METHOD AND APPARATUS FOR LIVESTOCK SUPPLY CHAIN COMPLIANCE MONITORING

This invention relates to the surveillance of livestock, in particular to condition of live animal exports destined for slaughter, and provides method for monitoring treatment meted out to animals in a supply chain on their way to and once at a remotely located abattoir. The apparatus comprises networked system of data capturing devices and controlling computer module to receive data electronically from remote monitoring stations on the supply chain, and process the data to detect and record the location and condition of each animal individually, according to identification tags, such as bearing a microchip on the body of the animal. Each animal may further be equipped with image capturing devices to add to the visual data being gathered and stored in relation to its condition and conditions to which it is subject in processing. The data is made available to bodies such as animal welfare watchdogs and regulators.
Method and apparatus for livestock supply chain compliance monitoring

Field of invention

[01] This invention relates to the surveillance of livestock, in particular to the condition of live animal exports for slaughter. More specifically, it provides a method and means for monitoring treatment metered out to animals on their way to and once at a remotely located abattoir.

Background to the invention

[02] A significant operating cost borne by livestock exporters arises from increasing compliance requirements imposed by governments and industry bodies to reduce and, if possible, prevent incidents of animal cruelty as well as losses of individual animals from the export supply chain.

[03] An animal is considered to be in a good state of welfare if it is healthy, comfortable, has a good supply of feed and water, is safe, able to express innate behaviour, and is not suffering any form of pain, fear or distress.

[04] The term traceability relates to the requirement for a continuous audit trail accounting for the whereabouts of cattle and their current status or condition regarding feed lotting, moving between facilities and processing. The audit trail covers the journey travelled by each animal from paddock to stockyard, land transport, quarantine, shipping, abattoirs and further processing facilities.

[05] Livestock identification systems are well known, a supplier being Datamars, Inc. which describes its products on the website at www.datamars.com.

[06] In such systems, a short-range wand device is utilised to detect an electronic tag attached to a close-by animal or embedded beneath its hide. The tagging device emits unique identification information that is captured with the wand and communicated to a data processor such as may be found in a mobile telephone or a desktop computer, or placed in an electronic memory. The information is able to be conveniently interpreted by software means to obtain or display data pertaining to the individual beast. The drawback of these systems is that they are localised to a particular premises, such as a farm environment, or an auction yard. Instead of a wand, the scanning for detecting the tagging device may be carried out by a fixed, stationary...
scanner, such as may be located at a gateway through which animals may be induced to pass.

[07] Existing systems for the processing of livestock exports often experience issues in the nature of the following:

- Cattle or buffalo are not individually identified before departure from their country of origin, for example Australia.
- Animal identification is not checked on arrival at or induction into the destination feedlot.
- Reconciliation of cattle and buffalo that have arrived at a feedlot against animals expected to arrive at the feedlot is not performed.
- Segregation between groups of cattle and buffalo in the feedlot is not performed.
- Management of lost animal identification in a feedlot is not performed.
- Unauthorised removal of animal identification in the feedlot.
- Cattle or buffalo present in the feedlot even though having been recorded as already slaughtered.
- Feedlot mortalities being neither recorded nor reconciled in the case of cattle and buffalo.
- Feedlot mortalities neither recorded nor accounted for in the case of sheep and goats.
- Cattle and buffalo identifications not checked prior to their departing the feedlot.
- Cattle and buffalo identifications not checked on arrival at the appointed abattoir.
- Segregation between groups of cattle and buffalo in the abattoir is not performed.
- Management of lost animal identification not being performed in abattoirs.
- Removal of animal identification in abattoirs prior to slaughter.
- Slaughter being performed without stunning, or equipment not being compliant with World Organisation for Animal Health (OIE) recommendations.
- Slaughter by means of more than one cut in the case of multiple non-stunned animals.
- Feedlot documentation or access to the feedlot, as requested by auditors, not being provided.
Abattoir documentation or access, as requested to abattoirs by compliance auditors, not being provided.

Auditors not being permitted access to facilities when requested.

An end-of-processing report or independent audit report on the performance of the supply chain is not provided to the relevant regulator for animal welfare or ethics regulator, even following requests to provide overdue end-of-processing reports.

**Objects of the invention**

[08] It is an object of this invention to address the shortcomings of the prior art and, in doing so, to provide effective means of monitoring the conditions and treatment of livestock destined for slaughter and undergoing slaughter.

[09] A second object is to improve the traceability of individual animals in the course of their being moved to the abattoir.

[010] A further object is to provide technology means for detecting whether an animal has been disposed of outside an authorised, predefined supply chain.

[011] The preceding discussion of the background to the invention is intended to facilitate an understanding of the present invention. However, it should be appreciated that the discussion is not an acknowledgement or admission that any of the material referred to was part of the common general knowledge in Australia or elsewhere as at the priority date of the present application.

