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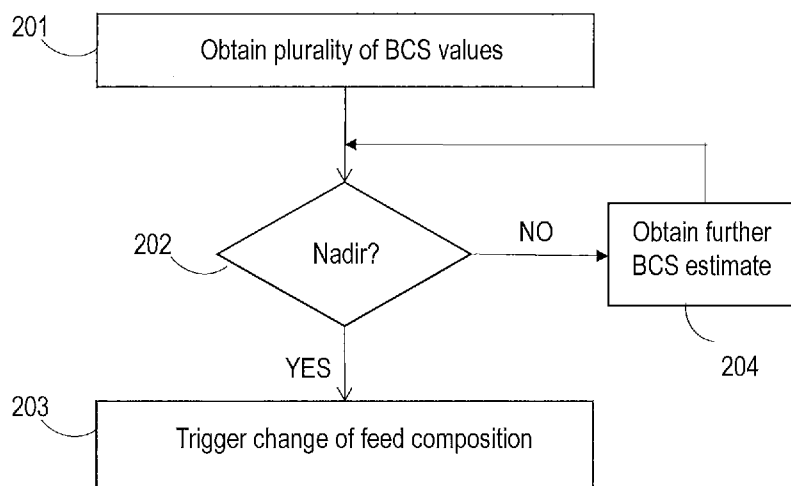


Figure 2

(57) Abstract: The invention relates to a control unit (601), a method and an arrangement for animal feeding management. The method, which is to be performed by the control unit (601), comprises obtaining a plurality of BCS estimates for an animal (603) from a BCS device operable to automatically derive a BCS estimate of an animal (603). The plurality of BCS estimates represent different points in time during a post-parturition period of the animal (603). The method further comprises determining that the animal (603) has reached Nadir based on the obtained plurality of BCS estimated, and in response, triggering a change of feed composition for the animal (603).



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METHOD AND ARRANGEMENT FOR ANIMAL FEEDING MANAGEMENT

TECHNICAL FIELD

The invention relates to a method and an arrangement for animal feeding management, in particular for feed management of animals based on their body condition.

5 BACKGROUND

Successful impregnation of female animals is one of the main factors and challenges of running a profitable animal herd, such as a dairy herd. It is, therefore, very important for an animal keeper to detect when an animal is in heat, in order to inseminate the animal at the correct time. Further, a healthy animal is more prone to successful insemination, e.g. Artificial
10 Insemination, AI, than a less healthy one. Therefore, it is also important to promote animal health to increase successful impregnation.

There are different methods for evaluating various health conditions of an animal. For example: visual inspection, weighing, and/or observation of milk yield, milk quality, feed consumption, activity, etc., could be used to collect indications of the animal health. One
15 method for evaluating body energy resources of an animal is so-called Body Condition Scoring, BCS. In other words, BCS is a method of evaluating fatness or thinness in animals, such as cattle, according to a scale (range of values), e.g. a five-point scale. When using a five-point scale, a score of one, "1", denotes a very thin animal, while a score of five, "5", denotes an excessively fat, or obese, animal.

20 Thus, a BCS estimate for an animal should reflect the body energy resources, or body condition, of the animal. The scale (range of values) used for the BCS differs e.g. between countries, and there are at least a five (5), an eight (8) and a ten (10) point scale. Irrespectively of which scale that is used, low values always reflect emaciation (thinness) and high values equate to obesity (fatness). Body condition scoring is often considered better for
25 monitoring body energy reserves than body weight. Body weight can change due to changes in e.g. body fat, gut size, udder size, pregnancy status, and intake of food and water. Body condition scoring, however, does not vary in the same manner with changes in these parameters. Traditionally, BCS has been performed based on visual and tactile inspection by professional scorers or skilled farmers, but use of 3D imaging technology has now made it
30 possible to derive BCS estimates in an automatic manner.

Research and field experiments have shown that the body condition of an animal influences productivity, re-production and longevity. In regard of BCS values, some studies have resulted in certain recommendations of desired, or "ideal", BCS values in different phases of an animal's life, such as e.g. during a period of lactation. Figure 1 show an example of

recommended BCS values for certain types of cows during a lactation cycle. By controlling the energy contents of the feed given to an animal, an animal keeper can try to align the body condition of the animal with a desired value or level, and thereby make the animal more susceptible to conception by insemination.

5

SUMMARY

High conception rates are desired when running a herd comprising female animals.

Therefore, it is desired to improve the fertility of female herd animals. An object of the invention is to improve the fertility of female animals for which BCS can be used, in a more efficient and successful manner than in the prior art. A method and an arrangement are provided for achieving this object.

10

Research and field experiments have shown that the body condition of an animal influences productivity, re-production, health and longevity. Thus, thinness or fatness can indicate underlying nutritional deficiencies, health problems, or improper herd management. By performing of BCS on animals in a herd on a regular basis, problems may be detected based on the results, and actions may be taken to improve the health of the herd.

15

Providing adequate feed to animals is an important aspect of animal management. It is identified that a certain time after parturition, when the animal regains its energy balance, is an important time for the fertility of an animal. For example, it is only after this time that the animal again may become susceptible to conception. It is also identified that starting to provide a feed composition which is composed for stimulating ovum quality and successful implantation of an embryo at or around this time promotes high conception rates.

20

In other words: promoting good fertility of female animals leading to high conception rates is a very important task for animal keepers. An object of embodiments of the invention is to promote animal fertility by enabling precision feeding and thereby make the animal more susceptible to conception, e.g. by artificial insemination.

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According to a first aspect, a method is provided for animal feeding management. The method comprises obtaining a plurality (time series) of BCS estimates for an animal from a BCS device operable to automatically derive a BCS estimate of an animal. The plurality of BCS estimates represent different points in time during a post-parturition period of the animal. The method further comprises determining that the animal has reached Nadir based on the obtained plurality of BCS estimated, and in response, triggering a change of feed composition for the animal.

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According to a second aspect, a control unit for animal feeding management is provided. The control unit is configured to obtain a plurality of BCS estimates (time series) for an animal from a BCS device operable to automatically derive a BCS estimate of an animal. The plurality of BCS estimates represent different points in time during a post-parturition period of the animal. The control unit is further configured to determine, based on the obtained plurality of BCS estimates, that the animal has reached nadir; and to, in response, trigger a change of feed composition for the animal.

According to a third aspect, an arrangement for feeding management of an animal is provided. The arrangement comprises a control unit according to the second aspect, and an identification unit configured to provide a unique identification of the animal. The arrangement further comprises a BCS device, configured to automatically derive a BSC estimate of the animal, and to provide the BCS estimate to the control unit.

According to a fourth aspect, a computer program is provided, which comprises instructions which, when executed on at least one processor, cause the at least one processor to carry out the method according to the first aspect.

According to a fifth aspect, a carrier is provided, which contains the computer program according to the fourth aspect. The carrier is one of: an electronic signal, an optical signal, a radio signal, or a computer readable storage medium.

