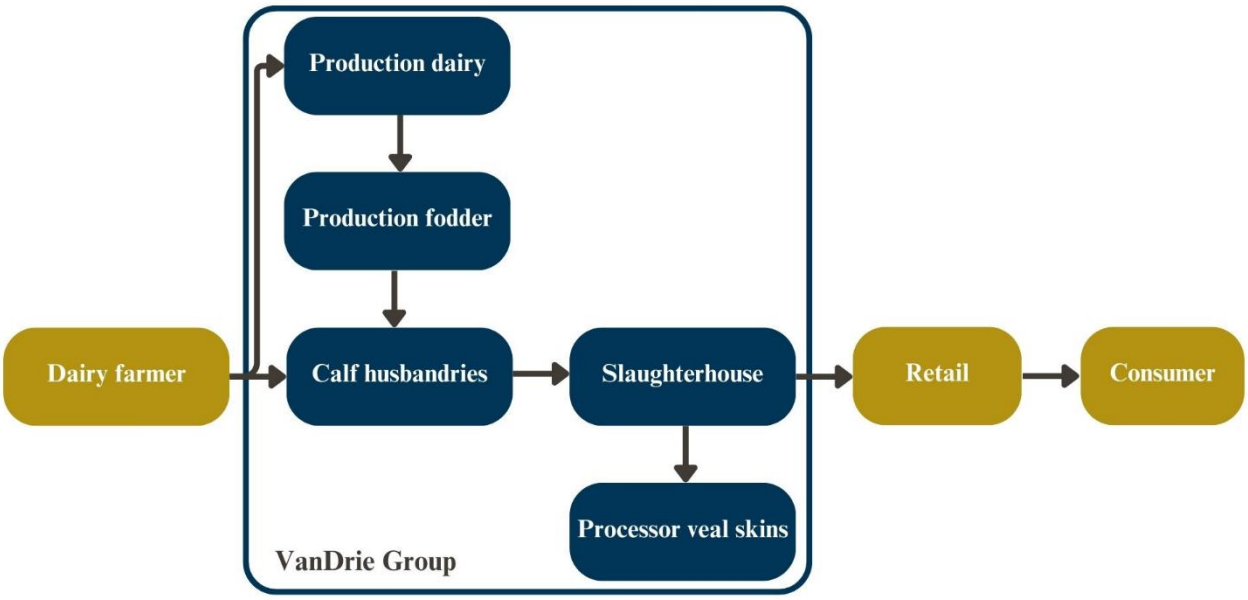


Figure 3. The supply chain of the VanDrie Group.

Next to this general information regarding the veal sector, two tables below are added to introduce the traceability and transparency system in the veal sector in the Netherlands. The first table (Table 1) includes the main actors that were or are of importance to the traceability and transparency systems in the Dutch veal sector. The second table (Table 2) includes the main (data) systems which together form the traceability and transparency systems of the Dutch veal sector.

Table 1. Main organizations that were or are of importance to the traceability and transparency systems in the Dutch veal sector.

Main function	Type
Foundation sector organization calf sector (SBK)	
SBK is the trade organization for the Dutch veal sector. SBK aims to promote and improve production, processing and sales in the interests of companies in the chain of production, processing and trade of calves, veal and calf feed. SBK is the owner of the sector-wide quality system Vitaal Kalf.	Foun-dation
Foundation quality assurance veal sector (SKV)	
SKV was founded to promote the quality of veal and to guarantee that veal is produced without the use of undesirable growth-promoting agents. Members are veal farmers, legal owners, collection centers, processors, and transporters of veal. SKV is accredited for the independent auditing of the sector-wide quality system Vitaal Kalf.	Foun-dation
Central college of experts (CCvD)	
Advice body for the SBK consisting of experts from the veal chain such as slaughterhouses, transporters, vets, calf husbandries, and fodder suppliers. They ensure that the regulation is kept up-to-date based on the newest guidelines and documents.	Foun-dation
VanDrie Group	
One of the four integral companies in the Dutch veal sector. The VanDrie Group is an international integrated chain of companies that is active as multiple actors in the veal supply chain and contains the second slaughterhouse company of the chain. They also have their own quality system: Safety Guard.	Private
Denkavit Group	
One of the four integral companies in the Dutch veal sector. Denkavit Group is an important player with an international focus on the production and sales of fodder and has contracted calf husbandries in the Netherlands.	Private

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Pali Group	
One of the four integral companies in the Dutch veal sector. The Pali Group is active in the chain with calf husbandries and one of the two slaughterhouse companies.	Private
Gebrs. Fuite group	
One of the four integral companies in the Dutch veal sector. This group is mostly active in the chain with the production and sales of fodder and calf husbandries. They directly transport the calves from the dairy farm to their calf husbandries.	Private
Vee & Logistiek	
Sector organization for trade companies in the livestock sector, such as traders, importers, exporters, transporters, and collection centers. Regarding the veal sector, they were included in the set-up of the sector-wide quality system Vitaal Kalf.	Associ-ation
Zuivel NL	
Sector organization for the dairy sector to strengthen the Dutch dairy chain in a way that respects the environment and society. Zuivel NL was also included in the set-up of the system Vitaal Kalf of the veal sector.	Associ-ation
Netherlands Veterinary Medicines Institute (SDa)	
Independent agency established to promote responsible drug use in Dutch animal husbandries with a focus on the usage of antibiotics. Veterinarians are obliged to report the use of antibiotics while treating animals, including calves. That way, the use of antibiotics can be benchmarked and can be compared with the amounts of antibiotics that animals are allowed to receive daily.	Authority
Dutch society of animal protection	
Its main goal is the protection of animal rights and increased animal welfare. The association helped develop the European welfare monitor in the veal sector to ensure good insight into medicine use and therefore the opportunity to improve the animal welfare condition of the calves.	Associ-ation
Dutch food-watching authority (NVWA)	
It has four focus areas: animal health, plant health, food safety, and product safety. They are the supervisors in the chain and perform controls and examinations. When working with live animals acknowledgement is needed from the NVWA to do so.	Public
Netherlands Enterprise Agency (RVO)	
RVO helps entrepreneurs and organizations to invest, develop, and expand their businesses and projects in the Netherlands and abroad. In the veal sector, they manage the registration system for all livestock and the registration system for all places where livestock is kept.	Public
Dutch Chamber of Commerce (KvK)	
The main tasks of the KvK are to manage the Dutch business register, provide information, advice and support to businesses, and promote regional economic development.	Public
Dutch Ministry of Economic Affairs	
This ministry's goal is to create an excellent entrepreneurial business climate by creating the needed conditions and providing entrepreneurs room to innovate and grow. Specifically, they were responsible for the Dutch digital agenda and investments in ICT infrastructure. Such as the physical infrastructure, research, security and integrity, capacity building, transparency and access.	Public
Ministry of Agriculture, Nature Management, and Food Quality	
This ministry aims to ensure good prospects for the Dutch farming, horticulture and fishing sectors. It wants to consolidate the agriculture sector's leading international position, strengthen the link between nature and agriculture, and improve farmers' economic situation. Specifically, they presented a vision for using digitalization to achieve sustainable agriculture and food chains.	Public
LTO department of the veal sector	
National association for advocacy of the agricultural sector. The department of the veal sector has the mission to increase the sustainability of the sector. They are involved in the quality regulation Vitaal Kalf and are initiators of certain animal health and welfare initiatives.	Associ-ation

Table 2. The main (data) systems which together form the traceability and transparency systems of the Dutch veal sector.

Main function	Link to other system
Identification and registration system (I&R)	
Every animal in the EU is required to have an earmark with an identification and registration number. Information, linked to the unique number, is added to the system, such as the calf's breed, dam, and date of birth. Every transport movement that the animal has undertaken is listed.	Seen as the basis for all other systems.
Unique Company Number (UBN)	
As a livestock farmer, you must register the location where you keep your farm animals, and you will receive a unique company number. This applies to entrepreneurs as well as part-time/hobby farmers.	The UBN will be registered in the I&R system for animals
Quality scheme Vitaal Kalf (Vital calf)	
This scheme is developed to ensure animal welfare and food safety, strengthening the position of Dutch veal on the international market. Vitaal Kalf is a sector-wide scheme and includes calf husbandries, calf traders, collection centers and slaughterhouses.	Information linked to the Unique Company Number
InfoKalf (Information calf)	
InfoKalf is the website (interface) of the quality system Vitaal Kalf. The website can be entered with a password, providing each account with a different set of data. It provides for example access to information such as the antibiotics delivered by the vet at the farm or Food Chain Information (VKI).	Information linked to the I&R number of calves.
Food Chain Information (VKI)	
The VKI-form is a form containing information about the food chain, such as the medication a calf received and the last disinfections that were performed. The form is filled in by the calf husbandry and checked by the slaughterhouse upon arrival of the calf and for use in the process of slaughtering.	Information linked to the I&R number of calves.
Kalf Volg systeem (KVS - Calf tracking system)	
KVS is the tracking and tracing system of Vitaal Kalf. The KVS is registering the transport of calves between dairy farms, collection centers, and calf husbandries. Livestock traders are obligated to enter each move into the system. Traders or transports check the calves at the dairy farms on their age, weight, healthiness, and correct registration of hair color and sex.	Information linked to the I&R number of calves.
Guarantee Tracing system SKV (GTSKV)	
An international tracing system was established to ensure imported SKV calves could be traced throughout their entire journey and not just in the Netherlands. SKV affiliates are therefore obliged to report the transport movement of calves in the GTSKV system before departure to the Netherlands.	Information linked to the I&R number of calves.
Sanco TRACES system	
System of the EU that ensures registration during transportation. Within the system, clear information can be found about which animals are in transit on which lorry in Europe. *NB: The sector and its quality assurance scheme have no entry to this system of the official authority NVWA and are therefore dependent on NVWA when traceability issues arise. The sector would like to have this access, so they have an up-to-date possibility for traceability when necessary.*	Information linked to the I&R number of calves.