[012] Further, and unless the context clearly requires otherwise, throughout the description and the claims, the words 'comprise', 'comprising', and the like are to be construed in an inclusive sense - that is to say, in the sense of "including, but not being limited to" - as opposed to an exclusive or exhaustive sense - that is to say meaning "including this and nothing else".

[013] In this specification, the words below are given the following meanings:

- "lairage" means pens, yards and other holding areas used for accommodating animals in order to give them necessary attention (such as water, feed, rest) before they are moved on or used for specific purposes, including slaughter;
• "slaughter" means any procedure which causes the death of an animal by bleeding;
• "slaughterhouse" or "abattoir" means premises, including facilities for moving or lairing animals, used for the slaughter of animals to produce animal products and approved by a competent authority;
• "stunning" means any mechanical, electrical, chemical or other procedure which causes immediate loss of consciousness; when used before slaughter, the loss of consciousness lasts until death from the slaughter process; in the absence of slaughter, the procedure would allow the animal to recover consciousness;
• "surveillance" means the systematic ongoing collection, collation, and analysis of information related to animal health and the timely dissemination of information so that action can be taken to remedy unacceptable health or slaughter situations.

Summary of invention

[014] The invention provides an integrated supply chain traceability and animal welfare surveillance system. The system extends to and includes a method and means for lairage management, encompassing monitoring vessel unloading, livestock transport, feed lot induction and dispatch, abattoir confirmation of death and meat processing activities. The system ensures the monitoring, recording and transmission of data relating to individual animals at such locations, there by to enable and ensure compliance with state legislation and any other audit or quality assurance standards concerning animal welfare, control and traceability that may be imposed as a condition of export of live animals.

[015] According to a first aspect of the invention, there is provided a transnational monitoring system adapted for livestock supply chain monitoring, comprising

a control module having data processing means and a plurality of remotely-located monitoring stations sequentially located along a supply chain to be monitored,

identifying means configured for identifying an individual head of livestock and data collection means installed at the stations,
i. the identifying means configured to identify an individual head of livestock when present at a station, and

ii. said data collection means configured for capturing data relating to the identified individual livestock head and its condition,

data communication means connecting the stations and the module to be in data communication, and

data storage for receiving and storing captured data for forwarding to a predesignated recipient device, subject to predetermined criteria.

[016] According to a preferred form of the invention, the system further comprises interface means enabling controllable data access to a recipient device associated with an authorised user of the system. The recipient device may be a mobile computation device such as a smartphone or notebook computer or tablet, or may be a fixed desktop PC and the like.

[017] In a further preferred form of the invention, the identifying means comprises a radio frequency identification device (RFID). Preferably the RFID is configured to operate at ultra-high frequency levels. In a preferred embodiment, the RFID is incorporated into a visible tag adapted for attachment to an animal being tracked according to the invention.

[018] The identifying means preferably further comprises reader means configured for collecting identification data unique to each individual head of livestock presenting within predetermined proximity thereof.

[019] The reader means is configured to collect data from the RFID.

[020] Further preferably, the identifying means comprises image capturing means.

[021] Additionally, it is desirable that the identifying means comprises means for capturing data relating to a physical feature of an individual head of livestock. For example, the feature is selectable from one or more of hide colouring, eye characteristics, facial characteristics and combinations thereof.

[022] In a further preferred form of the invention, the image-capturing means is synchronizable with the reader means, whereby an image of a head of livestock is
associated with individual identifying data. As a result, an image of an individual head is preferably time- and date-stamped and imprinted with the relevant identifying characters (numbers or letters) of the animal concerned.

[023] Still further, the invention preferably also includes a data processor programmed to carry out a comparison of data of an individual head of livestock captured at a first station with data of the same individual at a second station.

[024] Ideally, the system comprises programming instructions for issuing an alert if the comparison shows a deviation in compared data from a predetermined standard.

[025] Further, according to the invention, a livestock tracing system comprises at least two distally-located detecting stations adapted for detecting the presence in a station of a marked individual head of livestock, image capturing means positioned to capture images of the marked head of livestock and remote retrieval means operable over a global network of computers and configured to display images of a desired individual head of livestock on demand.

[026] In a preferred form of the invention, the system further comprises visual display means configured to display images captured of an individual head of livestock at each of said stations. In an embodiment, the display means is configured for simultaneous display of images captured at two or more different stations, or at one or more stations at different times. This embodiment facilitates visual comparison of the condition of the head of livestock as it was when at the different stations or over a selectable time period.

[027] In another preferred form of the invention, the system comprises means for transmitting live images of a specified individual head of livestock to a remote viewing device. The images may be still or moving video images. In an embodiment, the live video is streamed over a secure internet tunnel. Preferably, the video images are paired with the identifying data of the individual animal being captured.