BRIEF DESCRIPTION OF DRAWINGS

The foregoing and other objects, features, and advantages of the technology disclosed herein will be apparent from the following more particular description of embodiments as illustrated in the accompanying drawings. The drawings are not necessarily to scale, emphasis instead being placed upon illustrating the principles of the technology disclosed herein.

Figure 1 is a diagram illustrating reference BCS values for cows on a five point scale.

Figures 2-4 are flow charts illustrating a method for animal feeding management according to exemplifying embodiments.

Figures 5a-5c are schematic block diagrams illustrating different implementations of a control unit, CU, according to exemplifying embodiments.

Figure 6 shows an arrangement comprising a control unit, an identification unit and a BCS device, according to an exemplifying embodiment.

DETAILED DESCRIPTION

As previously mentioned, high conception rates are desired when running a herd comprising female animals. Therefore it of great interest to promote the fertility of the animals within the herd. There are known methods for promoting fertility, e.g. striving for the animals to have a recommended BCS. However, even if succeeding in keeping a herd with healthy body conditions, it is still desired to improve fertility and the number of successful inseminations even more. Thus, further measures to promote fertility within an animal herd are desired

Animal health can be positively affected by giving the animals adequate feed. However, it is not an easy task for a herdsman to know what feed is adequate at a certain time, nor to provide adequate feed at the right time to the right animals. Modern dairy farms often have quite large herds, some even have more than 10 thousand animals. Managing large herds is a challenge, e.g. since it is difficult to take notice of and attend to each individual animal according to its needs.

It has been identified that fertility of female dairy animals can be improved by changing the feed composition given to the animal at or around a certain point or period after parturition when the animal regains its energy balance. This point or period is reflected by a turn in the BCS profile of the animal, and indicates a transition between a negative energy balance and a positive energy balance. In other words, the BCS values of the animal will, typically, decrease over time after parturition until the animal regains its energy balance (and then start to increase). This point or period of regained energy balance is referred to as "Nadir", and is reached by dairy cows within an interval of 40-100 days after parturition. Nadir may be expressed as being reached e.g. after a number of Days In Milk, DIM, or to be reached a number of days after parturition.

Thus, by monitoring the BCS curve of an animal, this point or period, Nadir, may be anticipated and detected, and the feed composition given to the animal can be changed at the right time with high precision. This is very advantageous and improves the fertility of the animals and thus the number of successful inseminations. According to embodiments of the invention, such automatic detection of Nadir and control of feed composition can be accomplished in a completely automatic manner, which is an enormous help for an animal keeper, especially for large herds.

As an example of what is meant by changing the feed composition of the animal, the feed can be changed from a more so-called glucogenic feed composition, given during the period after parturition, to a more so-called lipogenic feed composition at or around Nadir.

By "glucogenic" is meant, very simplified, that the feed composition is composed to stimulate so-called gluconeogenesis, which is a metabolic pathway that results in the generation of glucose from certain non-carbohydrate carbon substrates. It has been identified that a more glucogenic (than lipogenic) feed composition improves the energy balance and decreases plasma ketone body concentration in dairy cows during early lactation. Examples of feed components that may be comprised in a more glucogenic, or "fat mobilizing", feed composition are e.g. starch, corn and propylene glycole.

By "lipogenic" is meant, very simplified, that the feed composition is composed to stimulate lipogenesis, which is a biochemical process by which organisms produce e.g. fatty acids from acetate. Examples of feed components that may be comprised in a lipogenic feed composition are dietary fat, and fiber, which is fermented to acetate and butyrate. Diets which are high in fiber and low in starch increase the acetate-to-propionate ratio. Propionate is the major precursor for gluconeogenesis, whereas acetate is a main precursor for de novo lipogenesis.

Thus, the feed composition could be changed by increasing the lipogenic-to-glucogenic nutrient ratio for the animal at or around Nadir. This could be done by reducing an amount of starch and/or corn given to the animal, and increasing an amount of fermented fibre and/or fat given to the animal. The change of feed composition in association with Nadir has been identified to stimulate ovum quality and also successful implantation of an embryo after insemination.

Within this description, cows will be used as the exemplifying animal. The invention is, however, also applicable for other types of (non-human) mammals, for which BCS may be used. Examples of such animals are e.g. buffalo, pigs, goats, sheep, camels, horses, etc.

Below, animal energy balance and BCS will be described in more detail.

The five-point BCS system was developed to measure the relative amount of subcutaneous body fat of animals. Most body condition scoring systems in dairy cattle use the five-point scoring system with quarter point increments. Instructions for a body condition scoring system have been devised to assess the body condition of a dairy cow at any point during the production cycle. The parts typically considered for BCS, at least of dairy cows, are the thoracic and lumbar regions of the vertebral column (chine, loin and rump), spinous processes (loin), tuber sacrale (hooks), tuber ischii (pin bones), and anterior coccygeal vertebrae (tail head). Use of only a single factor may be misleading, while considering all factors together provides an accurate score.

Figure 1 illustrates an inter-calving profile of BCS values for a cow. As previously mentioned, the body condition score of a cow may be assumed to decrease from the time of calving to 40-100 days after calving, when she reaches Nadir.

Three different values: the BCS value of a cow at calving; the BCS value of a cow at Nadir; and the amount of BCS value a cow loses post-calving, are associated with (have implications on, affects) e.g. milk production, reproduction, and health. Although the actual strength of the association may vary, there is relative consistency in the associations among calving BCS; Nadir BCS, and post-calving BCS change, on milk production; postpartum anestrus; the likelihood of a successful pregnancy and days open; the risk of uterine infection; and the risk of metabolic disorders. For many production and health variables, the association with BCS is nonlinear. For example, an optimum calving BCS value may be e.g. 3.0 to 3.25 (5-point scale) for certain breeds of dairy cows. For these breeds, a lower calving BCS (lower than optimum) is associated with reduced production and reproduction, whereas a calving BCS ≥ 3.5 (5-point scale) is associated with a reduction in early lactation dry matter intake and milk production and an increased risk of metabolic disorders.

The body condition, as measured with BCS, of a normal healthy cow fluctuates over time, and especially during periods of lactation, as can be seen in figure 1. At calving, a recommended body condition score value for certain breeds may be e.g. 3.25 to 3.75 (on a 5-point scale), or somewhat lower. At early lactation, the cow increases the production of milk until peak milk production is reached. During this period the cow uses its body reserves, (i.e. previously stored energy), to get the energy needed, as food intake will lag behind requirements, at least in the first six to eight weeks of lactation. It is desired to have a loss in the body condition of no more than 0.5 to 0.75 (on a 5-point scale) in early lactation. At mid-lactation, the body condition score should slowly increase to reach the same recommended value as at calving, i.e. of e.g. 3.25 to 3.75 (on a 5-point scale), at the end of late lactation.

Exemplifying embodiments of method, figures 2-4

Below, exemplifying embodiments of a method will be described with reference to figures 2-4. The embodiments are intended to be performed by a control unit which preferably constitutes a part of an arrangement for animal feeding management. The control unit and the arrangement will be described in more detail further below in association with figures 5 and 6.