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Safety Guard	
The VanDrie Group has developed its own private quality system called Safety Guard, which is an integral chain management system, including extensive traceability possibilities. The quality requirements are standardized with the quality system Vitaal Kalf.	Information linked to the I&R number of calves.
European Welfare monitor	
The tool is to measure the welfare of veal calves. The system is a cooperation between the veal sector, the Dutch Ministry of Economic Affairs, Agriculture, and Innovation and the Dutch Society of animal protection. *NB: This tool is very time and money-consuming. Therefore, this monitor is not implemented at the moment.*	Not implemented at the moment.
NVWA: Acknowledgement number	
To be permitted to work with live animals you need acknowledgement from the NVWA. When approved, you will receive an acknowledgement number which is linked to the company.	Only in contact with the NVWA.
Dutch Business Register	
Official and mandatory registration of your business in the Netherlands. In the register, you can check the official existence of a company by searching the company's name, address, or KvK number.	Check with the KvK number whether the legal owner of the calves is an official business.
GS1	
Global system of standards specifying how traceability data is captured digitally by use of a barcode. It defines the data types and interfaces for data exchange. Information in the system is linked to individual products or a class of product items, uniquely identified by a global identification code: Electronic Product Code (EPC).	With the barcode, you can still trace back the meat product to an individual calf.
GMP+	
Feed certification scheme that enables companies to contribute to safe feed.	Check the GMP+ certification status in the quality scheme Vitaal Kalf.

2. Case study components

2.1 Institutional oversight

A form of institutional oversight regarding the veal sector is the setting up of the European welfare monitor (Controlled Quality Veal, 2023b; European Commission, 2003). The monitoring system is a cooperation between the veal sector itself, the Dutch Ministry of Economic Affairs, Agriculture, and Innovation and the Dutch society of animal protection. For example, if any medication is used this needs to be registered and approved. By that, the sector was supposed to use the aggregated data to keep improving the animal welfare of the calves (Controlled Quality Veal, 2023b; European Commission, 2003). However, the monitor is found to be time and money-consuming, causing it to be not implemented at the moment. Something that is implemented, is the I&R database for all livestock, which everyone in the Netherlands can access. Within the system, you can look for a number of a certain animal and then you are able to see all movements of the animal. Next to that, there is the Dutch Business register of the Kamer Van Koophandel (KvK), the Dutch Chamber of Commerce, in which you can check the registration of all companies (including farms). Besides, there is the Netherlands Veterinary Medicines Institute (SDa) that supports responsible drug use in Dutch animal husbandries with a specific focus on the usage of antibiotics. Veterinarians are obliged to report the use of antibiotics while treating animals, including calves.

Although not institutional, an overarching organization is the Dutch SKV (Stichting Kwaliteitsgarantie Vleeskalversector), which is responsible for the independent auditing and testing of the animals, amongst others, on the calf husbandries. The audits include testing for undesirable substances but also include a check for compliance whether the calf is registered with a unique identification and registration number and entered into the I&R database (Positive Action Publications, 2006). These controls are part of the quality system Vitaal Kalf, which is the practical implementation of the mandatory control of prohibited substances required by law. Because of that, the role of the government is limited. Vitaal Kalf entails the complete chain, including calf husbandries, calf traders, collection centers, and slaughterhouses (SBK, 2023a). The primary focus of this system is to ensure animal welfare and food safety, which strengthens the position of Dutch veal on the international market. Therefore, the quality system focuses on demands from the international market, which are all additional to the demanded laws from governments.

The owner of the system is Stichting Brancheorganisatie Kalversector (SBK), the sector organization. Because of the implemented systems, the SBK can rapidly respond to developments in the sector. The SBK was also responsible for setting up the quality system Vitaal Kalf, together with the parties Vee & Logistiek (representing the livestock logistics sector) and Zuivel NL (representing the dairy sector).

Another party, the Centraal College van Deskundigen (CCvD) advises the SBK. The CCvD consists of experts from the veal chain such as slaughterhouses, transporters, vets, calf husbandries, and fodder suppliers. Controls on Vitaal Kalf are executed by SKV, as previously mentioned. This means tasks are separated because the SBK is the owner of the system and the one who determines the regulations, based on the advice of the CCvD. The CCvD manages and advises the SBK on changes required in the regulations and develops new documents when needed. SKV is the party that is accredited to execute controls and audits for Vitaal Kalf (SBK, 2023a).

As noticed, there is not a large role of governmental institutions in the traceability system of the Dutch veal sector. Because it is already that well-arranged, the government is not largely involved and leaves most of the responsibility for the development of a traceability system up to the private sector and organizations such as SBK and SKV. In case measures need to be taken or laws and regulations are violated, the government steps in. An example is that the SKV discovered doping cases within the sector, which they then handed over to the Nederlandse Voedsel en Waren Autoriteit (NVWA), the Dutch food-

watching authority. This governmental actor is also more present in the field of infectious animal diseases and during the import of calves. Next to that, for working with live animals (among others) you need an acknowledgement from the NVWA after which you receive an acknowledgement number.

The government thus acts as a sort of referee. They are responsible for managing the overall process, while the sector takes responsibility for the control of all individual animals. Next to that, the government can take the role of stimulation, which they mainly do through the development of policies and regulatory frameworks. These are discussed in more detail in the next section. Another role of the government proposed by the interviewed stakeholders is to take a leading role when it comes to overarching topics. For example, the use of renewable energy is becoming more important and the government likes to gather data on that too. However, it is fairly difficult for the sector to gather this data as farmers are likely to provide desired answers as it might influence given subsidies. Therefore, the government can take a leading role in gathering the data, with permission from the farmers, directly at its source: the energy-providing companies.

The overarching quality system Vitaal Kalf is summarized in Figure 4, indicating the most important actors that were or are of influence for Vitaal Kalf.

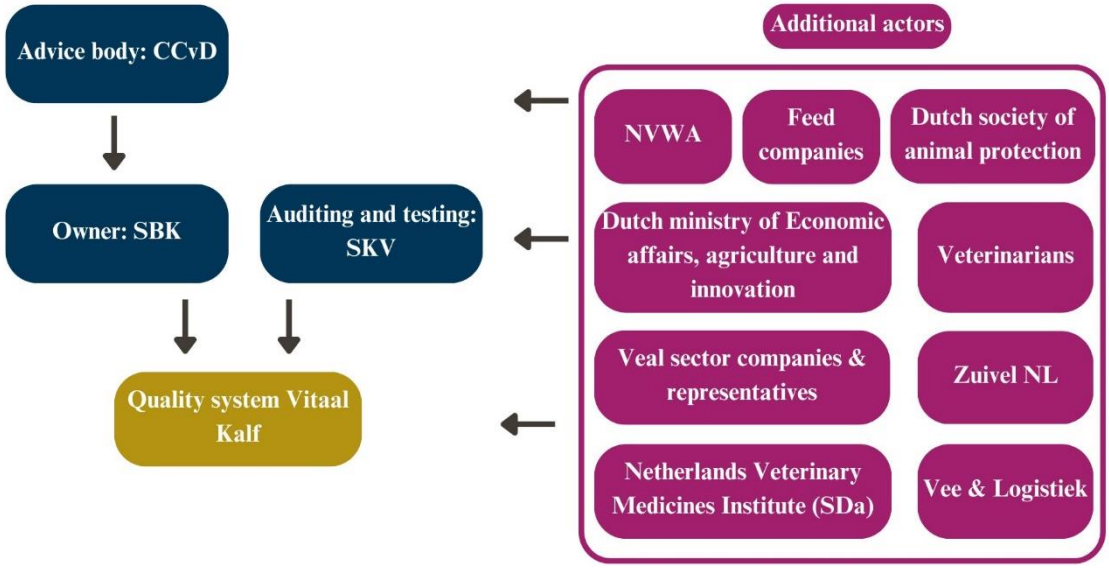

Figure 4. The overarching quality system Vitaal Kalf including the main actors of influence on this system.

The digital traceability system for the Dutch veal sector thus has been set up by the private sector itself, more specifically by the veal sector and the dairy sector. Together they identified a need for cooperation in terms of setting up an overarching traceability system, enhancing transparency.

2.2 Policy and regulatory framework

The European Commission and the Member States' representatives committed themselves in 2000 to emerging the European Union into "the most dynamic and competitive knowledge-based economy in the world" (High-Level Group, 2004). This vision was split into multiple strategic objectives, such as the definition of a regulatory framework for electronic communication, the spread of ICT, and the promotion of e-commerce (Bunte et al., 2009). Following this vision, the Dutch Ministry of Agriculture, Nature Management, and Food Quality focuses on the evolving knowledge and information economy of the food supply chain (Bunte et al., 2009).

The Dutch government has been stimulating the use of information technology through the ICT Agenda 2008-2011 presented by the Dutch Ministry of Economic Affairs (Bunte et al., 2009; Ministry of

Economic Affairs, 2008). The agenda presents support for the availability of ICT applications and ensuring that the (working) population is able to use them (Bunte et al., 2009; Ministry of Economic Affairs, 2008). The Dutch government therefore invested in the ICT infrastructure with regard to its physical infrastructure, research, security and integrity, capacity building, and competition issues such as transparency and access (Bunte et al., 2009; Ministry of Economic Affairs, 2008). These investments resulted in the ICT systems that are still here today and were thus a stimulating factor. There is also a new Dutch Digital agenda, of which one of the focus points is the data infrastructure (Rijksoverheid, 2023a). Data should be easily accessible and trustworthy systems should protect the data (Rijksoverheid, 2023a).

