

## ON FARM MONITORING OF ANIMAL WELFARE AND ENVIRONMENTAL IMPACT AS A BASIS FOR QUALITY ASSURANCE PROGRAMMES\*

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### ABSTRACT

The welfare, health and management of farm animals as well as environmental concerns are relevant issues that impact the success of the producer in the market and need to be considered to increase public and consumer acceptance. Criteria for the assessment of housing and management systems have been proposed by several groups and minimal standards for animal welfare, hygiene and environmental stewardship are already implemented in the legislation of most European countries. Issues of animal welfare, health and environmental care are often dealt with separately. As it can be foreseen that housing and management conditions will be increasingly regulated in future, a documentation and certification process that safeguards all requirements is needed. Concepts for the assessment of animal housing and management according to welfare and environmental criteria are proposed as part of a quality assurance scheme according to international standards. Based on these concepts, critical control points (CCP) and critical management points (CMP) have been developed for the categories health, behaviour, management and environmental impact. These criteria were first established to be used primarily by the farmer as an internal on-farm assessment scheme. However, they can also serve as quality assurance criteria used by government agencies, consumer organisations and commodity groups that have an interest to evaluate, monitor and licence housing and management systems. The following paper reviews quality assurance issues using examples from existing concepts in Germany (Pig Housing and Management Assessment according to Welfare and Environmental Criteria) and the United States (California Dairy Quality Assurance Program).

Keywords: pigs / dairy cows / animal welfare / quality assurance / environmental care

## SPREMLJANJE POČUTJA ŽIVALI NA KMETIJI IN VPLIVOV NA OKOLJE KOT OSNOVA PROGRAMOV ZAGOTAVLJANJA KAKOVOSTI

### IZVLEČEK

Počutje in zdravje domačih živali ter gospodarjenje z njimi, pa tudi skrb za okolje, so dejavniki, ki vplivajo na uspeh proizvajalca na tržišču in jih je potrebno upoštevati za povečanje zaupanja potrošnikov. Merila za ovrednotenje rejskih sistemov in načinov gospodarjenja so predlagale že različne skupine. Minimalni pogoji za zagotavljanje dobrega počutja živali, higiene in varstva okolja so v večini evropskih držav že določeni z zakonodajo. Počutje živali, zdravje in skrb za okolje so pogosto obravnavani ločeno. V prihodnosti bodo pogoji reje in gospodarjenje vse bolj nadzorovani, zato je potrebno pripraviti dokumente in predpise, ki jamčijo izpolnjevanje teh zahtev. Predstavljajo načrt za določitev načina reje in gospodarjenja z domačimi živalmi v

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skladu z dobrim počutjem živali in varstvom okolja kot del jamstva kakovosti glede na mednarodne standarde. Na osnovi tega načrta so razvili kritične kontrolne točke (CCP) in kritične točke gospodarjenja (CMP) za dejavnike: zdravje, obnašanje, gospodarjenje in vpliv na okolje. Ta merila so bila prvotno razvita kot pomoč kmetom za ovrednotenje lastne kmetije. Lahko pa služijo tudi kot kriteriji zagotavljanja kakovosti vladnim agencijam, potrošniškim organizacijam in interesnim skupinam, ki želijo ovrednotiti, nadzorovati in izdajati dovoljenja za rejske in gospodarske sisteme. Prispevek je pregled meril zagotavljanja kakovosti v Nemčiji (Reja prašičev in gospodarjenje z njimi glede na počutje in varstvo okolja) in v ZDA (Kalifornijski program zagotavljanja kakovosti pri prirerji mleka).

Ključne besede: prašiči / krave / molznice / dobro počutje živali / kakovost / zagotavljanje kakovosti / varstvo okolja