The identity of the animal, for which BCS estimates are obtained below, is assumed to be accessible to the control unit. For example, identity information may be obtained as part of information from a BCS device, also comprising the BCS estimates, or, e.g. be obtained

separately as information from an ID reading device with a time stamp, and possibly an indication of location. Such information from an ID reading device could then be matched to a specific BCS estimate based e.g. on a corresponding time indication.

The animal may be assumed to be a female mammal of a species for which BCS can be applied. The animal is preferably, but not necessarily, a dairy animal (kept for milk production).

Figure 2 shows an exemplifying method embodiment for animal feeding management. The method illustrated in figure 2 comprises the action 201, of obtaining a plurality of BCS estimates for an animal from a BCS device. The BCS device may be assumed to be operable to automatically derive a BCS estimate of an animal. The BCS device may derive the BCS estimate based e.g. on an image, such as a two-, or three-dimensional image of at least a part of the animal. The obtained plurality of BCS estimates represent different points in time during a post-parturition period of the animal. The plurality of BCS estimates could alternatively be described as constituting or being comprised in a time series of BCS estimates for an animal during a post-parturition period of the animal.

The method further comprises the action 202 of determining, or detecting, based on the obtained plurality of BCS estimates, that the animal has reached Nadir. As mentioned earlier, Nadir is a point or period in time, after parturition, when the animal regains its energy balance. The detection of that Nadir is reached is illustrated in figure 2 as the action 202 resulting in "YES". Action 202 is illustrated as an evaluation of whether Nadir is reached or not, based on the obtained plurality of BCS estimates. The method illustrated in figure 2 further comprises the action 203 of triggering a change of feed composition for the animal. Action 203 is to be performed in response to the determining of that the animal has reached Nadir.

For the sake of completeness, an exemplifying implementation of the case when Nadir has not yet been reached is also illustrated in figure 2. When the evaluation 202 results in that it is determined that Nadir is not yet reached (202 resulting in "NO"), a further BCS estimate may be captured, e.g. after a certain time period, in an action 204. The new BCS estimate may then become part of the plurality of obtained BCS estimates and be included in a next evaluation 202.

The obtaining 201 of a plurality of BCS estimates may be implemented as receiving e.g. messages, reports or indications from the BCS device, assuming the BCS device and the control unit are operable to communicate and that they are connected e.g. via wire or wirelessly, or a combination thereof. The BCS estimates may be derived by the BCS device

at certain events, such as e.g. at milking occasions, feeding occasions or other, depending on where a sensor of the BCS device is located or mounted. A BCS estimate for a specific animal could be derived by the BCS device e.g. once or twice a day or more often; or, every other day or more seldom. The derived BCS values could then be provided to the control unit, and be obtained by the control unit, either in association with that the estimate is derived or e.g. more seldom, such as once a day or in response to a request from the control unit, i.e. be retrieved by the control unit. In other words, more than one BCS estimate for a specific animal could be obtained by the control unit at a certain occasion.

The determining 202, or detecting, of that the animal has reached nadir may be implemented in different ways. For example, a difference between adjacent or consecutive (in time) BCS estimates may be calculated, possibly corrected with respect to differences in time elapsed between the deriving of different BCS estimates (if they are not derived with approximately similar intermediate time intervals). This difference could then be compared with a threshold value, such that when the difference between two consecutive values is smaller than the threshold value, this is interpreted as that the animal has reached Nadir. This also corresponds to calculating or deriving the slope or inclination of a straight line fitted to the consecutive BCS estimates in the time-BCS space. Alternatively, another mathematical function (than a straight line) can be fitted to more than two BCS estimates, and the slope (inclination) of the mathematical function can be derived and analysed for a time of interest. This time of interest could be the time since the latest BCS estimate comprised in the last evaluation 202, and/or the time about the deriving, and obtaining, of the latest BCS estimate (not comprised in the last evaluation 202). The slope of the mathematical function could be analysed over the time corresponding to the whole series of BCS estimates. Alternatively, or in addition, by using e.g. extrapolation of the mathematical function and analysing the slope in the extrapolated interval, the reaching of Nadir could be predicted. When predicting reaching of Nadir, this could be verified when BCS estimates for the predicted time of Nadir have been obtained 204 and evaluated 202.

The reaching of Nadir may be detected by that the slope, which may be determined e.g. by calculating a derivative, of a mathematical function fitted to the plurality of BCS estimates takes on a value around zero, "0". This could also be expressed e.g. as $|f'(x)| < |T_{\text{thresh}}|$, where $f'(x)$ denotes the derivative of the function $f(x)$ fitted to the plurality of BCS estimates; the variable "x" represents time after parturition, and "Tthresh" is a threshold value/interval around zero, as $T_{\text{thresh}} = 0 \pm d$. The value of "d" may be selected based e.g. on which precision that is desired for the decision or how early it is desired to measure reaching of Nadir. In other words, when a slope/derivative of a mathematical function fitted to the

plurality of obtained BCS estimates meets a threshold, it could be determined that the animal in question has reached Nadir.

Figure 3 shows an exemplifying embodiment in more detail, which comprises some of the features described above. For example, it comprises the action 303 of fitting a mathematical function to BCS estimates obtained in actions 301 and 302 (and later also in action 307). The embodiment further comprises an action 304 of analysing the slope of at least part of the mathematical function, and then determining 305 whether the slope meets a threshold, e.g. falls within a predefined range around zero. When the slope meets the threshold, it can be determined that the animal has reached Nadir, and a change of feed composition can be triggered 206. When the slope does not meet the threshold, one or more new BCS estimates can be obtained from the BCS device in an action 207.

The triggering of a change of feed composition for the animal may be implemented in different ways. For example, the animal could be reassigned from a first feed group to a second feed group, e.g. where the second feed group is given a more lipogenic feed composition than the first feed group. Such reassignment could be achieved e.g. by that the control unit sends a message comprising an animal ID and possibly an indicator of reached Nadir, to another entity controlling the feeding of animals, or by rewriting a register used as information of group belongings of animals for feeding. The indicator or register post of reached Nadir should then be interpreted, or recognized, by another entity as a trigger for change of feed composition. Alternatively or in addition, the control unit could provide instructions related to the change of feed composition to an animal feeding equipment operatively connected to the control unit. Thus, for example, a feed wagon or other feed dispenser could provide the correct feed composition to the animal. Alternatively or in addition, the control unit could change a feed instruction associated with the animal in a database and/or indicate to another entity, to a user interface, and/or in a database, that the animal has reached nadir.

Figure 4 illustrates a variant of the exemplifying method embodiments illustrated in figures 2 and 3. Actions 401-403 and 405 may correspond to actions 201-204 in figure 2, and to actions 301-307 in figure 3. When it has been determined in an action 402 that Nadir has not been reached, it is evaluated in an action 404 whether the post-parturition period (i.e. the time period elapsed since the parturition) associated with, or represented by, the obtained BCS estimates, exceeds a predefined threshold value. When it is determined 404 ("YES") that the post-parturition period associated with the obtained plurality of BCS estimates meets, e.g. exceeds, the predefined threshold value, an indication of late Nadir is triggered for the animal in an action 306. Then, one or more new BCS values may be obtained in

action 405. When the post-parturition period is determined not to meet, e.g. to fall below, the predefined threshold value, i.e. to still be within an acceptable or expected range, one or more new BCS values may be obtained in action 405.