Also, on the European level focus has been on a Digital Agenda, of which the first version was launched for 2010-2020 and the second for 2020-2030 (European Parliament, 2022). The focus was and is on initiating research in digitalization in the agricultural sector by, for example, subsidizing living labs. By doing so, the EU tries to stimulate the implementation of new technologies, such as blockchain technology, better ways to ensure cybersecurity and new insights to balance between the free flow of data and the preservation of data privacy. Therefore, large investments were made in the agri-food sector in terms of stimulating digitalization. Besides, several regulations, acts, and directives were set up. Although some of these regulations and initiatives were established after the set-up of the traceability system of the Dutch veal sector, these types of regulations stimulate the movement towards a more digital society. With that, also the traceability system in the Dutch veal sector can be continuously improved, because of increased knowledge, skills, technologies and possibilities. The following directives and regulations are relevant:

- The Regulation on the free flow of non-personal data (Regulation 2018/1807/EU) allows companies and public administrations to store and process non-personal data wherever they choose.
- The Open Data Directive (Directive 2019/1024/EU) consists of general rules for the European market on government-held data (European Parliament, 2022).
- The European Future Internet Public-Private Partnership (FI-PPP) program has the objective of accelerating the adoption of new internet-centric technologies in Europe and does so by providing the building blocks required to realize the (new) technologies (FI-PPP, 2013).
- The European Data Governance Act (Regulation (EU) 2022/868) aims to increase data availability, reusability and trust in data sharing (European Parliament, 2022).
- Additionally, the aim is to develop a European Data Space, including the agriculture sector, which should be an open, transparent, trusted, and secure digital system enhancing the free flow of data and services (European Parliament, 2022).

The Dutch government also helps in this regard, by for example providing open data sources (Rijksoverheid, 2023b). Therefore, the Dutch veal sector can extract this data and use it for example to benchmark farmers or veterinarians or to strengthen the position of their sector compared to other (livestock) sectors. These types of databases work with a so-called Commons Zero Declaration, meaning that all data may be re-used by other parties in their own applications. The government, however, cannot be held accountable in case of any (in)direct damage occurring from using or re-using the data (Rijksoverheid, 2023b). The Dutch Ministry of Agriculture, Nature Management, and Food Quality presented a vision for using digitalization to achieve sustainable agriculture and food chains (Ministry of Agriculture, Nature Management, and Food Quality, 2021). One of the presented opportunities is a better tracking and tracing system of products in the chain providing transparency of sustainability, origin, and price, within companies and between companies, suppliers, customers, and consumers (Ministry of Agriculture, Nature Management, and Food Quality, 2021). In the vision, also an overview is given of conditions that should be present for the digitalization to work, see Figure 5 on the next page.

Again, such a vision of the government stimulates digitalization, causing an increase in skills, knowledge, and technologies. This enables the Dutch veal sector to improve its traceability system.

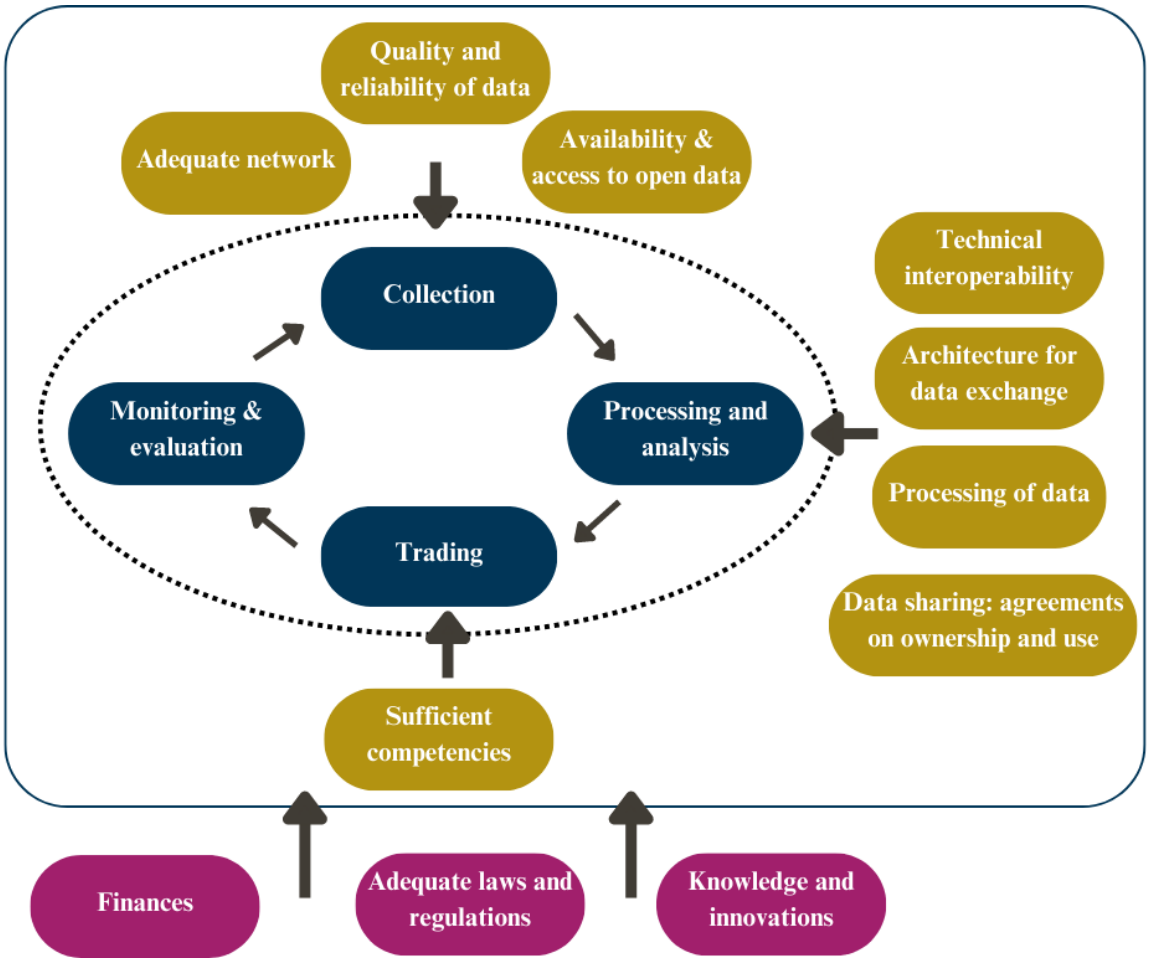

Figure 5. Conditions for effective digitalization. Source: Ministry of Agriculture, Nature Management, and Food Quality (2021).

A regulation that does not necessarily support integral digitalization of traceability and traceability systems, is the European General Food Law (178/2002/EG) since it only mandates the one-back/one-forward principle (European Commission, 2002; Kassahun, 2014). This law requires actors in the chain to only identify and share data with their direct suppliers and customers. This regulation was later specified for products of animal origin in Regulation (EC) No 853/2004. Next to that, in 2011, the Commission Implementing Regulation (EU) No 931/2011 was added to the European General Food Law to put more emphasize on the need for information on products of animal origin. However, digitalization of the traceability system is still not mandated in these regulations. The regulations state that full traceability should be accomplished within four hours, which might stimulate digitalization as it helps them to meet this timeline. However, not all companies invest in digitalization and consequently, data is lost throughout the chain since not all actors have innovative transparency or data systems and thus the availability to pass this detailed information onward (Kassahun, 2014).

Therefore, the need to share advanced traceability data in multiple food sectors led to a global system of standards (GS1), which is a global consortium of businesses that developed the Electronic Product Code Information Services (EPCIS) standard (GS1 EPCglobal, 2014). Within the standard, it is specified how traceability data can be captured digitally and it defines data types and interfaces for data exchange.

An advantage of this system is that the information is linked to individual products or a class of product items, uniquely identified by a global identification code: Electronic Product Code (EPC) (GS1 EPCglobal, 2014).

2.3 Data platforms

Please note that in the introduction table 1 and table 2 provide an overview of organizations that were or are important for the traceability system, as well as an overview of (data) systems that together form the traceability system of the Dutch veal sector.

The traceability system of the veal chain starts right after the calf is born. The calf receives an identification number within three working days and is put into the system. Previously, between 2008-2016, this system was called the IKB system, and is nowadays incorporated in the quality regulation Vitaal Kalf and its traceability system KalfVolgSysteem (KVS) (SBK, 2023a; SBK, 2023b). Next to these systems linked to the quality system for veal in the Netherlands, the calves are put into the I&R system. This is the Dutch database for all livestock. Information, linked to the unique number, is added to the system, such as the calf's breed, dam, and date of birth (Positive Action Publications, 2006). The KVS is registering the transport of calves between dairy farms and calf husbandries. Livestock traders are obligated to enter each move into the system and therefore have to report it when a calf is sold. Traders or transports check the calves at the dairy farms on their age, weight, healthiness, and correct registration of color and sex (SBK, 2023c). Therefore, the system facilitates communication between the dairy farms and the calf husbandries, ensuring reliable data sharing between these parties (SBK, 2023c).