[028] Further, according to the invention, the system includes means for logging the presence of an individual marked head of livestock at a station. Preferably, the system is programmed to enable the emitting of an alert when the presence is detected of a particular marked source.
According to a second aspect of the invention, there is provided a method of tracing an individual live head of livestock from paddock to abattoir, the method comprising steps of

- Defining a plurality of monitoring stations located along a route from paddock to abattoir,
- Installing a tracking device at each station;
- Capturing information that identifies an individual animal to be monitored
- Causing the devices to capture identification data relating to animals passing the station;
- Comparing the captured data with the data identifying the monitored animal;
- Logging each instance when the monitoring animal is detected,
- Comparing expected data with actual data; and
- Outputting an alert if the expected data differs from the actual data by a predetermined quantity.

Preferably, the method includes providing a website portal configured to allow access to an interested user.

In a preferred form of the invention, the step of capturing information includes scanning each animal for detecting an individual-identifying device carried by the animal. The device may be implanted in the animal, for example a transponder, or attached to it, for example an ear tag, or an external transponder.

In a preferred embodiment the method includes mounting to a head of livestock condition monitoring apparatus. The apparatus may include one or more of a thermometer, heart rate monitor, accelerometer, inclinometer and the like. The apparatus is configured to communicate data to data receiving apparatus. The data receiving apparatus preferably comprises a wand, smartphone or local or remote computer device.
Preferred data communication means may include wireless signal emitting and receiving means interfacing with a communications network.

The system extends to including a man/machine interface and means to communicate an alert when a condition that is predefined to trigger an alert is detected. The triggered alert may be communication by means of a short range wireless transmission protocol such as Bluetooth® instead of cable.

According to a third aspect of the invention there is provided a supply chain monitoring method comprising the steps of

(a) providing a plurality of monitoring stations sequentially located at preselected locations along a supply chain,

(b) causing a head of livestock having individual identification means defining a traceable data source to be passed along the chain from a first monitoring station at a starting point of the chain and thereafter to planned second and subsequent stations along the chain,

(c) detecting the presence of the source at selected stations, and

(d) at said stations collecting data concerning the condition of the source when at said respective stations.

Preferably the method includes comparing the condition data with condition data representing a predefined standard of acceptability.

Further preferably, the method includes directing an alarm signal to a predesignated recipient if a deviation from the predefined standard of acceptability according to a preset criterion is determined.

In a preferred form of the invention, the method provides for comparing a detected signal identifying a station, at which the source is present, with a predefined schedule of progress of the source and signalling a detected departure from said expected sequence.

According to a fourth aspect of the invention there is provided animal surveillance apparatus including a website portal having access control means for customers of an operator of said surveillance apparatus; said apparatus comprising data capturing devices, a plurality of individual animal identification devices, associated uniquely with respective individual animals, a
data server in data communication with the capture devices, a programmable data processor programmed with instruction code rendering it operable to compare captured data received via the server and pertaining to whereabouts of an animal with data identifying an expected location of the animal; and alarm giving means for actuation in the event of a comparison of captured and expected location data exceeding a predefined margin.

[040] In a preferred form of the invention, the apparatus has data capturing devices located in two or more countries.

[041] In a preferred form of the invention, the data capturing devices comprise image capturing means. The image capturing means preferably includes thermal imaging means able to be directed towards a selected individual animal.

[042] In a further embodiment, the image capturing means is operable for capturing still and moving images at different times. In a preferred embodiment, the image capturing means is synchronised with identification means capable of identifying an individual animal for providing a visual display of a selectable individual.

[043] According to a fifth aspect of the invention there is provided meat processing infrastructure comprising a first station adapted for receiving live animals, a discharge station adapted for shipping out animal carcasses derived from the live animals and at least one intermediate station located intermediate the first and discharge stations, a computer managed surveillance system integrated with surveillance devices at each station, the devices being positioned and configured to collect data relating to animals at the respective stations and transmit the data to a control module.

[044] In a preferred form of the invention, the animal related data includes data identifying each animal uniquely and condition data pertaining to each uniquely identifiable animal. Preferably, the condition data includes an image of the animal concerned as captured at each station.

[045] The invention in a sixth aspect provides for a surveillance kit for installation at a selected site for defining a monitoring station, the kit including communication means capable of data communication with a remotely located control module, and monitoring means capable of monitoring a condition of a potential food source and being connectable to be in data communication with said communication means for data transfer to said module.

[046] In a preferred form of this aspect, the monitoring means includes a device for monitoring a vital sign of livestock and an image capture device.
In a further form of this aspect, the kit comprises an image capturing device adapted to be affixed to an individual animal.