## QUALITY ASSURANCE BASED ON THE HACCP PRINCIPLES

The Hazard Analysis and Critical Control Point (HACCP) concept was originally developed as a microbiological safety system to ensure food safety for astronauts. It was based on an engineering system called Failure, Mode and Effect Analysis (FMEA), which focuses on weaknesses at each operational stage including problem cause and effect (Mortimore and Wallace, 1998). Effective control mechanisms are then put in place to ensure that the potential failures are prevented from occurring. HACCP looks for hazards in the product-safety sense and will eventually become a legislative requirement for food safety and food hygiene in many countries. Noordhuizen and Welpelo (1996) addressed the principles of the HACCP concept in relation to animal health management strategy. They demonstrated that process control (expressed in terms of controlling both general and specific disease risk factors) and product control (expressed in terms of testing animals or animal products for specific disease agents) could form the basis for improving animal health. HACCP can be considered as a strategy of quality control at the level of production process and the resulting product. Wood *et al.* (1998) considered the consumers perception in relation to meat quality, food safety, animal welfare and sensory aspects as major features of quality assurance schemes that are based on HACCP principles or best practice rules. The Dutch Integrated Chain Control (IKB) program is based on elements of the quality assurance system ISO-9000 (Vesseur and Den Hartog, 2000) and has recently implemented husbandry practices and transportation requirements relevant to animal welfare (Dutch Meat Board, 2003). The National Pork Board in the United States introduced a Pork Quality Assurance Program in 1989 which emphasizes 10 management practices for handling of pigs and use of animal health products that are based upon HACCP principles and food and drug compliance policies. HACCP principles have been mainly implemented in slaughterhouses and in the meat processing sector. However, more recently, critical control points and HACCP-type audits for livestock transportation and pre-slaughter handling were established (Grandin, 2000; von Borell and Schäffer, 2002) and the US National Pork Board (2003) has implemented a Swine Welfare Assurance Program (SWAP) consisting of nine major Care and Well-being Principles (CWPs) indicative of on farm welfare conditions. Most welfare standards and auditing programmes in the USA are currently retail-driven by organisations like the National Council of Chain Restaurants and the Food Marketing Institute (Mench, 2003).

## PIG HOUSING AND MANAGEMENT ASSESSMENT BASED ON WELFARE AND ENVIRONMENTAL CRITERIA

### Prerequisites

Prerequisites for defining CCP are usually support systems that can be verified according to the same principles that relate to the HACCP system in general (see previous Chapter). In the

food processing sector these could be good manufacturing practice, supplier quality assurance and quality management systems. The development of assessment criteria and potential risks for animal housing and management should be based on sound scientific data, ensuring that the necessary parameters can be objectively measured and verified. Several of the control points for pig housing assessment proposed in the literature actually do not fulfil the formal criteria of a CCP as described in quality assurance and management textbooks. A CCP basically ensures that a certain process is absolutely under control (e.g., a procedure in meat processing intended to exclude bacterial contamination), whereas many of the critical points on housing assessment are intended to reduce and minimize a risk. For example, welfare can not be seen as an absolute state of well-being within strict limits as many factors contribute to this state in a rather gradual way within a continuum between good and bad. For many situations the combination of specific factors (i.e., minimal technical, social and animal care requirements) determines whether the welfare of an animal is at risk. HACCP principle 2 relates to "*points where control is critical to assuring the safety of the product*". In the context of housing assessment, a control point could relate to certain limits that are already defined (i.e., by legislation) or relate to measures intended to reduce the risk for impaired welfare, health and pollution control. A number of prerequisites are already established in existing technical standards and legislation (e.g., for pig welfare, disease control, security of housing installations and technical requirements for pollution control). Control points for pig welfare are mainly based on existing European legislation and on the current knowledge of good farming practice.

### **Control points for the assessment of pig housing**

The working group on "Animal Husbandry and Welfare" (von Borell *et al.*, 2001) has elaborated control points for all stages of pig housing from breeding to fattening pigs. Table 1 illustrates the CCP concept using assessment of housing for fattening pig as an example. The main assessment criteria to be controlled are based on behaviour, health, management and environmental impact. These control points could be either seen as critical management points (e.g., manure handling) or critical control points (e.g., temperature requirements), depending on whether or not they fulfil the formal requirements for the HACCP concept. Control points and goals (yes or no) are listed in the order in which they should be assessed (specified under interval: from basic requirements that need to be controlled prior to entry of pigs into the housing system to control points that need to be assessed at the end, after or between fattening periods). Assessment tools and methods for sampling are further explained in a separate list (not included in this paper). Categories of animal behaviour, health, management and environmental impact are ultimately influencing each other but are often handled separately. This can be explained by the different approaches and specific contributions from various scientific disciplines. Therefore, we have merged all categories together in one list. As welfare not only implies freedom from suffering in the sense of prolonged pain, fear, distress, discomfort, hunger, thirst, etc. we included control points for preventive health, and measures to assess injuries and malnutrition. Animal behaviour is considered a reliable and sensitive indicator through which the animal expresses basic needs, deficits and contentment in a given housing environment. As behavioural observations are difficult to perform by a short time on-farm assessment, we have to assess the prerequisites for allowing the animals to perform basic behaviours such as the provision of materials that allow exploratory behaviour.