The data platform in the Dutch veal sector will be explained by following the supply chain and data collected at each step of the chain. The first half of the chain is visualized in Figure 6.

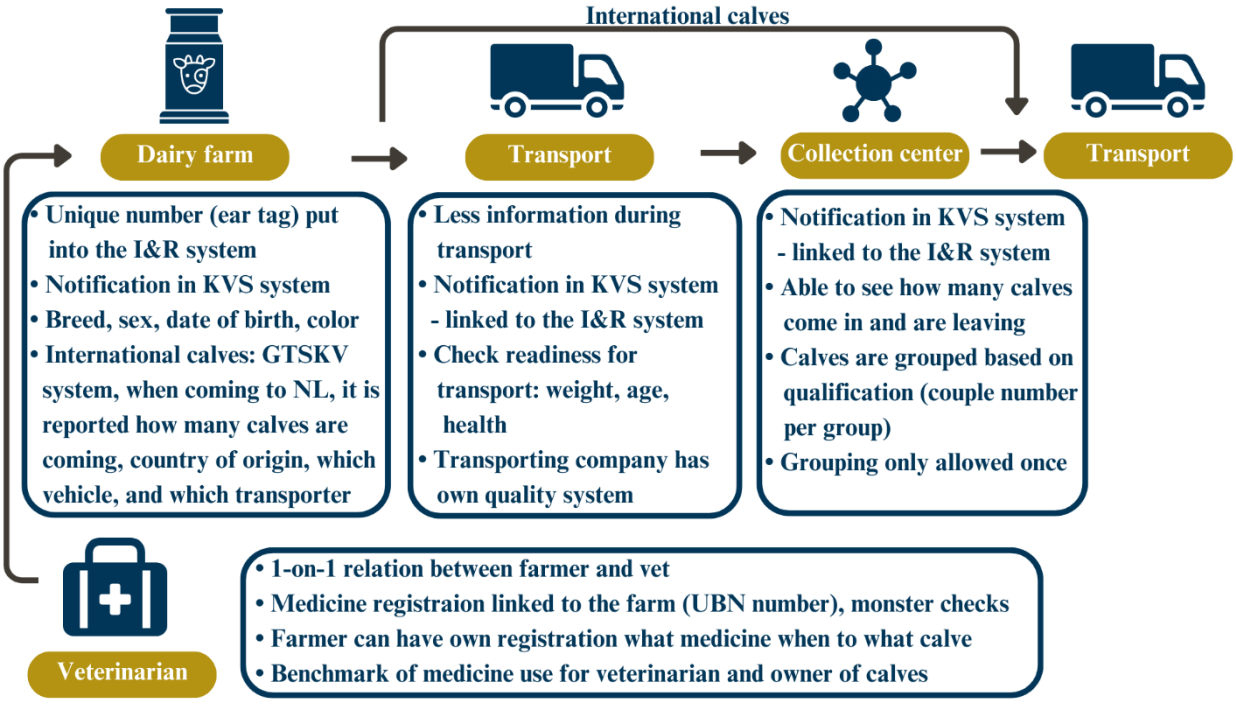

Figure 6. Data collection at each step of the supply chain, from dairy farm to transport to the calf husbandry. Please note that for actors who appear more than once in the value chain, the data collected is only described once.

It starts at dairy farms where within three working days after birth all calves receive an ear tag that contains an identification and registration number (Controlled Quality Veal, 2023b). With the identification and registration number, the details of the veal's origin remain available, such as information on where the calf was born, the stall it was raised in, the feed it received, the transporter, and carried out quality controls. After birth, the calf, when born in The Netherlands, is first transported to a collection center. After that step, calves are transported to calf husbandries. Some companies (such as the Gebrs. Fuite Group), skip the collection center and directly transport the calves from the dairy farm to the calf husbandries. Veterinarians play an important role in the chain too, as there always is a one-on-one relation between the farmer and the vet. They are responsible for registering medicine use which is linked to the farm through the farm's unique company (UBN) number. Medicine data is used to benchmark veterinarians with each other and owners of the calves with each other. Another way to identify a unique company is through the acknowledgement number given by the NVWA, the Dutch food-watching authority.

The second half of the chain in visualized in Figure 7, which is from the calf husbandry to the slaughterhouse.

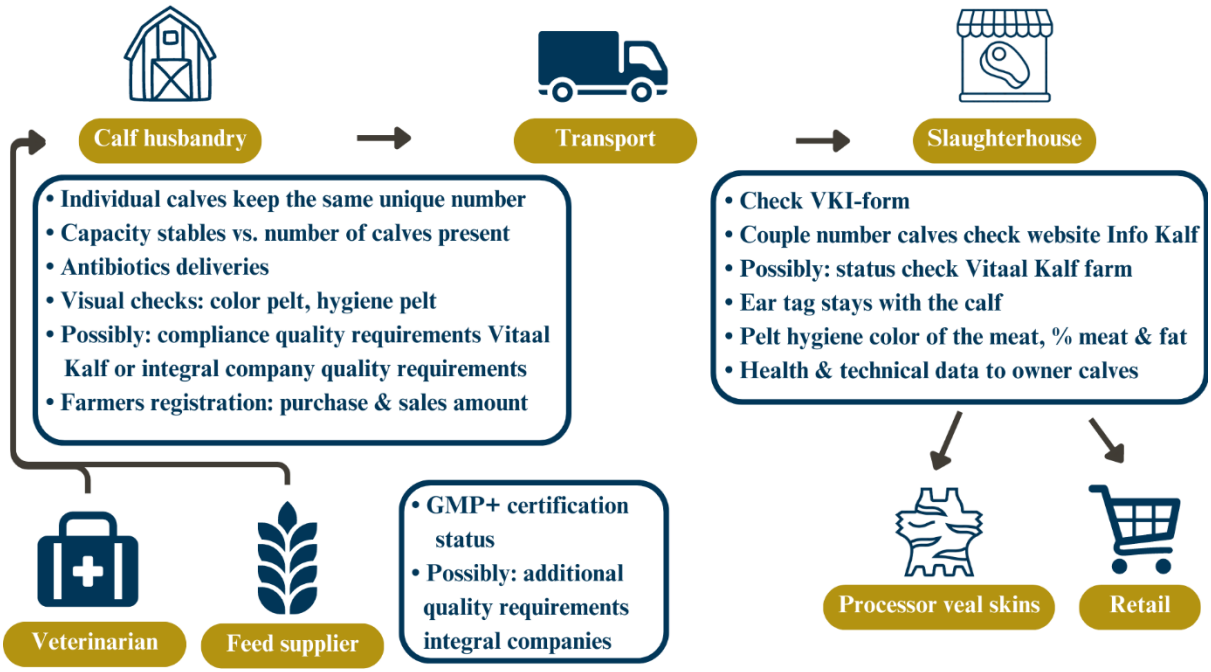

Figure 7. Data collection at each step of the supply chain, from calf husbandry to slaughterhouse. Please note that for actors who appear more than once in the value chain, the data collected is only described once.

Once arrived at the calf husbandry, new information about the calf is added to the identification and registration number (Controlled Quality Veal, 2023b). When the calves are old enough, they are transported to the slaughterhouse. On arrival at the slaughterhouse, the Food Chain Information form (VKI) is checked and filled in by the calf husbandry. The VKI-form contains information about the food chain such as the medication that the calf received and the last disinfections that were performed. At the slaughterhouse, the calves remain their individual identification and registration number by linking the ear tag to the meat hook the carcass will be hanged on (Controlled Quality Veal, 2023b). After slaughter, this information is printed onto a label and attached to the carcass, showing the unique ear number, information on the country of birth, and where it was raised. In the slaughterhouse, more information is linked to the number, such as the assessment of the color of the meat, the percentage of meat and fat, the slaughterhouse, the classification, and even the day on which the SKV permitted the quality certificate (Controlled Quality Veal, 2023b). This information is available for all supply chain suppliers

and customers through the website (interface) of the quality system Vitaal Kalf, which is called InfoKalf. This website can only be entered with a password and each account is linked to different access levels of data (Hanson, 2020). Health data, such as the organ states, and technical data, such as the weight are given back to the owner of the calves. The owner of the calves is often the integral company in case the calf husbandry is part of such a company.

At the processing stages where the carcass is divided are smaller pieces, barcode tags, designed by GS1, are attached to each meat piece. Because of sequential barcoding, each piece of meat remains linked to the individual calf, enhancing the accessibility to all its information. The unique barcode remains with each cut until the product is ready and labelled with a sale barcode, that adds the pricing information (Buhr, 2003; Controlled Quality Veal, 2023b).

Additionally, the Sanco TRACES (TRAde Control and Expert System) system of the EU ensures registration during transportation. Within the system, clear information can be found about which animals are in transit on which lorry in Europe (Pali Group, 2023). It contains information about where the calf departed from, where it stopped along the way, and what the destination is of the calf (Pali Group, 2023). This system is however only accessible to the Dutch food-watching authority (NVWA). Therefore, the sector depends on the NVWA when traceability issues arise outside the Netherlands.

Important to note, in the case of calves imported from SKV-affiliated companies, this data is also recorded in the guarantee system for tracing SKV veal calves: KalfVolgSysteem (KVS) (Pali Group, 2023). The KVS is also available through an application on smartphones/tablets, of which a few screenshots can be found on the next page, in Figure 8.