The embodiment shown in figure 4 further (in addition to what is comprised in the previously described embodiments) comprises the action, or feature, 302 of triggering an indication of late Nadir, e.g. an alarm or an alert signal, when the animal has not been determined to have reached Nadir within a certain time from parturition. For example, it may be desired to trigger an indication when Nadir has not been reached after 10-14 weeks. The time limit for when such an indication should be triggered may be set individually per animal, e.g. based on historical data for that animal, or for a group of animals, e.g. based on statistics for a certain group, breed or age. The time limit may be expressed e.g. as a maximum number of days in milk, as Dmax, illustrated in figure 3. The feature of indicating late Nadir can be implemented in any of the previously described embodiments.

In fully automatized systems, the triggering (203, 306, 403) of a change of feed composition will lead to a changed feed composition being provided to the animal without need for any human interaction. An indication of that the feed composition has been changed and/or that Nadir has been reached for the animal could, in addition, be provided to a responsible person or written in a database/register, if desired. In a less automatized system, e.g. when no automatized feeding equipment is available, the triggering of change of feed composition may result in an indication of that Nadir is reached and/or that the feed composition should be changed, is being provided to a user interface and/or a database, such as a file or register.

Exemplifying embodiments of control unit, figures 5a-5c

An exemplifying embodiment of a control unit is illustrated in a general manner in figure 5a. The control unit is operable to be part of a system or arrangement for animal feeding management. The control unit, which may alternatively be denoted e.g. "control device", may with advantage be implemented in, or as part of, a stationary or mobile computer, which is operable to communicate with a BCS device and other entities comprised e.g. in a feeding management system. The control unit may be a so-called system controller, SC, in, or otherwise associated with, a barn or other environment where animals are kept. The communication between the control unit and other entities may be performed over a wireless and/or wired interface. The control unit 500 could alternatively be implemented as part of the BCS device or as part of a feeding equipment (cf. BCS device 604 and feeding equipment 605 in figure 6). The control unit 500 is configured to perform the actions associated with a control unit of at least one of the method embodiments described above with reference to any of figures 2-4. The control unit 500 is associated with the same technical features,

objects and advantages as the previously described method embodiments. The control unit will be described in brief in order to avoid unnecessary repetition.

The control unit may be implemented and/or described as follows:

The control unit 500 comprises processing circuitry 501 and a communication interface 502.

- 5 The processing circuitry 501 is configured to cause the control unit 500 to: obtain a plurality of BCS estimates for an animal from a BCS device, the plurality of BCS estimates representing different points in time during a post-parturition period of the animal. The BCS device may be assumed to be operable to automatically derive a BCS estimate of an animal. The processing circuitry 501 is further configured to cause the control unit 500 to determine, based on the obtained plurality of BCS estimates, that the animal has reached Nadir, i.e. regained its energy balance after parturition. The processing circuitry 501 is further configured to cause the control unit 500 to trigger a change of feed composition for the animal in response to the determining of that Nadir is reached. The control unit 501 should be operable and configured to obtain data from the BCS device, and also operable and configured to evaluate a time series of BCS estimates. The control unit 501 should also be operable and configured to trigger a change of feed, e.g. by providing an indication or instruction to a feeding equipment, writing it in a database or provide it to a user interface, such as a display. Thus, the communication interface 502, which may also be denoted e.g. Input/Output (I/O) interface, includes an interface for sending data to and receiving data from other nodes or entities, such as a BCS device 604.

Figure 5b shows an embodiment of the processing circuitry 501 which comprises a processing device 503, such as a general-purpose microprocessor, e.g. a CPU, and a memory 504, in communication with the processing device, that stores or holds instruction code readable and executable by the processing device. The instruction code stored or held in the memory may be in the form of a computer program 505, which when executed by the processing device 503 causes the control unit 500 to perform the actions in the manner described above.

An alternative implementation of the processing circuitry 501 is shown in figure 5c. The processing circuitry here comprises an obtaining unit 506 for causing the control unit to obtain a plurality of BCS estimates for an animal from a BCS device, the plurality of BCS estimates representing different points in time during a post-parturition period of the animal. The processing circuitry further comprises a determining unit 507 for causing the control unit to determine, based on the obtained plurality of BCS estimates, that the animal has reached Nadir, i.e. regained its energy balance after parturition. The processing circuitry further

comprises a triggering unit 508, for causing the control unit 500 to trigger a change of feed composition for the animal in response to the determining of that Nadir is reached.

The processing circuitry 501 could comprise more units configured to cause the control unit to perform actions associated with one or more of the method embodiments described

5 herein. Alternatively, any of the units 506-508 could also be configured to cause the control unit to perform such other actions. The control unit 500 could, for example, comprise a detecting unit 509 for detecting whether the time to Nadir exceeds a predefined time limit.

The control unit 500 could further comprise a memory for storing obtained BCS estimates and/or reference data related to time limits other thresholds. This, and other tasks, could

10 alternatively be performed by one of the other units.

The control unit 500 may be assumed to comprise further functionality, for carrying out regular control unit functions.

The foregoing description of a control unit 500 is not intended be limiting. The processing circuitry may also be implemented by other techniques known in the art, such as, e.g., hard-
15 wired transistor logic or application-specific integrated circuits arranged in a manner sufficient to carry out the actions of the control unit 500 as described above.

Exemplifying embodiments of arrangement, figure 6

Figure 6 illustrates an arrangement 600 for feeding management of an animal 603 (animal not comprised in arrangement). The arrangement comprises a control unit 601, as the ones
20 described above, and an identification unit 606 configured to provide a unique identification of the animal 603, e.g. to the control unit. The arrangement also comprises a BCS device 604, configured to automatically derive a BSC estimate of the animal based e.g. on a two-, or three-dimensional image, and to provide the BCS estimate to the control unit 601. The identification unit 606 could alternatively be denoted e.g. "ID reader", and may derive the
25 identity of the animal e.g. by reading an RFID tag 602 attached to the animal, or by some other known method for identifying animals. The identification unit then provides the unique identification of the animal to the control unit or to the BCS device, depending on implementation.

The BCS device 604 preferably comprises a sensor for capturing a two- or three-dimensional
30 image of an animal, based on which the BCS estimate may be derived. The sensor may be optical, using reflection of light of suitable frequency, such as a time of flight camera (3D), but could alternatively use e.g. ultrasound to obtain images. The BCS device may comprise more than one sensor (not illustrated). For certain animal types, such as goats, more than one sensor may be used, since the BCS of goats typically includes evaluation of both the

lower back (as for cows) and the sternum area. The BCS device should be located and mounted such that images can be obtained of the relevant parts of the animals in question, e.g. at a milking stall where animals stand while being milked.

