

The Ticking Clock: Addressing Farm Animal Welfare in Emerging Countries

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Abstract Over the last decade many emerging economies, and in particular Brazil, have established themselves as major players in global food animal production. Within these countries much of the increase in food animal production has been achieved by the adoption of intensive housing systems similar to those found in most industrialized countries. However, it is now well established that many of these systems are associated with numerous welfare problems, particularly with respect to restriction of movement. Previous work has shown that people living in industrialized countries broadly support farm animal welfare reform, and that similar criticisms may be voiced from citizens living in developing countries as they become more aware of confinement housing and potentially contentious husbandry practices. Given the developments that have taken place in other countries, there are lessons that could be learned and applied by emerging economies that would undoubtedly ease or prevent the challenges observed in other countries. Thus, we briefly describe the vehicles used by different countries when addressing animal welfare that may provide insights into identifying possible challenges and potential solutions for Brazil and other emerging economies. Where available we review the associated science and identify gaps where more research is needed. We conclude by providing a possible roadmap on how farm animal welfare reform may be addressed in emerging countries. Solutions will need to be tailored, culturally relevant, and science must play a key role in supporting animal welfare reform in the emerging countries.

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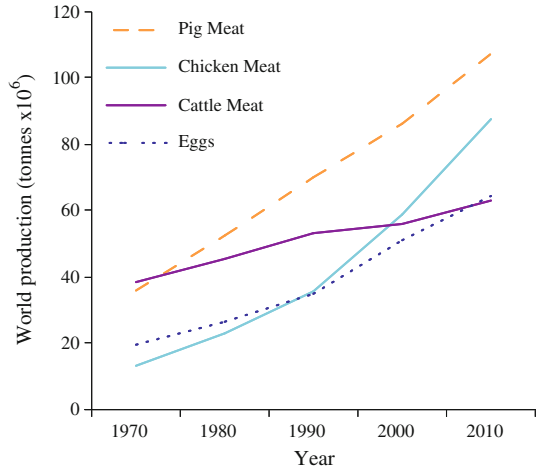
Introduction

As the world's population grows to unprecedented numbers, urban centers continue to expand and the socio economic status of citizens improves in developing countries, there is increased pressure to improve global food production, including food animal production (Godfray et al. 2010; Foley et al. 2011; Schneider et al. 2011; Herrero and Thornton 2013). In response to this pressure global food animal production has increased (Fig. 1), with the majority of this growth taking place in the developing world, where meat production efforts soared between 1980 and 2002 from 45 to 134 million tones (World Bank 2009). This growth has been led, in large part, by the tenfold increase in poultry and pig meat production (Fraser 2008a; World Bank 2009), which make up the majority of global exports of meats today (USDA 2013). Moreover, further growth is predicted as there is tremendous scope for increased food animal production in developing countries (Steinfeld et al. 2006) (Fig. 2).

These increases have been largely achieved through the adoption of confinement housing and management practices that facilitate intensification, which had been previously adopted by the industrialized world during the mid 20th Century (Steinfeld et al. 2006; Fraser 2008a). The trend towards intensification of agricultural production has resulted in heated debate in many parts of the industrialized world, and has largely focused on the impact on animal welfare, rural livelihoods, and the environment (von Keyserlingk et al. 2013; Foley et al. 2011; Garnett et al. 2013). The trend by many emerging economies to transition to intensive systems as a way to meet domestic demands as well as export markets has resulted in increased risk that they too will be subjected to similar scrutiny. Specifically, the continued adoption of controversial farm animal management practices places them in an especially vulnerable position.

We begin this review by briefly providing a definition of animal welfare and sustainability. We then go on to describe the changes that have taken place in many regions of the world regarding farm animal welfare, specifically Europe, Oceania and North America. Amongst the emerging countries, Brazil and China have established themselves as two of the fastest growing producers of farm animal products (Fig. 3). In the last decade China has secured its position in pig production, having more than 50 % of all pigs in the world (Nielsen and Zhao 2012) and Brazil now ranks among the top four world exporters for beef, poultry and pork meats (FAO 2013). Moreover, Brazil's aim is to have secured 45 and 48 % of the world's market for beef and poultry, respectively, by 2020 (MAPA 2012). Consequently, we will focus much of our discussion on describing some of the potential challenges facing the emerging economies, with particular emphasis on Brazil, as they strive to become global leaders in farm animal production. We conclude by providing a

Fig. 1 Global production of chicken meat, cattle meat, pig meat and eggs (tonnes $\times 1,000$) in the last five decades. *Source* FAOSTAT (2013)



possible roadmap on how farm animal welfare reform may be addressed in emerging countries.