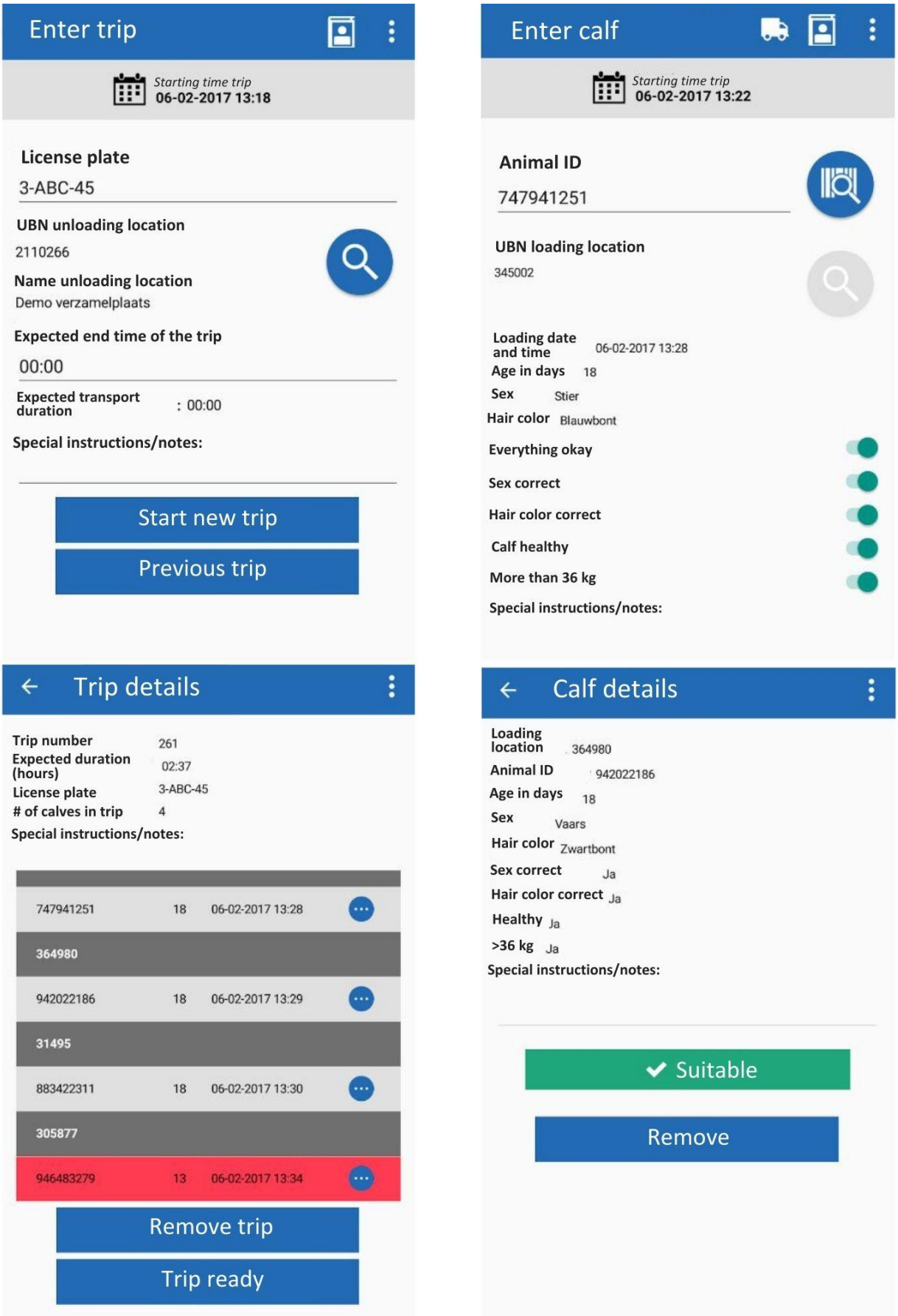

Figure 8. Screenshots of the guarantee system for tracing SKV veal calvess: KalfVolgSysteem (KVS). Please note that the screenshots were manually translated into English since the application was available in Dutch.

The VanDrie Group has developed a quality system called Safety Guard, which is an integral chain management system, including extensive traceability possibilities (Bunte et al., 2009; Controlled Quality Veal, 2023a). The quality requirements are standardized with the quality system Vitaal Kalf. In Safety Guard it is possible to trace the history of each calf throughout the entire chain, again with the earmark of the calf, containing the 12-digit unique identification and registration number. Also in their system, it is possible to trace the individual calf through the boning plant, regardless of the number of cuts in which it leaves the slaughterhouse (Buhr, 2003; Bunte et al., 2009; Controlled Quality Veal, 2023a). The main difference between Safety Guard and Vitaal Kalf is that all actors of the VanDrie Group are part of the Safety Guard system. Therefore, the VanDrie Group has a clear overview of all data collected through which the exchange of results and complaints is ensured. The VanDrie Group is thus better able to perform internal improvement management.

In terms of technology used to trace the calves, a lot is prohibited by law because not much can be added to living animals due to animal welfare. Only an earmark is allowed causing most of the work to be done with barcodes. There is an example of advanced technology in a slaughterhouse where AI is used. The calves are being filmed and when deviations are noticed in terms of animal or employee behavior, a notification is given so the slaughterhouse employees can look back at the situation and see what may have happened.

In the table below (Table 3) an overview of all data systems regarding traceability in the veal sector is given, including a description of the main function, the owner of the system, and an explanation of access to the data.

Table 3. Overview of data systems concerning traceability in the veal sector.

Main function	Ownership	Access
KVS		
Traceability system for all calves that fall under the quality system Vitaal Kalf. Interface: Info Kalf (information calf)	SBK, Foundation calf sector organization, Vee & Logistiek, and ZuivelNL Regulator: SKV, Foundation quality assurance veal sector	• Log-in credentials needed • Actors in the supply chain that deal with calves falling under the quality system Vitaal Kalf • Tracing with a couple number
I&R		
Mandatory registration system for all livestock (cow, pig, sheep, goat, poultry)	Netherlands Enterprise Agency (RVO), commissioned by the Dutch ministry of Agriculture, Nature, and Food quality (European legislation)	• Application I&R animals accessible to anyone in the Netherlands • Public information: date of birth, origin, and import date (if applicable) of each animal
UBN		
Mandatory registration system for all places where livestock is kept (e.g., farms)	Netherlands Enterprise Agency (RVO), commissioned by the Dutch ministry of Agriculture, Nature, and Food quality	• Application I&R animals accessible to anyone in the Netherlands • Search on UBN number and see the living place and type of farm • Search on zip code and house number and find the UBN

… Table continues on the next page

...Table continues

Main function	Ownership	Access
Safety guard		
The private quality system of the VanDrie Group	VanDrie Group	• All companies of the VanDrie Group • Tracing with the unique identification & registration number
TRACES		
Mandatory online platform for sanitary and phytosanitary certification required for importation into the EU, intra-EU trade, and EU exports of, e.g., animals	European Commission	• In the Netherlands only the Dutch food-watching authority • Tracing with the unique identification & registration number • Information about transport (routes)
Dutch Business Register		
Official mandatory registration of your business in the Netherlands	Kamer van Koophandel (KvK), Dutch chamber of commerce	• Anyone in the Netherlands • Check the official existence of a company by searching the company name, address, or KvK number
Acknowledgement number		
Lawful acknowledgement is required for, among others, working with live animals	NVWA – the Dutch food-watching authority	• Anyone in the Netherlands • Search on number, company name, zip code, and type of animal

2.4 Data (re-)use

Traceability data is not limited to food safety applications alone but can also be leveraged for other purposes. Often traceability data is utilized to enhance the quality of the meat, for example by communicating yield information of individual animals to farmers and feed producers, to adjust the diet of an animal (Ding et al., 2013). Moreover, using Radio Frequency Identification (RFID) chips and sensors, farmers can deliver live data, allowing for the monitoring and sharing of the living conditions and location of an animal, as well as the storage conditions and location of a carcass (Nilsson et al., 2019; Annosi et al., 2021). This data can then be used by companies to gain better insights into the product's whereabouts, enabling more accurate planning (Annosi et al., 2021). By modelling expiry processes more accurately, a more precise expiry date can be determined, while companies can also use this information to improve storage conditions and extend the shelf life of their products (Annosi et al., 2021). Traceability data thus has many applications beyond food safety and can be used to enhance product quality, optimize production, and improve supply chain management. By leveraging this data, companies can gain valuable insights, increase efficiency, and reduce waste, thereby improving their overall bottom line.

In the veal sector, most data is used for tracking and tracing the product to ensure food safety, but also to ensure animal welfare and health. Identifying problems and keeping them as small as possible is only feasible when you have enough data. That way, you can have a clear overview of what is happening to

each actor in the chain. Incoming goods control is a way of using data for food safety purposes, e.g., measuring the pH of incoming fodder. Using the data for animal welfare and health is done by the Foundation quality assurance of the veal sector (SKV) by extracting data on calf husbandries. This way, the SKV can report on the calf's health in combination with data deliveries of the veterinarians (e.g., use of antibiotics). The SKV can then ensure the quality requirements of Vitaal Kalf are met. Something else that the SKV does with the data to ensure animal welfare, is to automatically compare the capacity of a stable at a farm with the number of calves present at the stable, extracted from the I&R public database. By doing so, they are quickly aware in case the capacity of the stable has been exceeded and the animal welfare of the calves may be at risk. Also, an automatic link is created between the SKV database and that of the Dutch Chamber of Commerce (KvK) to ensure that the legal owner of the calves is registered and thus is an official business. Also, at the slaughterhouse checks are performed, such as looking at deviations in the calf's organs which can signal animal health issues and is given as feedback to the owner of the calves.