The arrangement 600 may further comprise other devices, such as feeding equipment 605.

- 5 This could be a complete feeding system or an automatic feed dispenser. The feeding equipment 605 could then obtain indications or instructions from the control unit 601 and execute a change of the feed composition provided to the animal. Alternatively, the feeding equipment 605 may obtain information from a database 608 concerning the change of feed composition, where the database 608 comprises information or instructions provided by the control unit 601.
- 10

The arrangement 600 could also comprise or be operatively connected to entities such as a PC 607 or to a network 609, such as the Internet and/or radio access systems, with all the possibilities associated with such networks in terms of connecting to mobile and remote devices 510.

- 15 To summarize, the steps, functions, procedures, modules, units and/or blocks described herein may be implemented in hardware using any conventional technology, such as discrete circuit or integrated circuit technology, including both general-purpose electronic circuitry and application-specific circuitry. Alternatively, at least some of the steps, functions, procedures, modules, units and/or blocks described above may be implemented in software such as a computer program for execution by suitable processing circuitry including one or more processing units. The software could be carried by a carrier, such as an electronic signal, an optical signal, a radio signal, or a computer readable storage medium before and/or during the use of the computer program in the nodes.
- 20

- The flow diagram or diagrams presented herein may be regarded as a computer flow diagram or diagrams, when performed by one or more processors. A corresponding apparatus may be defined as a group of function modules, where each step performed by the processor corresponds to a function module. In this case, the function modules are implemented as a computer program running on the processor.
- 25

- It should also be understood that it may be possible to re-use the general processing capabilities of any conventional device or unit in which the proposed technology is implemented. It may also be possible to re-use existing software, e.g. by reprogramming of the existing software or by adding new software components.
- 30

The embodiments described above are merely given as examples, and it should be understood that the proposed technology is not limited thereto. It will be understood by those skilled in the art that various modifications, combinations and changes may be made to the embodiments without departing from the present scope. In particular, different part solutions
5 in the different embodiments can be combined in other configurations, where technically possible.

When using the word "comprise" or "comprising" it shall be interpreted as non-limiting, i.e. meaning "consist at least of".

It should also be noted that in some alternate implementations, the functions/acts noted in
10 the blocks may occur out of the order noted in the flowcharts. For example, two blocks shown in succession may in fact be executed substantially concurrently or the blocks may sometimes be executed in the reverse order, depending upon the functionality/acts involved. Moreover, the functionality of a given block of the flowcharts and/or block diagrams may be separated into multiple blocks and/or the functionality of two or more blocks of the flowcharts
15 and/or block diagrams may be at least partially integrated. Finally, other blocks may be added/inserted between the blocks that are illustrated, and/or blocks/operations may be omitted without departing from the scope of inventive concepts.

It is to be understood that the choice of interacting units, as well as the naming of the units within this disclosure are only for exemplifying purpose, and nodes suitable to execute any of
20 the methods described above may be configured in a plurality of alternative ways in order to be able to execute the suggested procedure actions.

It should also be noted that the units described in this disclosure are to be regarded as logical entities and not with necessity as separate physical entities.

CLAIMS

1. A method for animal feeding management, the method comprising:

5 -obtaining (201) a plurality of BCS estimates for an animal from a BCS device operable to automatically derive a BCS estimate of an animal; the plurality of BCS estimates representing different points in time during a post-parturition period of the animal;

-determining (202), based on the obtained plurality of BCS estimates, that the animal has reached Nadir; and, in response to this:

10 -triggering (203) a change of feed composition for the animal.

2. The method according to claim 1, wherein the determining of that the animal has reached nadir comprises:

-analyzing a slope of a mathematical function fitted to the plurality of BCS estimates.

3. The method according to claim 1 or 2, wherein the determining of that the animal has reached nadir comprises:

-comparing a slope of a mathematical function fitted to the plurality of BCS estimates with a threshold limit.

4. The method according to any of the preceding claims, wherein the animal is determined to have reached nadir when a slope of a mathematical function fitted to the plurality of BCS estimates has a value within a predefined range around zero.

5. The method according to any of the preceding claims, wherein the triggering of a change of feed composition for the animal comprises at least one of:

-reassigning the animal from a first feed group, to a second feed group;

-providing instructions related to the change of feed composition to an animal feeding equipment operatively connected to the control unit;

-changing a feed instruction associated with the animal in a database;

-indicating, to another entity, to a user interface, and/or in a database, that the animal has reached nadir and/or that the feed composition should be changed.

6. The method according to any of the preceding claims, wherein the feed composition is changed by an increase of a lipogenic-to-glucogenic nutrient ratio.

7. The method according to any of the preceding claims, further comprising:

-determining that the duration of the post-parturition period associated with the obtained plurality of BCS estimates meets a predefined threshold value (Dmax); and:

-triggering an indication of late Nadir for the animal.

8. A control unit (500) for animal feeding management, the control unit being configured to:

-obtain a plurality of BCS estimates for an animal from a BCS device operable to automatically derive a BCS estimate of an animal; the plurality of BCS estimates representing different points in time during a post-parturition period of the animal;

-determine, based on the obtained plurality of BCS estimates, that the animal has reached nadir; and [in response to this] to:

-trigger a change of feed composition for the animal

9. The control unit according to claim 8, being configured to determine that the animal has reached Nadir based on analysis of a slope of a mathematical function fitted to the plurality of BCS estimates.

10. The control unit according to claim 8 or 9, being configured to determine that the animal has reached Nadir based on comparing a slope of a mathematical function fitted to the plurality of BCS estimates with a threshold limit.

11. The control unit according to any of claims 8-10, being configured to determine that the animal has reached nadir when a slope of a mathematical function fitted to the plurality of BCS estimates has a value within a predefined range around zero.

12. The control unit according to any of claims 8-11, being configured to trigger a change of feed composition for the animal by at least one of:

-reassigning the animal from a first feed group, to a second feed group;

-providing instructions related to the change of feed composition to an animal feeding equipment operatively connected to the control unit;

-changing a feed instruction associated with the animal in a database;

-indicating, to another entity, to a user interface, and/or in a database, that the animal has reached nadir and/or that the feed composition should be changed.

13. The control unit according to any of claims 8-12, wherein the feed composition is changed by an increase of a lipogenic-to-glucogenic nutrient ratio

14. The control unit according to any of claims 8-13, being further configured to:

-determine that the duration of the post-parturition period associated with the obtained plurality of BCS estimates meets a predefined threshold value

(Dmax); and to, in response:

-trigger an indication of late Nadir for the animal.

15. An arrangement (600) for feeding management of an animal (603), which arrangement comprises:

a control unit (601) according to any of claims 8-14;

an identification unit (606) configured to provide a unique identification of the animal (603);

a BCS device (604), configured to automatically derive a BSC estimate of the animal, and to provide the BCS estimate to the control unit (601);

16. Computer program (905) comprising instructions which, when executed on at least one processor, cause the at least one processor to carry out the method according to any of claims 1-7.