Defining Farm Animal Welfare

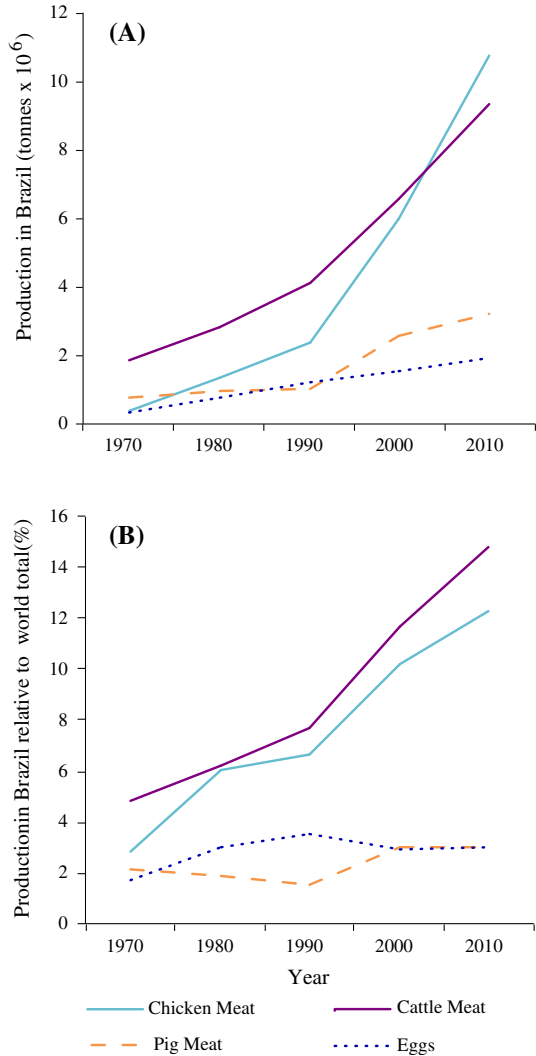
Considering the purpose of this paper, we felt that it was important to provide a definition of animal welfare. Fraser et al. (1997) modified by (Fraser 2008a) reported what is now widely accepted as the three constituents of animal welfare: (1) animals should exhibit good physical health and biological functioning, (2) animals should have the ability to live reasonably natural lives consistent with their evolutionary history, and (3) animals should experience minimal negative psychological states and the presence of at least some positive psychological states.

These three aspects of animal welfare have been included in official definitions such as the World Organization for Animal Health (OIE) which defines an animal as being in good welfare if it is “healthy, comfortable, well nourished, safe, able to express innate behavior, and it is not suffering from unpleasant states such as pain, fear, and distress” (OIE 2013). Incorporation of these constituents are also central to the Five Freedoms (FAWC 2013), frequently used by organizations, certification bodies and others when assessing animal welfare.

Given the potential economic importance of food animal production systems to many of the emerging economies it is important to also consider the role of farm animal welfare in the context of sustainability. Animal welfare has been argued to be an important ethical social concern and, as such, needs to be integrated to the concept of sustainable agriculture, rather than made to ‘compete’ with environmental goals (Hötzel 2014).

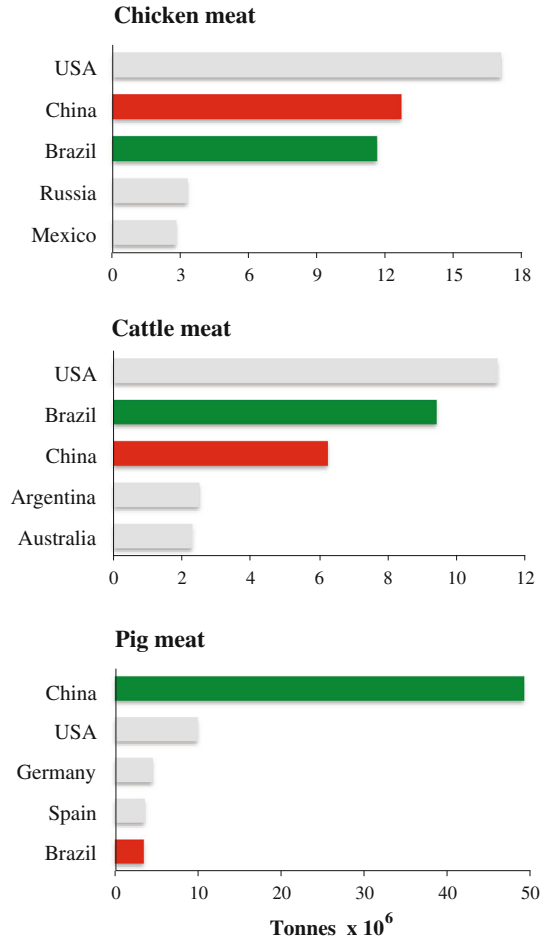
For the purposes of this paper we have adopted the definition that acknowledges that there are three pillars of sustainability: economic, environment and social (see von Keyserlingk et al. 2013). Historically farmers and most scientists have placed great emphasis on the environmental and economic pillars (Boogaard et al. 2011b).