The invention provides further, in a seventh aspect, for apparatus adapted to receive a written submission from a prospective exporter seeking acceptance to use existing animal export infrastructure that comprises a chain of lairage facilities extending from a first country to a second, the apparatus including a control system comprising computer means loaded with optical character recognition (OCR) software programmed for reading the submission and translating it into text, processor means adapted for acting on instructions contained in driver software rendering the processor operable to compare content within the scanned submission with criteria predetermined for establishing capability of a prospective exporter for compliance with said criteria, wherein the criteria are representative of an agreed standard of supply chain management.

There is further provided a method of detecting whether an animal may have been disposed of outside a predefined supply chain, the method comprising the steps of providing a plurality of monitoring stations sequentially located at preselected locations along a supply chain, causing a head of livestock having individual identification means to be passed along the chain from a first monitoring station at a starting point of the chain and thereafter to planned second and subsequent stations along the chain, predicting a time of arrival of the head of livestock at the second or subsequent station, scanning livestock arriving at the station at the predicted time and, on failure to detect the individually identified head at the station, causing such failure to be flagged to an operator associated with the chain.

**Brief description of drawings**

In order that the invention may be readily understood, and put into practical effect, reference will now be made to the accompanying figures. Thus:

Figure 1 shows in schematic perspective view a preferred embodiment of the system of this invention.

**Detailed description of an embodiment of the invention**
The invention establishes communication channels between livestock exporters and importers, importers and transport operators, and importers and abattoir operators. Movements of cattle are recorded from information provided at various times by the exporter and the importer.

The system of the invention monitors the condition of livestock on the way to slaughter in a distant overseas abattoir and compiles reports relating to individual beasts. The reports are made available to interested parties including (without limitation) welfare groups (for example the OIE), industry watchdogs, compliance auditors, abattoir management, station management and individual farmers.

The system, in an embodiment, makes use of existing visual tags of the kind commonly applied as ear tags to cattle, and in another makes use of subcutaneously implanted transponders that emit an identifying signal when receiving an activation scan, according to methods well known in the art. Such devices are often referred to as radio frequency identification devices or RFIDs and may be of relatively low frequency or ultra-high frequency (UHF).

The present invention expands monitoring to cover the full supply chain that an individual head of livestock, such as individual sheep or cattle, travel from paddock to plate (almost). It encompasses more than just slaughterhouse conditions by providing infrastructure at interim lairages that enable monitoring of protocols according to which identification means on the animal may not be removed until an approved point in the chain is reached after slaughter. The infrastructure provided thus enables monitoring of animal handling and slaughter processes, by means including, but not restricted to, CCTV cameras, and the reviewing of recorded footage. Through use of the apparatus of the monitoring system, there is provided means for detecting whether an animal has been disposed of outside an authorised, predefined supply chain.

In the case of UHF RFIDs having writable on-board data storage, data specific to an individual animal bearing such an RFID is written to it. This data includes data pertaining to the identity of the animal, enabling cross-checking with visible tag information, as well as real time data that is gathered in the course of its progress from stockyard to abattoir. The data is recorded to be readable by sensors located at various points along the supply chain and is able then to be communicated to interested monitoring stations, including those relating to audits. Preferably, the RFID is incorporated into a visible externally attachable tag.
In a preferred embodiment, an action-capturing digital camera is adapted for mounting to be affixed to an individual head of livestock in the supply chain and configured to capture images for uploading to a server when the livestock arrives within range of a receiving station. An individual animal may be equipped in this way with more than one camera device, or with a camera device capable of multidirectional image capture, including the capture of moving and still images. A particularly desirable monitoring device is a camera having motion-activated image capture software. Ideally it is mountable on the saddle portion of the horns of an animal for being directed either forward or rearward, or adapted for swivelling from one to the other. The video images captured are streamed over a secure internet channel (tunnel) to be recorded at the system control module or other designated data storage location, as well as being available for live viewing by authorised system users having access.

Thus all RFIDs that are detected passing, by being on livestock delivered, across international boundaries are logged and their movements recorded against delivery documents thereafter and regularly reconciled until after the point of death of the respective animals being identified.

The RFID tags will be scanned at a range of locations, for example at loading. The use of UHF RFIDs enables scanning and at a range of differing locations where low frequency RFID tags are found not to be suitable for efficient and reliable scanning. Condition information such as the assessed fitness to load for each animal will be written to their tag as it departs from one assessment point to another. In particular such scanning will take place at the holding yard prior to loading on to a vessel, on or after unloading from the vessel, on loading to a truck, on entry to a feedlot.

Portable or handheld microchip scanners, or temporarily positionable microchip scanners are equipped with internal docking functionality for both battery recharging and extraction of the user activity log and RFID log-file data. The logged data is retained for analysis and use in the detection of user negligence or violation of standard operating procedures.