17. A carrier containing the computer program of claim 10, wherein the carrier is one of an electronic signal, optical signal, radio signal, or computer readable storage medium.

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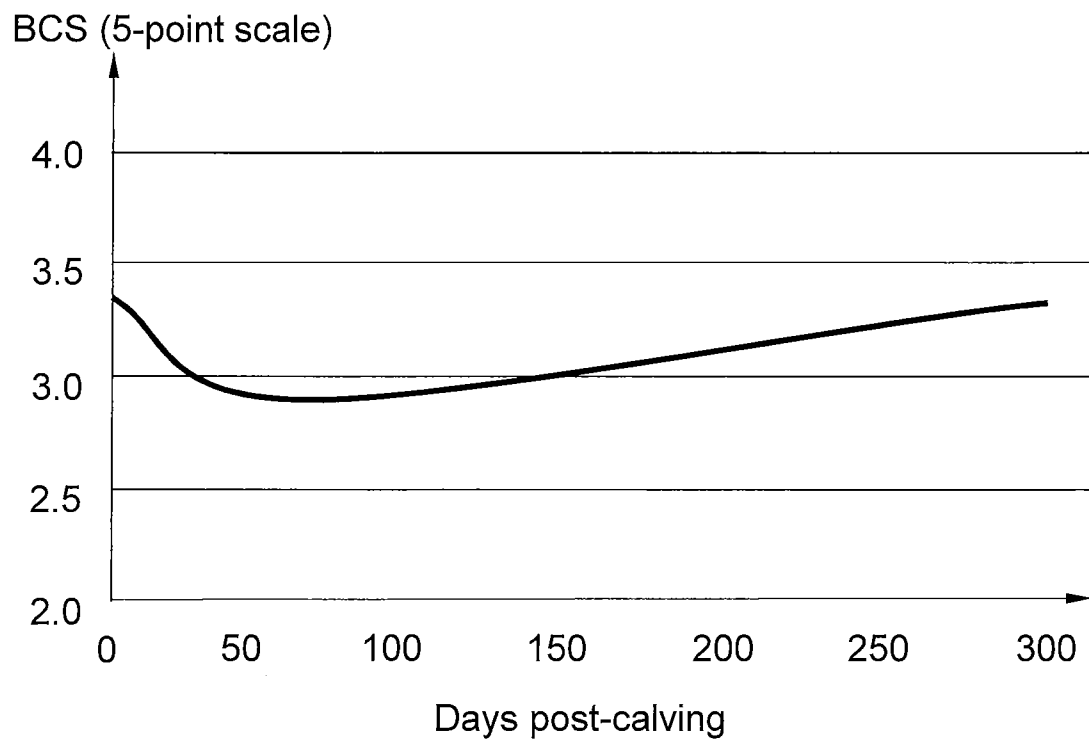


Figure 1

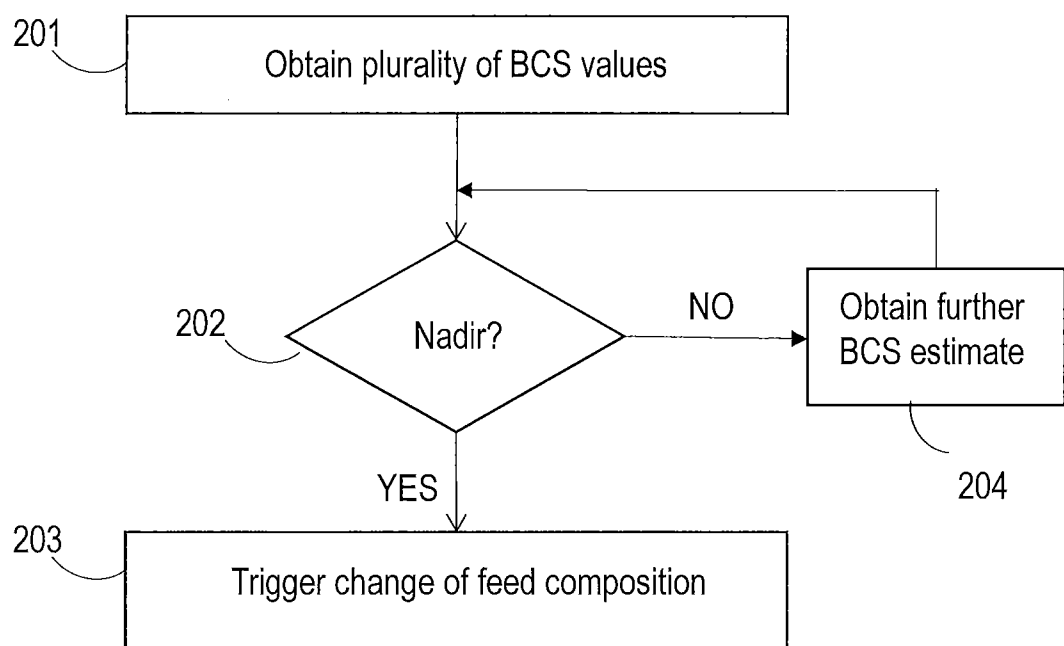


Figure 2

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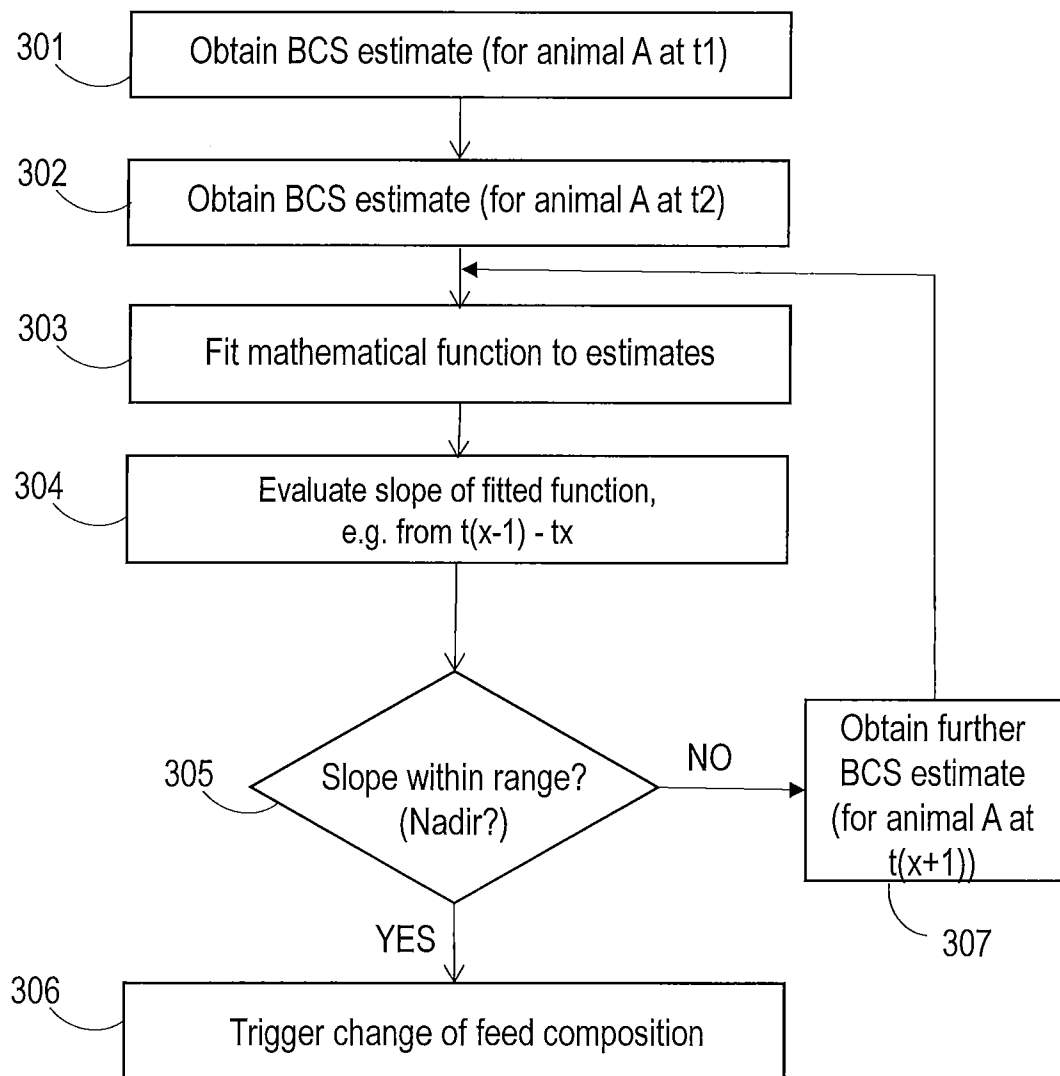