Fig. 2 Increase in the last four decades in chicken meat, cattle meat, pig meat and eggs in Brazil (a) and relative to total world production (b). Production of chicken meat, cattle meat, pig meat and eggs increased 29.3, 5.1, 4.2 and 5.8 times, respectively, from 1970 to 2010. *Source* FAOSTAT (2013)



The fact that the social pillar has received the least amount of attention may be explained in part by the fact that it includes an aspect of human values (Thompson 1997), and thus is more difficult to quantify using traditional natural science based metrics. Furthermore, values are influenced by cultural norms within societies (Boogaard et al. 2011b) and thus do not always transcend easily across political borders. However, despite these difficulties there has been a growing recognition over the last quarter century that the socio-cultural pillar is indeed important and deserving of discussions concerning sustainability (e.g. Mench et al. 2011). This is particularly evident in the case of intensive housing systems used in food animal

Fig. 3 Top five countries producing chicken, cattle and pig meat in 2012 (FAOSTAT 2013)



production systems, where the way that animals have been cared and managed has been subjected to increased societal criticism (Thornton 2010).

Changes in current livestock production systems seem inevitable, driven initially by the notion that reductions in the environmental impact of livestock cannot be met by keeping ‘business as usual’ (Steinfeld et al. 2006). However, how this will translate into practice, and the speed at which change will take place, is difficult to predict given that rapid cultural changes observed in public attitudes (Thompson et al. 2011). The increasing role of social media campaigns will also likely play a role in the social acceptability of food animal production systems (Tonsor and Olynk 2011).

Animal welfare has been argued by some (Garnett et al. 2013) to be an essential component of ‘sustainable intensification’, but not by others (Godfray and Garnett 2014). However, Verbeke et al. (2010) argue that societal values and demands must be integrated into the food animal production sectors, as only then can animal

production systems be justified to society and government. It follows therefore that if societal values regarding animal welfare change in the future (for whatever reason) then one could predict that farmers would again be faced with the possibility that the production systems adopted today would no longer be acceptable tomorrow.

Lessons Learned from Industrialized Countries

Much has been written on the events that have taken place over the last 50 years influencing today's view on animal welfare and the changes seen in the protection of farm animals in many countries (Bayvel 2004; Fraser 2006; Broom 2011). Some of the first questions regarding the ethics of farm animal production methods were raised in 1964 with the publication of *Animal Machines* by Ruth Harrison (Harrison 1964). The book describes production practices used for laying hens, broiler birds and veal calves, concluding that these practices are so unnatural that they cause animals to lead miserable and unhealthy lives. Public reaction to the book set in motion a series of events (Fraser 2008a) that over a 50-year period have resulted in a highly regulated system in the UK aimed at assuring animal welfare. For example, the first laws focused on the protection of farm animals were introduced through the Agricultural (Miscellaneous Provisions) Act in 1968 (HMSO 1968), followed by more specific laws such as the banning of gestation stalls for pregnant sows in 1999 (HMSO 1994).

Similar changes have taken place in other European countries. Most notably, Sweden passed animal welfare laws in 1988 effectively ending the use of battery cages for hens, stalls for gestating sows, and zero grazing systems for dairy cattle (Ministry for Rural Affairs—Government Offices of Sweden 2009). The EU has also actively promoted animal welfare, announcing its first Directives focused on care and housing of laying hens (1988) and of pigs and calves (1991). The EU Directive for laying hens underwent several amendments, with the standard battery cage for hens banned effective 2012, and only larger, enriched cages (e.g. containing a next box and perch) permitted (Stevenson 2012). Changes in how farm animals are cared for have not been limited to housing type, but also include specific practices such as painful procedures, many of which are now regulated. For instance the European Commission Directive 2001/93/EC, which relates to the minimum standards for the protection of pigs, states that pigs older than 1 week must be castrated or tail docked by a trained veterinarian using anesthesia and additional post-operative analgesia.