The system enables detailed information of each animal and the conditions under which it is being kept to be gathered, retained and compared. The information of interest includes any of the following examples: individual identity, species, origin, destination, date and place of slaughter, enabling the calculation of the following statistics: -
• Numbers and identities of livestock exported
• Numbers and identities of livestock received at a particular lairage
• Number and identities of mortalities at each lairage
• Numbers, identities and dates of livestock entering quarantine at a particular post-arrival facility at destination country
• Numbers, identities and dates of departure or transfer from the quarantine facility
• Numbers and identities of mortalities in quarantine
• Numbers and identities of livestock departing each feedlot for each abattoir
• Number of livestock received in a consignment and slaughtered by each abattoir
• Date of slaughter of the last non-pregnant animal from the consignment
• Number of pregnant animals in the consignment
• Number and percentage of livestock traced back to the tag list compiled at the time of export
• Number and percentage of livestock that remained in the supply chain but were not traced back to the original tag list (i.e. lost or non-functional tags)
• Number and percentage of livestock that left the exporter supply chain
• Number and percentage of livestock not accounted for
• Number of livestock that departed from each feedlot to each depot [if applicable]
• Number of livestock received at each depot [if applicable]
• Number of mortalities in each depot [if applicable]
• Number of livestock that departed from each depot to each abattoir [if applicable]
• Number of livestock from the consignment that departed the supply chain(s) as breeding animals

[061] From the above, explanation can be better sought for livestock that are noted as having somehow left the supply chain without being accounted for. In addition, the statistics are useful in adding to the sum of knowledge about the livestock export industry and inform future training and compliance initiatives.
Referring to figure 1, in a preferred embodiment of this invention, the apparatus of the invention is generally denoted by the number 10. The apparatus comprises a number of distributed livestock monitoring stations, only three of which are depicted here, being numbered 20, 30, and 40. Animals passing along a designated supply chain will pass in a predetermed sequence from station to station. In this non-limiting example, station 20 is a lairage located at a transportation feedlot, for example at a railway siding, or dockside. It may be found too at an auction site or other market.

In this non-limiting example, station 30 is a lairage located at the holding yard of an abattoir and station 40 a loading bay of a dispatch facility, from which carcasses are shipped for further processing via distributors to retailers such as butcheries.

Each station is equipped with a condition monitoring kit, comprising an identifying device 22, 32, 42 that reads the identification data present on a live animal 12 arriving at the station and the carcass 12* after slaughter. The identification data is affixed to the live animal prior to its being sold and transported by means commonly used in the art, such as ear tags or RFID tags or implants, or other electronically readable devices, including optical character recognition devices. The example illustrated in figure 1 depicts the animal in question having an RFID implant denoted by means of the number 14. At post-slaughter station 40, carcass 12* still contains the identifying device, which is read by means of a stationery scanner 42, which the carcass passes in the course of being carried away for further processing and dispatch. Data from the scanner is forwarded to the system control computer module 50, described below, for reconciliation of the identifying tags from slaughtered animals with the identity data on delivery notes and other shipping documentation leading up to the arrival of the live animal at the slaughterhouse of station 40.

The kit also includes image capturing equipment 24 for recording images of the animal. Video images are streamed to a data storage facility at or as directed by control module 50. The video is also streamed to an interested party with authorised access, such as the owner of the animal or a monitoring agency. In cases of interruption of streaming, the image data is retained on location for later transmission.

The imaging equipment may advantageously include a thermal imaging camera. The kit further preferably includes at least one condition-data collecting device 26, for example a load cell, body composition / fat monitor, hydration monitor,
thermometer or pulse rate monitor. In post slaughter monitoring, at station 40, the kit shown includes a load cell and body composition monitor 46.

[067] The data collected at each station is communicated to a system control module 50 where the data is analysed and stored using a computer system 52 containing data storage servers and managed by way of data management and analysis software customised for integration with an internet access portal allowing external interested parties to have access via their internet enabled computers 62, or portable communications devices 64, such as smartphones, tablets, smart watches and the like, to portions of the data. Restrictions are placed on the level of access according to the relevant interests. For example, a station manager or owner may have access to images of cattle received from his or her own station only, whereas an animal cruelty prevention organisation may be allowed access to images irrespective of station of origin.

[068] The data is communicated from the collection stations using wireless internet technology. Thus at station 20, the data collected from identification RFID sensor 22, load-cell 26 and cameras 24 is communicated in packages via modem 28 over the internet 60, to control module 50. This module may be located at any suitable geographic location. Preferably, in the case of livestock being exported from Australia, the module is located at premises operated by an Australian organisation having oversight of the entire supply chain from pasture to carcass leaving the abattoir, right up to the moment when identification device 14 is removed, as authorised, and details logged, according to agreed protocol. This stage in the chain is represented by the numeral 70 in figure 1.