Figure 3

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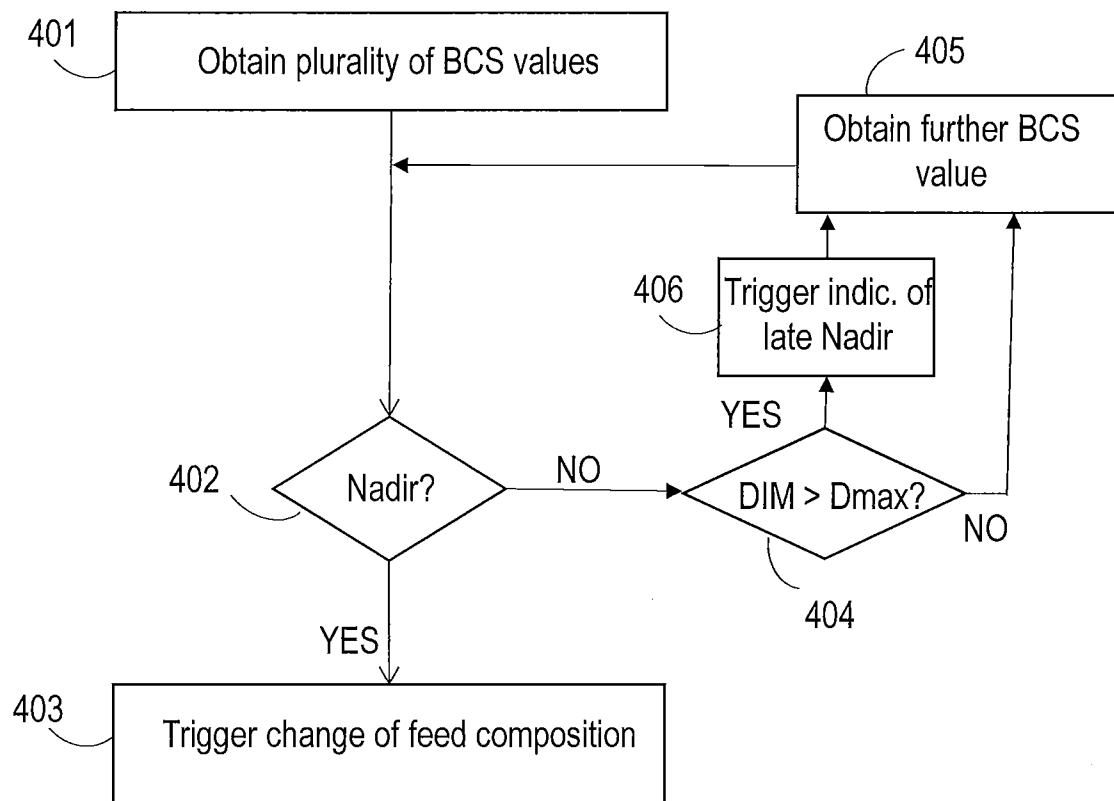