Table 1. Check list with suggested control points for the housing of fattening pigs (emphasis on welfare, management and environment; modified from von Borell *et al.*, 2001)

CCP	Assessment Criteria	Interval	Goal
1	Buildings or rooms managed according to all-in/all-out principle?	B	Yes <input type="checkbox"/>
2	Cleaning and disinfection of rooms according to the specific on-farm condition?	B	Yes <input type="checkbox"/>
3	Origin of all pigs from a known producer?	B	Yes <input type="checkbox"/>
4	All pigs within a group born within the same week?	B	Yes <input type="checkbox"/>
5	Information and documentation from the piglet producer (i.e., vaccinations, feeding regime)?	B	Yes <input type="checkbox"/>
6	Do vaccinations fulfil the specific requirements?	B	Yes <input type="checkbox"/>
7	Monitoring and controlling of rodents?	B	Yes <input type="checkbox"/>
8	Provision of pens for sick animals (for 1% of pigs)?	B	Yes <input type="checkbox"/>
9	Climatic conditions in the building according to legal requirement and farm specific needs?*	S/B	Yes <input type="checkbox"/>
10	Fans in the building with a max. speed of 900 revolutions/min (low speed fans)?	B	Yes <input type="checkbox"/>
11	Controlled exhaust air discharge over fans?	B	Yes <input type="checkbox"/>
12	Exhaust air blown outside 1.5 m above middle of the ridge?	B	Yes <input type="checkbox"/>
13	Air supply via drop down channels or via feeding alley?	B	Yes <input type="checkbox"/>
14	Air exhaust under the floor with a min. distance of 0.5 m between manure and slatted floor?	B	Yes <input type="checkbox"/>
15	Separate drainage of liquid manure in deep bedding systems?	B	Yes <input type="checkbox"/>
16	Storage capacity for liquid manure (for a defined period)?	B	Yes <input type="checkbox"/>
17	Covered liquid manure storage or artificial layer over the entire surface (e.g., with chopped straw)?	B	Yes <input type="checkbox"/>
18	Provision of a separate lying area?	B	Yes <input type="checkbox"/>
19	Separate area for defecation, resting and feeding?	B	Yes <input type="checkbox"/>
20	Feeder design according to the number of animals in the group?	B	Yes <input type="checkbox"/>
21	Feeding hygiene according to the legal requirements?	B	Yes <input type="checkbox"/>
22	Adjusted diet composition according to the requirements during the fattening period?	B	Yes <input type="checkbox"/>
23	Drinker design according to the hygiene requirements?	B	Yes <input type="checkbox"/>
24	Water quality and amount according to requirements?	B	Yes <input type="checkbox"/>
25	Provision of grooming devices?	B	Yes <input type="checkbox"/>
26	Floor design according to legal requirements?	B	Yes <input type="checkbox"/>
27	Opportunity for thermoregulation, if applicable?	B	Yes <input type="checkbox"/>
28	No mixing of pigs during the fattening period?	B	Yes <input type="checkbox"/>
29	Hiding/escape opportunities?	B	Yes <input type="checkbox"/>
30	Licensed stockperson in charge of operation?	B	Yes <input type="checkbox"/>
31	Application of liquid manure close to the soil surface (e.g., by dragging hoses on grassland) or directly into soil?	R	Yes <input type="checkbox"/>
32	Use of performance data software?	R	Yes <input type="checkbox"/>
33	Performance data used for analysis of operation deficiencies?	R	Yes <input type="checkbox"/>
34	Effective worming treatment of pigs at entry?	E	Yes <input type="checkbox"/>
35	Scoring of pigs at entry?	E	Yes <input type="checkbox"/>
36	Unrestricted standing up and lying down?	E/F	Yes <input type="checkbox"/>
37	Cleanliness of perforated floor?	E/F	Yes <input type="checkbox"/>