A practical model where data is used beyond food safety and animal welfare and health in the veal sector is the following. The VanDrie Group uses their traceability system, besides for tracking and tracing, also for transparency towards consumers. The products sold under the label Peter's Farm contain a QR code on the package. Consumers can scan these and are redirected to the website of Peter's Farm (Hanson, 2020). On the website, they can read information about the farm where the calf was brought-up, unique elements of the environment, information about the individual farmer and his/her family, and the feed used on the farm. In case consumers do not have a QR scanner, they can also search for the code on the website which is still traced back to the farm of origin (Peter's Farm, 2023). The website also contains live webcams at Peter's Farms whereby consumers can have a live look into the calf stables (Peter's Farm, 2023).

One of the feed suppliers of the VanDrie Group, Navobi, also extensively uses data (Buhr, 2003). In their Enterprise Resource Planning (ERP) system, they use electronic ration balancing for their milk-replacer mixing. The result is that within each batch of milk replacer, it is possible to uniquely identify all sources and quantities of ingredients. Some of this information (the ingredient list, batch identification number, and microbiological analysis) is made available on their website, with access only available via a password. With that, subsequent actors in the chain, such as calf husbandries, can access this information without being able to see confidential information of the feed supplier, e.g., prices or proportions. This system is a great example of a traceability system that enables efficient information transmission throughout the chain while ensuring the security of the data (Buhr, 2003).

2.5 Data privacy and ownership

The European Union (EU) has a long-standing history of regulating databases, personal data, and non-personal data. In response to the increasing susceptibility of data to privacy violations, the EU introduced the General Data Protection Regulation (GDPR) in 2016 (Regulation 2016/679/EU) (Van de Burg et al., 2020). Initially focused on personal data, the scope of the legislation was subsequently expanded to cover non-personal data and, as such, traceability data. The implementation of a code of conduct has been crucial in this regard (Van de Burg et al., 2020). The code of conduct consists of five fundamental principles illustrated in Table 4.

Table 4. The five principles of the EU code.

Principles	Key features
Data ownership	• Rights are assigned to the entity that engages in the creation/collection of ag-data either independently, via advanced machinery or by way of commissioning data providers to do so (i.e., Data originator) • This entitles the 'data originator' to exclusive control over ag-data, its subsequent use, access and/or distribution • 'Data originators' can be farmers, but also other parties in the supply chain whose data are being collected (such as input suppliers, nurseries, the slaughterhouse)
Data access/control/ portability	• The access, use, storage and potential sharing of ag-data with third parties is only permitted if the 'data originator' explicitly consents to this in the contract
Data protection and transparency	• Unauthorized ag-data sharing cannot occur with third parties that are not originally referred to in the contract • Prior consent must first be received to rectify the contract should circumstances change, and include the intended third parties • Personal, or sensitive information requires replacement with pseudonyms (artificial identifiers) to ensure it is 'less identifiable'
Privacy and security	• Personal data should not be subject to potential losses, theft, or unauthorized access • There is a need to notify 'data originators' of any security breaches that may occur • GDPR becomes applicable in circumstances where data originators' personal/sensitive data is exploited to the advantage of third parties and utilized to make decisions about the data originator as a natural person
Liability and intellectual property rights	• The contractual agreements must entail any terms of liability • However, liability does not ensure the faultiness of data machinery or devices during farming operations. There must be protection of any relevant IP rights that may result from the ag-data supply chain

Collectively, these principles require parties in the data-sharing network to ensure that data originators have control over their data, including knowledge of how the data is used and who has access to it. Contracts should be transparent, presented in understandable language and clearly explain the purpose of data sharing, data collection, storage, and usage methods (Van de Burg et al., 2020). This code of conduct has been crucial in safeguarding data privacy, transparency, and accountability, and serves as a guiding framework for effective data management in the EU (Van de Burg et al., 2020).

The data privacy and ownership in the veal sector have been arranged as follows. It should be noted that data privacy can be considered extra important in this sector, since most (veal) farmers work where they live, meaning that company data is often intertwined with personal data. Years ago, a lot of data was shared within the sector and there is a lot of transparency where most actors know each other well. Because of that, there have been already many data standardizations (for example Agro Connect) which make sharing data between actors easier. Only in the past few years, the focus has been on data warranties, to make clear agreements on what data is shared with whom. Previously farmers would for example just share all data with their feed supplier and make them responsible for using only the relevant

data. Nowadays, the farmers have become more considerate and share with their feed suppliers only the weights and quality, but leave out the profits they make, since that is irrelevant to know for the feed supplier.

For the KVS traceability system, the SKV (Foundation quality assurance veal sector) is responsible, although the owners of the system are the SBK (the sector organization). The owner of the actual data remains the actor to whom the data belongs. Agreements on what can and cannot be shared have been made on the sector level. Before calf husbandries become part of the quality system that the SKV regulates, the calf husbandries sign an agreement on what data can be extracted by the SKV for quality control purposes. This data cannot be shared at a company level with the SBK. The SBK only receives aggregated data from SKV. In case the calf husbandry itself does not become the legal owner of the calves, this agreement is made with the legal owner. The party who has access to most data in the chain is the legal owner of the calves and in most cases, they are the owners of the data too.

Within the interface of the quality system Vitaal Kalf, called Info Kalf, and its traceability system KVS, it regulates who can access what information. There are certain combinations for data access, specified for the different actors in the chain. Slaughterhouses must sign an agreement about what data they can extract from the system. In case they extract more information than what is to be expected and can be explained, the SKV can block that specific slaughterhouse from the system as a consequence.

There are some examples in the veal sector where there is some discussion about who is the owner of what data. One of them is between the supplier of machines or sensors and the farmers. The machines and sensors (automatically) collect data and often the supplier assumes to be the owner of the data and acts accordingly. The owner of the data should be the farmer, as the machine or sensor is often bought by them and is located on their farms. The suppliers pressure the farmer to let them know with whom the farmer is sharing data, even though it is only of concern to the farmer. Next to that, in case the farmer stops sharing the data with these suppliers, the supplier sometimes pressures the farmer by mentioning that they stop carrying out the maintenance of the machine or sensory until the farmer starts sharing the data again. This duty of sharing data is often incorporated into the general terms and conditions when buying the machine or sensor and cannot be avoided by the farmer since they do need the machine or sensor. This discussion about data ownership may lead to a so-called data ‘lock-in’, because when the farmer would shift to a machine or sensor from another supplier, often the data remains with the original supplier unless the farmer pays for it.

This problem also arises because the farmer does not have direct access to his or her data, but gains access to it through a cloud of which he or she is not the owner. This makes it difficult for a farmer to transfer the data in case of switching suppliers. The focus should therefore be on data portability through an interface, making it possible for farmers to easily transfer data in case they for example switch suppliers.

Important agreements for data sharing considered by the interviewed stakeholders are the following:

- Make responsibilities lawful and use the General Data Protection Regulation as the basis, since in this sector company data is much interlinked with personal data.
- Set clear terms and conditions about what the shared data can be used for, only share and ask for data that fits the purpose.
- Ensure it is clear who is responsible in case there is a data breach.

2.6 Incentives for participation

When it comes to including multiple chain actors in a digital data-sharing platform, there are typically two approaches that can be taken.

1) Contractual agreements, where system owners enter into agreements with their suppliers to determine how their data will be shared. In many cases, these agreements involve some form of financial compensation (Cao et al., 2022).
2) Creating a strategic alliance, whereby partners work together to align their goals and objectives (Singh & Teng, 2015; Ding et al., 2013).

The second approach is more commonly seen in the Netherlands, where partners with similar goals are more likely to trust each other and adopt a more collaborative attitude towards data sharing within the supply chain. A combination of trust and aligned goals is considered the most important prerequisite for data sharing (Ding et al., 2013; Annosi et al., 2021).

Shared collective need: risk mitigation

In the Dutch veal sector, also the second approach is applicable. The government had and has no direct influence in the extensive traceability system as there was a shared need and strong desire from the sector and the parties within. It started with the desire to guarantee animal welfare and animal health and decrease the use of antibiotics. When problems with calves occurred for example during transport, it was unclear who was responsible for it. Was the calf sick because of the feed? Because of mistreatment at the calf husbandry? Because the handlers did not evaluate the calf's health well? Or because the transporter did not take good care of the calves? This resulted in a shared desire to have more insight into each other's data to be able to see the responsible actor and increase accountability (Marvin et al., 2022). This incentive is risk mitigation, since in case of a problem, not all actors in the chain have to be affected because the data can often show which actor was responsible for creating the problem.

Individual need: money

Besides this shared collective need, actors also see a clear individual need. The dairy farmer who delivers the calves wants the calves to leave his or her farm as soon as possible since every day a calf stays longer than needed costs money. However, they also want to be sure the calves are well taken care of since otherwise it reflects the image of the dairy sector too. It might affect consumers' perception towards dairy products because the dairy farmers are the ones who deliver the calves. The feed supplier wants the data to be able to improve their feed, and the calf husbandry to be able to predict better which calves and treatments end up with the highest quality meat. It all comes down to being able to optimize operational decisions (Marvin et al., 2022). Therefore, the second incentive is money, as all individual actors have to see an added advantage in terms of money, being able to make more profit or reduce costs and losses. Next to that, those who act according to the set quality requirements and act ethically also want to show that they do so. Not only towards other actors in the chain but also towards the consumer. Especially because the veal sector remains a sector of debate in society.