Figure 4

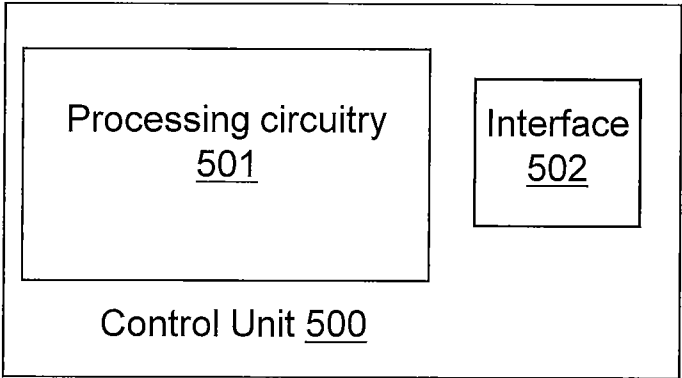


Figure 5a

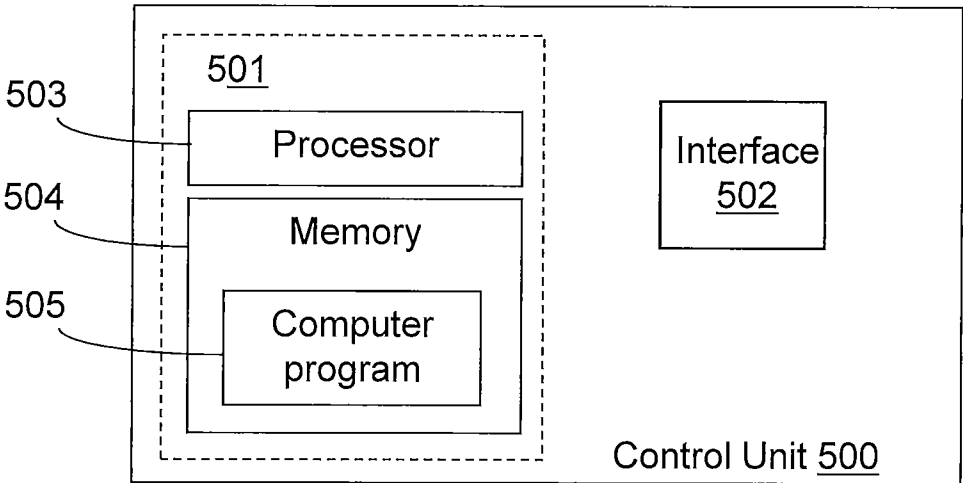


Figure 5b

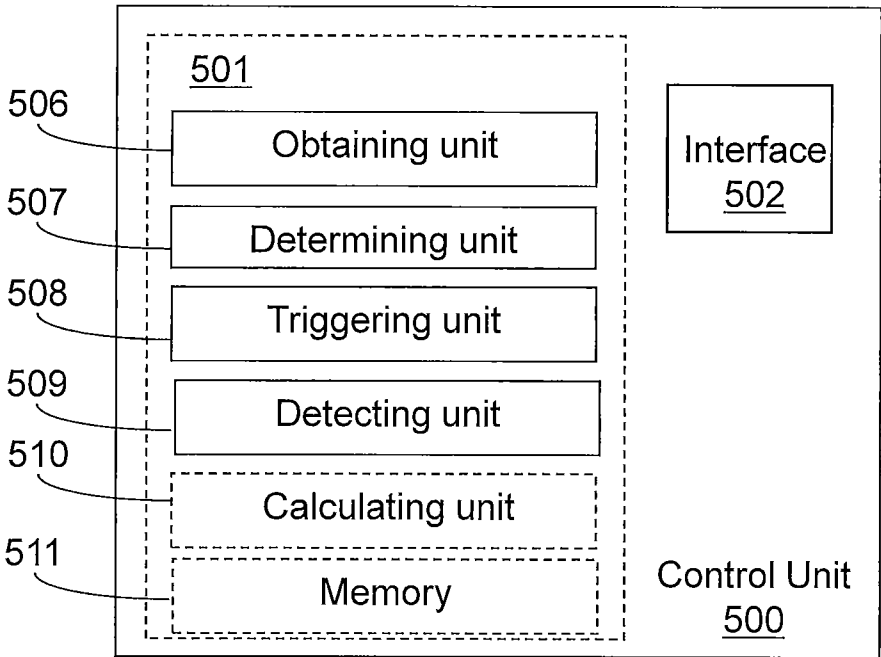


Figure 5c

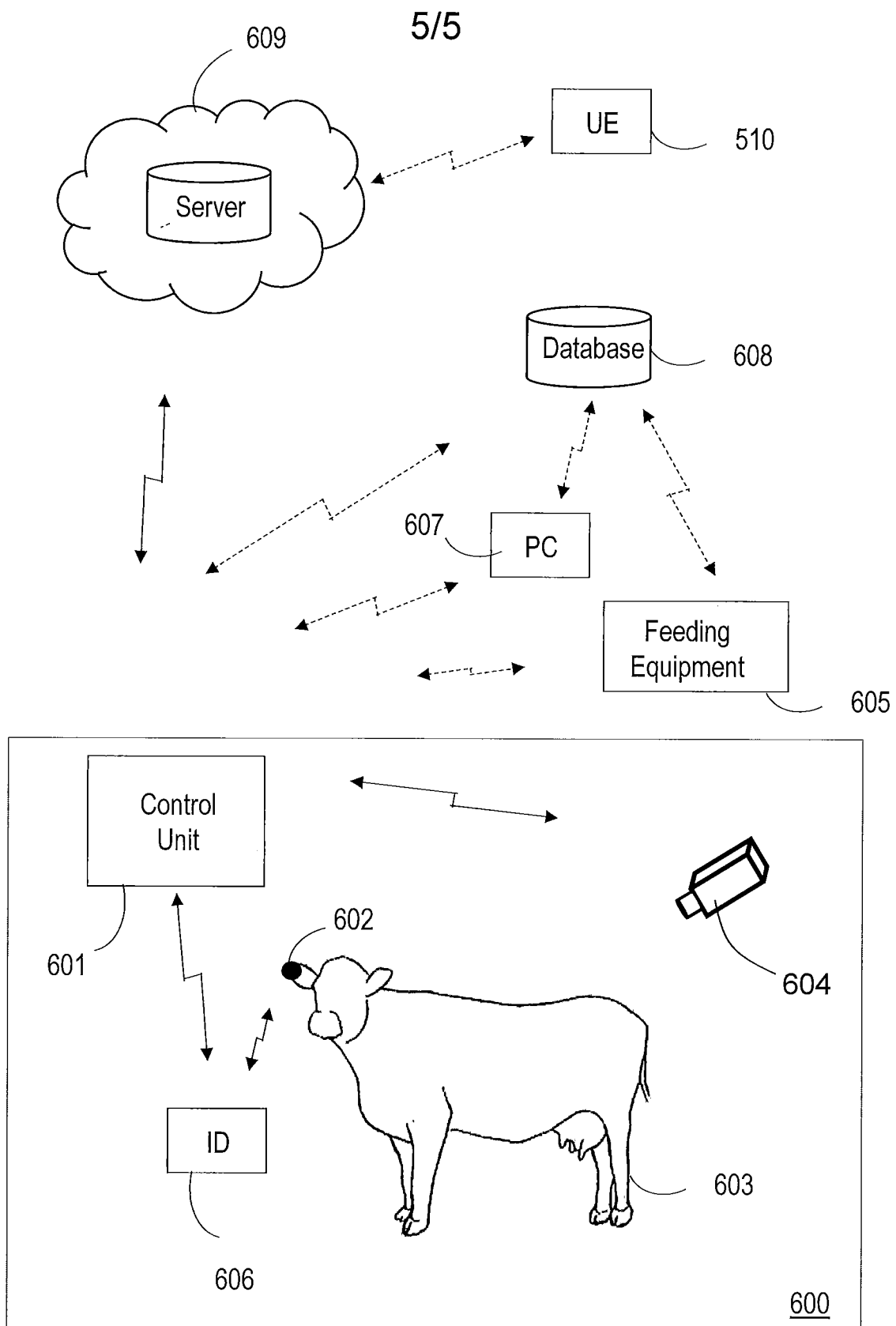


Figure 6

INTERNATIONAL SEARCH REPORT

International application No
PCT/SE2018/050037

A. CLASSIFICATION OF SUBJECT MATTER

INV. A01K5/00 A01K29/00 A01K11/00
ADD.

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)

A01K

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)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2011/279650 A1 (LIAO BOHAO [SE] ET AL) 17 November 2011 (2011-11-17) paragraphs [0055] - [0057], [0067] - [0069] figures 1, 5	1-17
A	----- US 2003/127057 A1 (SINGH BHAJMOHAN [US] ET AL) 10 July 2003 (2003-07-10) paragraphs [0081] - [0085] figure 5	1-17
A	----- CN 201 577 386 U (ZHONGYUE GUO) 15 September 2010 (2010-09-15) paragraphs [0011], [0021] figures 1-3 -----	1-17

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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"&" document member of the same patent family

Date of the actual completion of the international search

29 March 2018

Date of mailing of the international search report

11/04/2018

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/SE2018/050037

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