[069] Data collected at stations 30, 40 and 70 is similarly transmitted via computer modems 38, 48, 78 associated with the monitoring kits and to which the components in the kit are operatively connected.

[070] It will be appreciated that the various components of the monitoring system and its management may be replaced by items with like functionality.

[071] In the case of the mobile telecommunications devices 64 receiving data accessed via internet 60 from the data storage facilities associated with control module 50, a number of alternative interfaces, web portal access arrangements and touch screen configurations may be employed within the scope of this invention.
[072] An additional feature of the invention is the provision of means for users to flag alarm events in cases where they are aware of, notice, or suspect unacceptable treatment of livestock or conditions to which livestock are subject. By way of example, a smartphone touchscreen is programmed to display an alarm button, which, when tapped by a user, will connect the user directly to the control module for leaving a voice message, or to a human operator, who will receive and log the call. In an embodiment, if the caller has reacted to an image of an animal or conditions at premises where it is being processed, the tapping of the alarm button captures and transmits the image in question to be logged with the call. Instead of by means of a voice call, the user may signal the alarm by means of a short text message or multimedia message.

[073] The operator of the control module may then perform remedial action, logging a response or escalating the matter to an appropriate agency.

[074] Comparison of condition data captured from different stations in relation to an individual animal is a task that is programmable by software adapted to this purpose. The software is run principally at the computer system at the control module 50. Reports are programmed for delivery to various designated agencies according to request criteria and interest qualifications. For example, the mass of an individual animal is measured when first introduced into the system, such as at station 20 in a railway loading yard, and a photograph is taken, synchronised with the measuring of its mass. Its pulse rate and body composition may also be measured. The data is timestamped and location-stamped, preferably also including the global positioning satellite (GPS) co-ordinates of the location where captured.

[075] Later, when it reaches station 30, which may be in a feedlot associated with an abattoir, these same measurements may be repeated and further photographic images captured. The images may be captured from various angles simultaneously or in succession and electronically identified with the animal’s unique identification data. The data is communicated to the control module 50 and a comparison is made, with differences being calculated and recorded. If differences exceed predetermined thresholds, the software programmed in the system causes the logging of an alarm condition and a report to be issued by communication to an agency preordained to be relevantly informed, for example a non-government organisation such as the Royal Society for the Prevention of Cruelty to Animals (RSPCA), an industry group such as a
stock breeders' association, a commercial enterprise that owns the individual animal concerned, or a government department, including law enforcement.

[076] In a further example of the implementation of the invention, the apparatus at slaughter station 40 optionally includes a timing device located to measure the time elapsing between stunning of an animal and its moment of slaughter, and comparing this against a desired standard time interval. If the time exceeds the standard, an alert is logged and reported by software and communication means to the operator of the facility and to control module 50.

[077] Further, according to a preferred embodiment, the system includes vital signs monitoring means located after the point of slaughter 40 to monitor the vital signs of the animal being slaughtered and ensure that the animal's death has occurred, before its carcass is authorised for transfer to the station where dressing and cutting will proceed.

[078] In implementing the invention, lairage designs are such that all animals move in one direction from point of unloading to the point of slaughter. To encourage animal movement according to natural tendencies, lairages are constructed to provide height for the animals to be able to stand comfortably, sufficient floor area for the animals to lie down, and lighting adapted to provide increasing illumination from entrance to exit. The lighting used for illumination is controllable by means of a regulator of conventional design, but programmed to be responsive to the desired residence time of animals entering a holding zone, so that the rate of increasing the degree of illumination from entry to exit can be varied according to the throughput desired. Monitoring of the lighting is performed locally or via control module 50.

[079] When an animal is confined in a pen, the pen is large enough to permit the animal to turn around and is equipped with restraining apparatus where this is required for safety.

[080] Races are arranged to permit inspection of the animals at any time and to permit removal of sign of injured animals. Separate accommodation is provided for such animals. The races are preferably straight, but, if curved, are consistent in curvature and with radius of curvature appropriate to the animal species for which they are designed - shorter radius for sheep and goats than for cattle. Preferably, the races are defined by walls having solid sides. However, in cases where the race is intended as a double race, the shared dividing partition is adapted to allow adjacent animals to see each other, for
example by comprising transparent wall material such as Perspex, or comprising slotted panels.

[081] In the cases of races designed for pigs and sheet, passageways are of sufficient width to permit at least two animals to walk abreast. Width reduction is by means of gradually converging side walls that permit animals time to form a single line without excessive bunching and congestion.

[082] Images captured from the cameras of the system of the invention are processed by means of image recognition software, which is designed with instructions according to which the images are processed and compared. Algorithms within the instructions enable fractious animals to be spotted and individually identified, and an alert sent to a device of an appropriate handler, with instructions identifying the animal to be calmed or removed to a fast-trackng queue for slaughter.