continued overleaf

38	Passage of faeces through slots guaranteed?	E/F	Yes <input type="checkbox"/>
39	Provision of natural materials to allow for exploratory activities?	E/F	Yes <input type="checkbox"/>
40	Sufficient space according to legal requirements?	E/F	Yes <input type="checkbox"/>
41	Consideration of group composition?	E/D	Yes <input type="checkbox"/>
42	Dryness and cleanliness of the bedding material?	D	Yes <input type="checkbox"/>
43	Cleanliness of solid floor surface in partly slatted pens?	D	Yes <input type="checkbox"/>
44	No incidence of behavioural deviations?	D	Yes <input type="checkbox"/>
45	Health inspection by the stockperson?	D	Yes <input type="checkbox"/>
46	Functionality of technical installations?	D	Yes <input type="checkbox"/>
47	Preparation for shipment of slaughter pigs according to legal requirements?	F	Yes <input type="checkbox"/>
48	Feed back information from abattoir on lung and liver rejections?	C	Yes <input type="checkbox"/>
49	Documentation and analysis of performance data?	C	Yes <input type="checkbox"/>

B=Basic requirement (e.g., structural prerequisites), C=following each production cycle, E=at entry; D=daily, F=at the end of the fattening period, R=on routine, S=season (winter, summer, transition period).

\* Measurement requires methodological expertise and special monitoring equipment.

### Quality Assurance/Audits on Pig Transportation

Audits for the documentation of pig welfare during transport and at the abattoir have been proposed and tested for organic pig production in Denmark (Barton-Gade, 2002). Based on an on-farm assessment scheme that has been developed by a working group (von Borell *et al.*, 2001), an additional scheme has been proposed for the assessment of all pre-slaughter handling processes of pigs between farm and stunning area of the slaughter house (Schäffer and von Borell, 2002a,b,c; Schäffer and von Borell, 2003, 2004). Checklists that require mandatory answers contain critical control points (CCP) for transport execution including loading and unloading, resting in the waiting pen, driving to the restrainer and the stunning procedure. The following tables refer to CCPs that are proposed for the transport of pigs. These control points do specifically relate to the conditions in Germany; they might need to be adjusted for the situation in other regions or countries (e.g., vehicle and equipment requirements for transport).

Table 2. Checklist for transport assessment in pigs – critical control points (CCP) relating to vehicle requirements (Schäffer and von Borell, 2002a)

CCP	Assessment Criteria	Goal
1	Vehicle: single deck (solid top or tarp)?	Yes <input type="checkbox"/>
2	Double deck vehicle: lowering of upper deck?	Yes <input type="checkbox"/>
3	Double deck vehicle: manual unloading in case of emergency?	Yes <input type="checkbox"/>
4	Distance between neck of pigs and ceiling 25 cm?	Yes <input type="checkbox"/>
5	Elevator for unloading at the docking ramp?	Yes <input type="checkbox"/>
6	Partitions between individual pens?	Yes <input type="checkbox"/>
7	Separate access to individual pens?	Yes <input type="checkbox"/>
8	Non-slippery flooring material?	Yes <input type="checkbox"/>
9	Tachograph use?	Yes <input type="checkbox"/>
10	Provision of absorbent litter (summer)?	Yes <input type="checkbox"/>
11	Provision of straw (winter)?	Yes <input type="checkbox"/>
12	Availability of mechanical ventilation?	Yes <input type="checkbox"/>
13	Control of ventilation from the drivers cab?	Yes <input type="checkbox"/>
14	Inside light for loading and control?	Yes <input type="checkbox"/>
15	Availability of a stunning bolt in case of emergency?	Yes <input type="checkbox"/>
16	Symbol and note „Live Animals“ on the vehicle?	Yes <input type="checkbox"/>

Table 3. Checklist for transport assessment in pigs – critical control points (CCP) relating to transport logistics (Schäffer and von Borell, 2002a)

CCP	Assessment Criteria	Goal
17	Definite delivery appointment?	Yes <input type="checkbox"/>
18	Signs on vehicle indicating area and height?	Yes <input type="checkbox"/>
19	Consideration of outside ambient temperature (not > 25°C)?	Yes <input type="checkbox"/>
20	Additional space provided if temperature > 25°C?	Yes <input type="checkbox"/>
21	No mixing pigs of different origin?	Yes <input type="checkbox"/>
22	Route planning (road surface, curves, jams, traffic lights)?	Yes <input type="checkbox"/>
23	Domestic transport duration of < 8 h?	Yes <input type="checkbox"/>
24	Complete transport declaration (origin, owner, dispatch location and place of destination, day and time of loading)?	Yes <input type="checkbox"/>