Benchmarking and reactiveness

Benchmarking is the third incentive, as when more actors are sharing data, it also means that an individual actor can benchmark him or herself with similar actors (Marvin et al., 2022). Another incentive for digital data sharing is a more practical one since online data sharing saves a lot of paperwork and therefore time. For SKV for example, data analyses have to happen fast as they want to see as soon as possible when a calf husbandry is exceeding the quality requirements. Something that the

SKV is able to check quickly is the capacity of a stable compared to the I&R database indicating how many calves are present in the stable. The incentive here is thus to become more reactive.

In summary, these incentives are all about becoming a transparent chain in which everyone has insight into their supply chain partners and in which the actors that are causing problems can be easily identified and the actors that are performing well are able to showcase this.

Forced incentives

Besides these voluntary incentives, there are also some more forced incentives. One of them is adhering to rules and regulations as by law a company is required to be able to trace products one step back and track products one step forward. To obtain certification for Vitaal Kalf, there are also certain data-sharing requirements. Also, retailers have a lot of power in the chain and they put pressure on all actors involved to share data with them. The same holds for suppliers of machines and sensors that can automatically collect data. These suppliers often demand receiving the data in the terms and conditions when farmers buy such a machine or sensor.

Incentives for improving the system

Besides incentives for (digital) data sharing, there are also incentives for improving the digital data traceability system. General drivers to apply information technology into a supply chain are the following (Bunte et al., 2009):

- Changing market demands: Western European consumers formed more specific desires for their food products related to quality, integrity, safety, sustainability, and diversity.
- Sustainability: the focus is more on the impact of food production and distribution on the environment.
- Economies of scale: in Europe, large retail companies dominate the markets and enforce their own requirements on their suppliers, for example regarding logistics, quality management, and sustainability. This increases the demand for responsive and lean supply chains, making well-structured information systems essential.
- Increase in international competition: because of the increase of globalization, the trade of food products is expanding across borders and continents. With that, more questions arise concerning the quality, integrity, and safety of the food.
- Increased complexity of logistics flows: because of the increased international trade, the complexity of the logistics flow grows. With that, a need grows for optimized business networks and chain controls.
- Increased level of outsourcing: this also influences the complexity of the logistics flow and increases the need for trust and information sharing amongst actors.

These incentives were recognized in the interviews, during which changing market demands were identified as most important. In case farmers put in the effort to generate meat free from antibiotics, showing good animal welfare and health benefits for consumers, data throughout the entire chain must reflect this. This will show good product quality and investments can be earned back by increasing demand or by an increased consumer price. Also, nowadays, consumers expect more information about the products they buy, for example about where the product is coming from. With an extensive digital traceability system, actors can meet this consumer demand. Another market demand is the focus on sustainability and therefore on plant-based products. Because of that, the meat sector has the incentive to reflect their products as good as possible, in terms of quality and animal welfare, to be able to compete with these plant-based products.

Next to these identified incentives, another incentive is to increase efficiency. For example, the SKV requires accurate data from the calf husbandries that are part of their quality system Vitaal Kalf. Therefore, it is up to them to make data entering for calf husbandries as easy as possible, for example, by developing a convenient application.

The last incentive is to increase the quality of the data. Better input means better output and therefore accurate data that is of high quality is of utmost importance. With new technologies emerging throughout the years, digital traceability systems can be continuously improved. Also, new laws and regulations are an incentive, although forced. An example is a new regulation in Germany where they demand calves to be 28 days old before they can be transported. In the Netherlands, this is still 14 days. Digital traceability systems have to ensure that this is reflected in the data, to be able to prove that they are adhering to this regulation.

The incentives for data-sharing and improving the system are summarized in Table 5 below.

Table 5. Incentives of actors in the veal chain for data sharing and improving the system.

Data-sharing		Improving the system
Voluntary	**Forced**	
Shared collective need: risk mitigation	Adherence to laws & regulations (Dutch and EU)	Increase efficiency
Individual need: money	Certification	Increase the quality of the data
Benchmarking	Power of chain actors (retailers, suppliers of machines/sensors)	Changing market demand (e.g., showcase sustainability, increased consumer demand for information)
Increased reactiveness		New laws and regulations

2.7 Limitations

Data integration in supply chain management is a complex undertaking that is often impeded by various challenges. The most frequently named challenges are:

- the lack of trust among stakeholders, who may be hesitant to share sensitive information for fear of it falling into the hands of competitors, which can lead to a loss of control over shared data (Singh & Teng, 2015; Nilsson et al., 2019).
- a lack of understanding about the potential benefits or insufficient education and competencies to work with such systems. Not all members of the supply chain are equally prepared to engage in data integration efforts, with some stakeholders resistant due to a lack of understanding about the potential benefits or insufficient education and competencies to work with such systems (Nilsson et al., 2019; Annosi et al., 2021; Wiseman et al., 2019).
- incompatible ICT systems or business goals within the supply chain can create obstacles to the smooth integration of data, further complicating the process (Nabila et al., 2022).

Collectively, these challenges underscore the difficulties involved in achieving effective data integration in supply chain management and the need for careful planning and consideration of the unique needs and capabilities of each stakeholder involved in the process.

For the Dutch veal sector, implementation costs are found to be a limitation. For complete implementation in one veal processing plant, including scanners, production chain changes, and additional employees, costs are estimated to be around $6.5 million (Buhr, 2003). To implement it at

the feed manufacturers, calf husbandries, and other processing plants, costs were estimated to be around $24 million (Buhr, 2003). Besides, the more data is collected, the higher the costs of maintaining the data systems.

The limitation that is identified mostly by the interviewed stakeholders is that most data goes to the end of the supply chain and not so much data is going back into the chain. When the calves are at the calf husbandries, farmers have a lot of information about their calves and veterinarians share their inspections with them. However, once the calf leaves their farm, calf husbandries often hear more when something is wrong with their calf. This way, they cannot adequately perform continuous improvement management, as they do not know what frequent smaller (quality) problems with the calves they deliver are.

Also, the quality of the data is still perceived as a limitation. There are several 'layers' of data, of which the first one is raw data. The second layer is dashboard data, meaning that data is transformed into an interpretable number, for example, binary data (0/1) to' yes, certified' and 'no, uncertified'. The third layer can be considered as business intelligence (BI) dashboard data, where data is combined and the fourth layer, analytics, where even more data is combined (with external data). The final and fifth data layer is that of predictive data, where accurate predictions can be made. Dynamic data (data coming from sensors) retrieved in the sector is often of low quality as it remains in the raw data layer. The dynamic data is collected in high volume and is mostly unstructured, because of lacking standards. Therefore, it requires a lot of work and skills to translate it into dashboard, interpretable data. These skills are not largely present in the veal sector. Besides, the fourth layer of analytical is also not often reached as external data is not linked to the internally collected data, even though the technical designs for this do exist (Marvin et al., 2022).

Another limitation, although majorly improved the recent years, is the trust of calf farmers towards governments or larger companies to share their data with them. They fear that they share the data under certain terms and conditions, namely that the requesting party just wants to have insights, but that these parties will use their data differently in the future and that it may have consequences for the calf farmers. Also fear of competition is still present, as the one who has the most data is often also the one with the most power.

The above-listed limitations are summarized in Table 6.

Table 6. Limitations of the current digital tracking and tracing system in the Dutch veal sector.

Limitations
A limited amount of data is going back into the chain
Implementation costs
Quality of the data: (1) dynamic data often in high volume and is mostly unstructured, (2) not much data in the analytical data layer
The trust of farmers towards governments or larger companies

2.8 Best practices and lessons learned

The first lesson learned from the Dutch veal sector is that governments should find the right balance between not forcing a system on the actors by keeping the markets open and being able to provide more specific rules and regulations. An example is the European General Food Law (178/2002/EG), which only demands actors to trace one step back and track one step forward. It is not clearly mentioned in

how much time information should be shared or how the traceability systems should be set up. Although this leaves the markets open, it also does not stimulate actors to have a well-established digital traceability system and many actors therefore still use a lot of paperwork. It would be good to have more clarity on these rules. The Dutch government could specify these European rules and make them more concrete and specific, for example by adding how this should be traceable, digitally, and demand a certain period in which information has to be found.

It is also learned that the digital traceability and transparency system in the Dutch veal sector works very well because there is trust and a shared common need of the actors, in which each actor also has a clear individual incentive for sharing and receiving data. In the Dutch veal sector this shared common need was to improve animal welfare and health. When this would be improved, it would result in healthier calves in the complete chain, and thus also an increase in profit for all actors. Thus, a win-win situation was created in which each actor was highly motivated to participate. The government does not have to play a big role in this, besides acting as a referee, where they step in when something goes wrong. In the Dutch veal sector, it worked very well because the traceability system (KVS) was set up by all three involved sector organizations: (1) the dairy sector who provides the calves, (2) the trade sector who is responsible for the trade and transport of the calves, and (3) the veal sector who handles the process from calf to veal. With these three organizations working together, trust was created since all actors trusted their own sector organization. Discussions were not amongst all actors, but amongst the three sector organizations whose task it is to represent the needs and wishes of their sector.

A learned solution for possible distrust amongst actors to share data is to have a cooperating data actor who is able to function as an intermediate party and who is responsible for setting the terms and conditions for the data sharing. This cooperation creates a platform where all actors are provided access to certain data. That way, it is clear for everyone who has access to which data and this cannot just be changed unless new agreements are signed. In case such cooperation is non-existent, the following agreements are important when agreeing to data sharing. These are:

- Make responsibilities lawful and use the General Data Protection Regulation as the basis, since in this sector company data is much interlinked with personal data.
- Set clear terms and conditions about what the shared data can be used for, only share and ask for data that fits the purpose.
- Ensure it is clear who is responsible in case there is a data breach.