[083] An advantage of the system is that it is configured and programmed to compile and issue specific reports relating to complete supply chains, portions of supply chains and individual facilities, and these reports are made available to be viewed at any time by authorised subscribers.

[084] The apparatus of the invention provides means for use in a method of detecting whether an animal may have been disposed of outside an predefined supply chain. This method is implementable where there is a plurality of monitoring stations sequentially located at preselected locations along a supply chain as previously described with reference to Figure 1. In implementing the method, a facility operator causes a head of livestock having individual identification means to be passed along the chain, from a first monitoring station at a starting point of the chain, to planned second and subsequent stations along the chain. Based on the time of leaving the first station and the transportation method, an estimated time of arrival of each head of livestock in a batch being transported at the second or subsequent station can be predicted. The prediction is improved in accuracy by monitoring the changes in location of the transportation means, be it by road transport, rail or ship.

[085] The identifying microchips of livestock arriving at the next station at about the predicted time are scanned and, on failure to detect each of the individually identified heads of livestock at the arrival station, the failure is flagged to an operator associated with the chain and automatically to the control module computer. The
operator at the station or the control module then issues a notification alert to the appropriate official via his communications device in contact with the module.

[086] In addition to scanning for detection of the identifying microchip, the scanning apparatus is programmed to attempt to match a visual image of the individual head of livestock with the microchip in question with images of livestock scanned at the station, as a backup means of detection, in case a tag has been lost or removed from an animal.

[087] The equipment installed for monitoring, data capture and processing at the various field units, is configured to be remotely accessible over a wireless network such as the internet or mobile telephone network for both firmware updates and system diagnosis and maintenance purposes.

[088] Another advantage is that the system permits and assists importers and exporters to identify critical control points in the supply chain. From this information, risk mitigation strategies are able to be developed and implemented in a real and dynamic environment.

[089] In the case of an exporter seeking regulatory approval or industry acceptance to use existing animal export infrastructure that comprises a chain of lairage facilities extending from a first country to a second for exporting live animals for slaughter, the control module is adapted to receive a written submission from the prospective exporter. The module has a computer loaded with optical character recognition (OCR) software programmed for reading the submission and translating it into text. The computer processor acts on programmed instructions contained in driver software rendering it operable to compare content within the scanned submission with criteria predetermined for establishing capability of a prospective exporter for compliance with these criteria. The criteria are representative of an agreed standard of supply chain management, including factors described above. The content to be identified and associated with particular criteria is extracted according to fields into which the prospective exporter is required to insert it. In a refined form of the invention, language processing instructions cause key concepts or word strings to be searched for and, if detected, mapped to a relevant criterion.

[090] These embodiments merely illustrate particular examples of the method and apparatus of the invention providing for supply chain traceability and animal export
compliance monitoring. With the insight gained from this disclosure, the person skilled in the art is well placed to discern further embodiments by means of which to put the claimed invention into practice.
Claims

1. A transnational monitoring system adapted for monitoring a livestock supply chain comprising
   a. a control module having
      i. data processing means and
      ii. a plurality of distally-located monitoring stations sequentially located along a supply chain to be monitored,
   b. identifying means configured for identifying an individual head of livestock and data collection means installed at the stations,
      i. the identifying means configured to identify an individual head of livestock when present at a station, and
      ii. said data collection means configured for capturing data relating to the identified livestock head and its condition, and
   c. data communication means connecting the stations and the module to be in data communication, and
   d. data storage for receiving and storing captured data for forwarding to a predesignated recipient device subject to predetermined criteria.

2. The system of claim 1 further comprising interface means enabling controllable data access to a recipient device associated with an authorised user of the system.

3. The system of claim 1 wherein the identifying means comprises reader means configured for collecting identification data unique to each individual head of livestock presenting within predetermined proximity thereof.

4. The system of claim 3 wherein the identifying means comprises image capturing means.
5. The system of claim 3 or 4 wherein the identifying means comprises means for capturing data relating to a physical feature of an individual head of livestock.

6. The system of claim 5 wherein the feature is selectable from one or more of hide colouring, eye characteristics, facial characteristics and combinations thereof.

7. The system of claim 4 wherein the image-capturing means is synchronizable with the reader means, whereby an image of a head of livestock is associated with individual identifying data.

8. The system of claim 4 having data processor means programmed to carry out a comparison of data of an individual head of livestock captured at a first station with data of the same individual at a second station.

9. The system of claim 8 having programming instructions for issuing an alert if the comparison shows a deviation in compared data from a predetermined standard.

10. The system of any one of claims 4 to 9 wherein the image-capturing means includes an image-capturing device adapted to be affixed to an individual animal in the supply chain.