Table 4. Checklist for transport assessment in pigs – critical control points (CCP) relating to the state of the animal (Schäffer and von Borell, 2002a)

CCP	Assessment Criteria	Goal
25	Any pig losses?	No <input type="checkbox"/>
26	Any injured pigs?	No <input type="checkbox"/>
27	Density within the required range (100 – 110 kg / 0.42 – 0.6 m <sup>2</sup> )?	Yes <input type="checkbox"/>
28	Are pigs dirty?	No <input type="checkbox"/>
29	Are all animals marked?	Yes <input type="checkbox"/>
30	Separate pens for sows?	Yes <input type="checkbox"/>
31	Separate pens for boars?	Yes <input type="checkbox"/>

### CALIFORNIA DAIRY QUALITY ASSURANCE PROGRAM (CDQAP)

The California Dairy Quality Assurance Program (CDQAP) is a voluntary partnership programme of governmental agencies, the University of California, Davis, and the dairy industry, working together to help California dairy producers understanding and complying with federal, state and local regulations. It provides education, resources, and funding for the certification of dairy producers in the areas of environmental stewardship, animal welfare, food safety and specific diseases. This programme is an example of how the general principles of quality assurance can be applied to the specific needs of regions and commodity groups..

#### Air Quality Curriculum of the CDQAP

For CDQAP certification, dairy producers have to undergo a six-hour Environmental Stewardship Short Course (that covers various environmental laws and what they mean for the dairies) in addition to an air quality short course. An on-site evaluation, which includes dairy records and facilities, are conducted at no cost to the producer by third-party evaluators that visit dairies to ensure they are in compliance with all environmental laws. Evaluators are independent of both the producer and environmental regulators.

Due to the specific climatic conditions in the California Central Valley, where most of the 2.3 million dairy cows are housed in open sided free stalls and dry lot corrals (average herd size 700 cows) particulate matter emissions (which largely is fugitive dust) from dairies are of particular concern. The California Air Resource Board considers agriculture as one the primary source of

PM<sub>10</sub> (particulate matter with less than 10 microns in size) emissions in California. In addition to PM<sub>10</sub>, ammonia, and volatile organic compounds are other pollutants of concern.

The CDQAP partners (under leadership of University of California Cooperative Extension) have developed a risk assessment document for particulate matter. The worksheet is designed to help the producer to:

- understand the options available to control particulate matter emissions on his dairy
- rank activities according to how much impact they have on air quality
- provide easy-to-understand rankings that help to analyse the emission potential of certain management procedures
- determine which of the practices are reasonably safe and effective, and which practices might require some modification to better protect air quality.

Table 5. Assessing direct particulate matter emissions from dairy facilities and activities (modified checklist adopted from CDQAP, 2004)

Emission category	Low emissions (Rank 3)	Moderate emissions (Rank 2)	High emissions (Rank 1)
1) Housing type	All cattle in free stalls with no exercise pens	Free stalls with exercise pens or corrals with shades	Corrals with no shades. No free stalls
2) Corral shape and condition	Pen shape and condition allows complete removal of dry manure		Pens are irregularly shaped and/or have obstacles to complete removal of dry manure
3) Surface characteristics	Even, compacted surface with no holes, pits, or depressions to accumulate dust	Holes, pits, or depressions are corrected at least annually after manure removal	Holes, pits, or depressions that may accumulate dust are uncorrected
4) Maximum depth of dry loose manure in corrals at cleaning	Corrals are firm and hard with less than 1 inch of dry manure	Corrals have between 1 and 3 inches of dry loose manure	Corrals have more than 3 inches of dry loose manure
5) Bulk materials (dry loose feed)	Stored inside a commodity barn or covered with a tarp	Materials partially covered or located partially inside commodity barn	No protection from wind
6) Bulk materials (bedding and dry manure)	Covered with a tarp	Materials partially covered	No protection from wind
7) Feed preparation	High moisture ingredients added at beginning of mixing	High moisture ingredients added at end of mixing	No high moisture ingredients used
8) Vegetative barriers downwind (May - Oct.) of corrals, & manure storage (shelterbelt)	A dense shelterbelt or other vegetative barrier is maintained	Sparse, immature or partial shelterbelt or other vegetative barrier present	No vegetative barrier
9) Total daily vehicle trips (Regulation VIII & CMP compliance)	Less than 10 trips on a day	Between 10 and 75 trips per day	More than 75 trips per day
10) Road surface	Treated and/or firm compacted surface	Compacted coarse textured surface	Untreated loose and/or fine textured surface