Regarding the technological best practices, it is important to think about how to make data accessible to which actors. For example, for the traceability system of Vitaal Kalf, the KVS system, there is a website and an application. In the application only those things that are frequently required are accessible, such as being able to notify a transport in the application, to make the task easy to perform. The purpose of collecting and delivering data should thus meet the way it can be entered or retrieved. Complex data in an application is not useful, the possibility to enter data that should be reported frequently is. The system should also be technically functioning, such as the quick loading of an application. Especially in the veal sector, a trader cannot wait one day because the system is out of function since it involves live animals.

Another technological best practice is data portability. This ensures that farmers can easily transfer data in case they are switching suppliers for example. This avoids the risk of data lock-in, where the data of the farmers remains at the previous supplier of a certain machine or sensor. For example, Safety Guard, the quality system of the VanDrie Group entails a lot of actors in the chain. When a company that is part of the VanDrie Group would switch suppliers or customers, there is a high likelihood that they are also part of the Safety Guard system and therefore the data will still be managed in the same system, namely in Safety Guard.

Besides, there should be a clear unique key while communicating and sharing information. In the Dutch veal sector, these clear unique keys are the identification & registration number of an individual calf and the UBN number for a certain farm. This way, data can always be linked in a way that gives meaning to data. This also helps in terms of data integration and having a more standardized flow of data.

Another lesson learned is related to finances. Setting up a new digital traceability system costs a lot of money and actors should be willing to invest. The costs of setting up the system are often underestimated and the added value in terms of money is often overestimated. Individual initiatives turn out to be very expensive and therefore, there is a need for initiatives on a larger scale. This way, investments can be split throughout the complete supply chain. This was exactly the case for the Dutch veal sector, as the traceability system, the KVS, was set up by the three sector organizations of the dairy sector, trade sector, and veal sector. Because of that, not just one actor invested in the system, but all actors were involved.

Also, in terms of data quality, there are best practices. One of them is to have objective and high-quality data. For example, when calves are given a certain quality qualification, the handlers are trained to do so. This not only creates trust but also ensures objective data as much as possible.

Finally, for a digital traceability and transparency system to work, there should be enough resources available, such as skills and ICT systems. That is where the government can play a role by investing in ICT infrastructures, investing in research in digitalization, and subsidizing projects such as living labs. By doing so actors are stimulated and enabled to contribute to a digital world, and thus to possibilities for digital traceability and transparency systems.

The best practices and lessons learned are summarized in Table 7, separating them per topic.

Table 7. Best practices for a digital tracking and tracing system, based on lessons learned from the Dutch veal sector.

Best practices
Role of the government
Governments should balance between not forcing a system on the actors and being able to provide more specific rules and regulations
Governments can act as a referee
The government can stimulate digitalization through investments and subsidies
Data-sharing
There must be trust and a shared common need of the actors, complemented by an individual incentive
Cooperation data actor who functions as an intermediate party and is responsible for setting the terms and conditions for data collection and data sharing
Data sharing agreements: (1) lawful responsibilities, (2) clear terms and conditions, (3) clear who is responsible in case of a data breach
Technological
Have a clear unique key during communication and information sharing
Data portability
Objective and high-quality data
Financial
Financial need for initiatives on a larger scale, individual ones are expensive
Enough resources available: skills and ICT systems

3. Conclustion

For a digital traceability and transparency system, the keyword for success is trust. All actors in the chain should be willing to share data and rely on each other for delivering accurate, objective, and high-quality data.

For the set-up of such a system, there should be a common need between the actors making them willing to invest in the set-up. In the case of the veal sector, this was a need to increase data sharing to better ensure animal welfare and health and to ensure it is clear which actor may have caused a problem. An additional feature should be that there is an individual need of each actor, which is often an increase in efficiency and insights, in the end resulting in a gain in terms of money. In the Dutch veal sector, an example of an individual need is that of the feed supplier that wants data on the calves, to be able to improve their feed. When this common and individual need is strongly present in the supply chain, it can create enough trust and willingness in the sector to put effort into the traceability system.

In case trust is limited in the supply chain a solution can be to have a cooperation data actor who can function as an intermedia party and who is responsible for setting the terms and conditions for data sharing. They can create a platform where all actors can share and access data. The cooperation sets clear regulations on who is able to access what data. This way, actors are not afraid that chain partners will misuse their data.

For a traceability system to work optimally, data should go back and forth in the chain. Often, and in the Dutch veal sector chain, data is mostly transferred to the end of the chain. An opportunity is lost there for actors at the beginning of the chain to learn and improve based on results later in the chain. It also creates a more evenly distributed power across the supply chain. The one with the most data is, generally speaking, the one with the most power and is also the one who decides on innovation in digitalization. When data is not only sent towards the end of the chain, but is also sent back, not only the data is more evenly distributed, but also the power in the supply chain.

Data portability is also an important theme in traceability systems. Owners of the data should be easily able to transfer their data in case they are working together with another chain partner. In case a farmer switches from the supplier of a machine, often the data is lost since the supplier blocks access for the farmer to their data. When data portability is well-established, the farmer can transfer his data and continue to build his or her own database.

The role of the government in the digital traceability and transparency system can be limited. They should act as a referee and step in when something goes wrong. Besides this referee role, their role is to provide clear laws and regulations. The best is if the overarching government (for example, the European Union) establishes directives to enhance a movement. The country's government (for example, the Dutch government) can specify the regulation a bit. The country's government should not be too specific, as the role of the sector is to follow these regulations and define how to best work for them. So, the regulations should not be too demanding for the sector to make them better applicable to their needs and use the regulation as a set of basic requirements to work on.

Another role of the government is a more stimulating one. The government can invest in ICT infrastructures, invest in research on digitalization, and subsidize projects such as a living lab. This helps to stimulate and enable actors in the supply chain to set up a digital traceability and transparency system, as the resources are available.

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5. Annex

5A Interviewees

Organization	Specifics	Subjects
1. Small-scale calf husbandry	Not part of the national quality system Vitaal Kalf	• Data collected • Requirements for collected data • The system used for data collection • Quality system
2. SKV, Foundation quality assurance veal sector	Control body for quality system Vitaal Kalf	• Data collected • Data privacy and ownership • Data sharing agreements • Incentives • Institutional oversight • Best practices
3. Wageningen University & Research	Active in research in (digital) traceability in the meat sector	• Incentives • Data sharing incentives • Regulations • Best practices
4. Join Data	A trustworthy platform for data sharing in the agricultural sector	• Data ownership • Data privacy • Data access • Data sharing agreements • Incentives • Limitations • Institutional oversight
5. ZLTO	Regional association for advocacy of the agricultural sector	• Incentives • Institutional oversight • Limitations • Best practices
6. LTO	National association for advocacy of the agricultural sector	• Incentives • Institutional oversight • Limitations • Best practices
7. VanDrie Group	Integral company in the veal sector	• Data collected • Data (re-)use • Data privacy and ownership • Incentives • Limitations • Best practices
8. SBK, Foundation sector organization calf sector	Organization of the Dutch veal sector	• Data privacy and ownership • Data sharing agreements • Incentives • Institutional oversight

		• Limitations • Best practices

5B Interview guide

Please note that this interview guide is used as a basis and adjusted for each interview based on the organization's field of expertise.

Introduction:

- Cover the practicalities (thanking the interviewee, recording, introductions, length of interview)

Data platform:

- What data is shared by each actor in the supply chain?
    - Fill it in step-by-step in the drawn supply chain from the birth of the calf up to retail
- What technologies are used in collecting data?
    - Barcode, microchips, radio frequency transmitters, ear clips, live data sharing
- What are the reasons for choosing the technology that is currently in use?
- Are there any plans of improving the technology used?
    - Testing, new developments, demands from customers, optimizing used technology, use of new technology

Data (re-use);

- For what is the data collected used?
    - Internal, external, predictions, food waste, food safety, animal welfare
- Are there any links between the databases in the private sector and public databases?

Institutional oversight:

- How would you describe the role of the government in the set-up of the digital traceability system in the veal sector in the Netherlands?
    - To what extent were they of influence, compared to the involvement of the private sector?
    - To what extent did the government pose any incentives for the private sector to improve the digital traceability system?
- How do you see the role of the government in the digitalization of the traceability system in the veal sector in the Netherlands?
    - In comparison with the private sector, to what extent are they of influence?

Data privacy & ownership:

- How are responsibilities and ownership often arranged in the sector?
- Who is (mostly) responsible for and owner of which data?
    - Who controls the data?
- How are agreements (mostly) determined for data sharing between all actors?
    - Contract, involved in an integral company, differences in agreements
- Who has access to which data?
- What are important arrangements in terms of data-sharing agreements?
    - Ownership, way of data exchange, access, etc.

Incentives:

- What are the incentives for these actors to share the data with other actors?
    - What do the actors get in return for sharing the data?
    - What are the incentives posed by the government for actors to share the data?
- What are the main incentives for the development of more transparency through digital traceability in the veal supply chain?
    - changing market demands, sustainability, economies of scale, increase in international competition, increased complexity of logistics flows, increased level of outsourcing, demands from the government, rules and regulations, increase knowledge

Limitations:

- What are, currently, the biggest limitations in the digital traceability system in the veal sector?
    - Costs of scale-up, trust, data integration, lacking ICT systems, actors who do not see the added value

Best lessons learned/best practices:

- What are the main lessons learned for setting up a well-functioning digital traceability system?
    - Data needs, data systems, rules and regulations, policies, institutional oversight, incentives
- Which three aspects are most important for a well-functioning digital traceability system?