11. The system of any one of the preceding claims wherein the identifying means comprises an ultra-high frequency radio identification device adapted for affixing to an animal being tracked in the supply chain.

12. A supply chain monitoring method comprising the steps of

a. providing a plurality of monitoring stations sequentially located at preselected locations along a supply chain,

b. causing a head of livestock having individual identification means to be passed along the chain from a first monitoring station at a starting point of the chain and thereafter to planned second and subsequent stations along the chain.
c. detecting the presence of the identified livestock head at selected stations and

d. at said stations collecting data concerning the condition of the identified livestock head when at said respective stations.

13. The method of claim 12 including comparing the condition data with condition data representing a predefined standard of acceptability.

14. The method of claim 13 including directing an alarm signal to a predesignated recipient if a deviation from the predefined standard of acceptability according to a preset criterion is determined.

15. The method of any one of claims 12 to 14 including comparing a detected signal identifying a station at which the source is present with a predefined schedule of progress of the source and signaling a detected departure from said expected sequence.

16. A surveillance kit for installation at a selected livestock processing site for defining a monitoring station in a supply chain, the kit including communication means capable of data communication with a remotely located control module, and monitoring means capable of monitoring a condition of a potential food source and connectable to be in data communication with said communication means for data transfer to said module.

17. The kit of claim 16 wherein the monitoring means includes a device for monitoring a vital sign of livestock.

18. The kit of claim 17 wherein the monitoring means includes an image capturing device.

19. The kit of claim 18 wherein the image capturing device is adapted to be affixed to an individual animal in the supply chain.
20. The kit of any one of claims 16 to 19 including radio frequency identification means adapted for affixing to an animal for tracking the supply chain.

21. Meat processing infrastructure comprising a first station adapted for receiving live animals, a discharge station adapted for shipping out animal carcasses derived from the live animals and at least one intermediate station located intermediate the first and discharge stations, a computer managed surveillance system integrated with surveillance devices at each station, the devices being positioned and configured to collect data relating to animals at the respective stations and transmit the data to a control module.

22. Meat processing infrastructure according to claim 21 wherein the animal-related data includes data identifying each animal uniquely and condition data pertaining to each uniquely identifiable animal.

23. Meat processing infrastructure according to claim 22 wherein the condition data includes an image of the animal concerned as captured at each station.

24. Animal surveillance apparatus including a website portal having access control means for customers of an operator of said surveillance apparatus; said apparatus comprising data capturing devices, a plurality of individual animal identification devices, associated uniquely with respective individual animals, a data server in data communication with the capture devices, a programable data processor programmed with instruction code rendering it operable to compare captured data received via the server and pertaining to whereby bouts of an animal with data identifying an expected location of the animal; and alarm giving means for actuation in the event of a comparison of captured and expected location data exceeding a predefined margin.

25. Apparatus according to claim 24 wherein the data capturing devices comprise image capturing means synchronised with the identification devices for providing a visual display of a selectable individual animal.
26. Apparatus according to claim 25 wherein the image capturing means further comprises thermal imaging means.

27. A method of detecting whether an animal may have been disposed of outside a predefined supply chain, the method comprising the steps of providing a plurality of monitoring stations sequentially located at preselected locations along a supply chain, causing a head of livestock having individual identification means to be passed along the chain from a first monitoring station at a starting point of the chain and thereafter to planned second and subsequent stations along the chain, predicting a time of arrival of the head of livestock at the second or subsequent station, scanning livestock arriving at the station at the predicted time and, on failure to detect the individually identified head at the station, causing such failure to be flagged to an operator associated with the chain.

28. The method of claim 27 including attempting to match a visual image of the individual head of livestock with images of livestock scanned at said second or subsequent station.
INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU2016/050772

A. CLASSIFICATION OF SUBJECT MATTER

G06Q 10/00 (2012.01)  A01K 29/00 (2006.01)

According to International Patent Classification (IPC) or to both national classification and IPC.

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPODOC, WPIAP: IPC and CPC Used (A01K1 1/006, A01K1 1/004, A01K1 1/008) & keywords (alarm+, alert+, notif+)

EPODOC, WPIAP: Keywords (Livestock?, cattle?, monitor+, surveil+, alarm+, alert+, notif+)

Google, Google Patent, Google Scholar: Keywords Searched (livestock, identification, chain, slaughter, route, alarm, image) & similar keywords

Google, Google Patent, E-Sp@cenet, Intess, Nose: Inventor and applicant name search

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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Documents are listed in the continuation of Box C

Further documents are listed in the continuation of Box C

See patent family annex

Date of the actual completion of the international search 18 November 2016

Date of mailing of the international search report 18 November 2016

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Telephone No. 02628637922

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