continued overleaf

11) Track out	No access to public roadways from unpaved surfaces or access over track out control mechanisms	Heavily used access points to public roadways that have only partial pavement or have track out control	All frequently used access points to public roadways are from unpaved roads without track out control
12) Direction of prevailing winds during summer months	Prevailing winds from animal housing and manure storage area blow away from neighbours		Prevailing winds from animal housing and manure storage area blow towards neighbours
13) Proximity of animals and manure storage facilities to NEAREST business, home, school, church, etc., IN ANY DIRECTION	More than 1.0 mile	Between .25 and 1.0 mile	Less than .25 mile
14) Proximity of animals and manure storage facilities to NEAREST DOWNWIND business, home, school, church, etc., from the property line	More than 1.0 mile	Between .25 and 1.0 mile	Less than .25 mile
15) Intensity of wind gusts during summer months	5 mph or less	Between 5 and 20 mph	20 mph or more
16) Proximity of animals and manure storage facilities to nearest roadway	More than 1.0 mile	Between .25 and 1.0 mile	Less than .25 mile
17) Roadside vegetation and fence line enhances aesthetics	Well maintained and landscaped operation		No landscaping, debris and weeds present, facility in disrepair
18) Vector control management (flies, mosquitoes and rodents)	Vector control plan implemented. Plan is in compliance with local regulations. Feed, animals, manure, etc., managed to minimize vectors	Vector control plan developed but implementation lax	No vector control plan in place
19) Mortality management	Mortality removed from corrals within 24 hours and isolated from scavengers, pets, rodents etc. Mortality not visible from roadside	Mortality removed from corrals within 24 hours and isolated from scavengers, pets, rodents etc. Stored away from roadside but still in public view	Mortality not removed from corrals within 24 hours or mortality stored in public view at roadside
20) Odour	Odour management plan developed and implemented	Odour management plan developed and not completely implemented	No odour management plan



Table 6. Animal Welfare Assessment of the Dairy Facility (preliminary checklist adopted from UC Davis, Cooperative Extension – Stull *et al.*, in preparation)

Item	Statement	Yes	No	N/A
1	Management establishes and implements standards for the care, handling and well-being of animals on the dairy and communicates expectations to employees	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2	On-farm written policies are reviewed twice per year to remind employees, management, field staff or other personnel of the importance of animal care, well-being, and comfort	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3	Dairy personnel are trained in proper animal handling and animal behaviour	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4	All animals on the dairy are observed daily for comfort, locomotion, and behavioural changes	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5	Written emergency/weekend/holiday animal care plans (emergency phone numbers, contacts and protocols) are posted in a visible location in both English and Spanish	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6	The dairy operation has a valid veterinarian-client relationship (name of veterinarian and contact information is posted)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7	Tail docking is not performed as a routine practice	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8	Vaccine schedule	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
9	Pest and parasite control schedule	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
10	Quarantine procedures for newly arrived animals	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
11	Reproductive examinations	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
12	Locomotion scoring	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
13	Hoof trimming	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
14	Body condition scoring	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
15	Cleanliness and hygiene scoring	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
16	Fresh cow and calving observations	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
17	Sick and injured animal care, including non-ambulatory animals	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
18	Euthanasia protocols for animals	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
19	Castration	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
20	Dehorning	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
21	Extra teat removal	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
22	Facilities are designed and maintained to provide safe and comfortable conditions for all dairy animals	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
23	Adequate lighting allows for inspection of animals and provides safe working conditions	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
24	All animals are provided with a clean, dry area to lie down and ruminate	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
25	If free stalls are used, there is a stall for every cow	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
26	Animals in corrals can avoid standing in mud or manure over their dewclaws	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
27	Facility is sized so cows can exercise at will, and timid cows can avoid dominant cows and still have access to feed, water, and resting place	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
28	Milking facilities are designed so that cows are standing on concrete for less than 2 hours from the time they leave the pen until they return at each milking	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
29	Milking equipment is tested and maintained to prevent injury or discomfort to cows	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
30	Heat stress is reduced using one or more of the following as needed: shades, sprinklers, misting, fans, or dietary alterations	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
31	An isolation area is provided for sick animals, and is separated from the calving, fresh cow, and calf areas	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

continued overleaf

32	All animals, including replacement stock, have access to shade in the summer and shelter in the winter	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
33	Animals must receive adequate levels of nutrition for growth and production needs. Rations are formulated and fed to meet NRC (2001) requirements for growth and production	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
34	Adequate feed bunk space allows for all cows in a pen to eat at the same time, including timid cows	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
35	When not being milked, lactating cows have continuous access to feed	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
36	Cows have free access to clean water	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
37	Water is protected from freezing	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
38	Waterers are positioned at a convenient height for the animals	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
39	Flags and plastic paddles are used during handling of animals to encourage movement. Whips and electric prods are only used when animals or human safety is in jeopardy, and as a last resort	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
40	Cows are not restrained for more than two hours for routine care and management procedures	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
41	Loading facilities are designed to avoid animal injuries and facilitate ease of animal movement	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
42	Transportation is planned to minimize transit time and avoid extreme temperatures	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
43	Sorting animals according to size prior to transport and using proper loading densities within the transport vehicle are used to minimize stress and injuries during transport	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
44	Non-ambulatory animals are not transported off the dairy to market channels or processing facilities	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
45	On the dairy, appropriate equipment (sling, sled, or bucket) is used for moving injured or non-ambulatory animals	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
46	Calving area is clean, dry, well lit, and well ventilated	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
47	All calves (bulls and heifers) receive appropriate amounts of quality colostrum	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
48	Dry, clean housing is provided for calves	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
49	Calves which are tethered or housed in a small enclosure are able to turn around, lie down and groom themselves	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
50	Navels are dipped in an appropriate disinfectant soon after birth	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
51	Only calves with a dry navel and able to walk unassisted are transported off the dairy	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
52	Calves are moved by walking or lifting them, not by pulling or dragging by body parts such as the ears or tail	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

The risk assessment relates to emission categories for corral management (lactating cows 1–4), overall management (5–8), unpaved roads (9–11) and nuisance conditions (12–20). Emission categories for replacement heifers and dry cows as well as for unpaved vehicle and equipment areas and confined spaces are not reported here. After having assessed the rank of emissions (Low, Moderate and High) from a section of his operation, the farmer is asked to identify management practices from a handbook for air quality conservation management practices to reduce the emissions of PM for categories with high emissions (Rank 1).

### Dairy Welfare Assurance

The California Dairy Welfare Guide (Stull *et al.*, in preparation) is designed to accurately evaluate well-being of dairy cows on facilities of all sizes and geographical locations throughout California. It consists of two parts: Assessment of the Dairy Facility and a Technical Guide, which provides science-based information on best management practices. Future certification

and audits of dairy facilities for animal welfare are foreseen. Nationwide (for the USA), certification programmes that are either industry driven (DQA, 2004: Five-Star Dairy Quality Assurance) or initiated by the humane societies (HFAC, 2003: Certified Humane) are already in place.

The Assessment of the Dairy Facility is designed to objectively evaluate the major areas of welfare on the dairy, including check points for management policies (1–5), health care (6–21), facilities and environment (22–32), feed and water (33–38), handling and transport (39–45), and management of calves (46–52). The programme is still under development and may be further modified. The Table 6 contains statements to which detailed information is provided in the Technical Guide (not included in this paper). The dairy manager is asked to check “Yes” if the entire statement supports the current practices and policies of the dairy, or “No” if the statement is not an accurate description. The “N/A” denotes a statement that does not apply to the specific facility.

## IMPLICATIONS

Welfare, health, management, economy, public perception, consumer acceptance and environmental impact are factors that depend on each other and therefore need to be addressed as integral components of sustainable animal production systems. Voluntary or legislated standards for quality assurance could be based on HACCP-like critical control points or management points as outlined in this paper for pig housing and transportation as well as for dairy management. Although recent efforts from international organisations are aimed towards uniform standards (such as the World Organisation for Animal Health (OIE, 2004) initiative to create international acceptable animal welfare standards), these standards will be of a very general nature when considering the cultural and geographical diversity in farming practices around the world. However, basic principles of on-farm quality assurance can be applied to any specific regional need as long as they are based on sound ethical and scientific principles that are accepted by the society.

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