In New Zealand, where the export of food animal products is a significant contributor to the GDP, animal welfare issues have played a central role in legislation. The 1999 Animal Welfare Act (Parliamentary Counsel Office of New Zealand 1999) clearly states that those in charge of animals have an obligation to ensure the physical, health and behavioral needs via practices supported by sound scientific knowledge. Implications of this legislation and subsequent laws, combined with on going public pressure, have resulted in significant changes in animal care at the farm level in New Zealand, including the phasing out of gestation stalls by 2015 and battery cages by 2022. Reflections on the development of this line

of legislation indicate that broad stakeholder engagement was the most important part of the process (O'Connor and Bayvel 2012).

In Canada, a country where government intervention has been notably absent from these discussions, producer organizations have worked collaboratively with both the humane movement and scientists to create voluntary codes of practice for the care and handling of farm animals. Code development is a multi-step process, beginning with a scientists' report reviewing the relevant research on contentious practices such as tail docking, castration, or housing type (e.g. gestation stalls). This report helps to inform deliberation by the code development committee that includes representatives from the animal industry, government, scientists, grocery chain distributors and the Canadian Federation of Humane Societies. The draft code is then open to public comment before being published (National Farm Animal Care Council 2014). Whether this process, and ultimately the voluntary compliance by farmers of the agreed upon animal welfare standards, is sufficient to maintain consensus amongst all stakeholders in the long run remains to be seen.

In many countries, including the US, discussions regarding animal welfare regulations have received strong opposition from many food animal industry groups (Fraser 2001) leading to a polarized debate between industry lobby groups and animal advocates (Cantrell et al. 2013). Not surprisingly, in the US the legal system has played a more prominent role than the voluntary compliance route used in Canada. For instance, a number of farm animal welfare laws in some US states have been enacted either via legislation or ballot initiatives. The state of Florida was the first to use the ballot initiative process to ban the use of gestation stalls in 2002 (effective 2008). This landmark ban was followed by a string of additional measures—across nine states—banning a variety of standard industry practices including the well publicized 2008 California ballot initiative (“Proposition 2”) prohibiting the use of the conventional battery cage for hens and crates for gestating sows and veal calves, with changes effective in 2015.

The changes described above in food animal production practices have not been limited to individual countries or regions. In 2002, the member nations of the OIE voted unanimously to develop international standards for animal welfare, with the first guidelines adopted in 2005 (Bayvel et al. 2012). The acknowledgement by the OIE regarding the importance of farm animal welfare is of particular interest as we contemplate the future of emerging countries striving to increase their economic growth by growing their export of animal products, particularly as the OIE is the reference body used by the World Trade Organization (WTO) for standards regarding animal health and zoonosis (Fraser 2006).

Under WTO law, subject to certain requirements, countries are allowed to impose trade restrictions that are “necessary to protect human, animal or plant life or health” or “necessary to protect public morals”. The Agreement on the Application of Sanitary and Phytosanitary Measures (the SPS Agreement) provides more specific guidance on measures related to animal health. However, animal welfare is not explicitly included in the SPS Agreement or other WTO law; hence there are no specific provisions that would allow a country to restrict trade for purposes of protecting animal welfare. However, in 2013 a WTO panel, seeking to settle a dispute over the EU's refusal to allow the importation of seal products from Canada

and Norway, ruled that protecting public morals concerning the welfare of seals was a legitimate objective that could be pursued through trade restrictions (WTO 2013). This ruling, if upheld upon appeal, could have broader implications for trade restrictions designed to protect animal welfare. Moreover, nothing prevents countries entering into bilateral trade agreements from agreeing to conform to certain animal welfare standards as a basis for trade (Howse et al. 2014). For example, the EU-Chile Free Trade Agreement (EC 2002), which came into force in 2005, was the first example of a bilateral trade agreement that included specific references to animal welfare standards.

The power of retailers and processors as driving forces for change in animal welfare must not be overlooked (Fraser 2006). Given their direct relationship to consumers they are highly sensitive to actual and perceived public opinion. Many companies now include animal welfare and environmental stewardship as central tenets of corporate social responsibility initiatives, and require suppliers to adhere to their private standards as vehicles to maintain customer loyalty and secure market share (Fulponi 2006). Frequently these standards are higher than government regulations, as shown by recent surveys in the EU (Fulponi 2006). In North America recent announcements also indicate that this sector will continue to play a major role in driving change. In April 2013, eight of Canada's largest grocery chains announced that they would phase out sourcing pork from pigs raised in facilities employing restrictive gestation crates by 2022, for reasons in support of more humane practices in pig rearing (Retail Council of Canada 2013). In January 2014, two large American processors reconfirmed their commitment to phasing out the use of gestation stalls for pregnant sows within their supply chains (Tyson Foods 2014; Smithfield Foods 2014). The spread of private animal welfare assurance programs is expected to continue exerting tremendous influence on how food animals are cared for. Unfortunately, farmer input into these types of standards has been minimal to date, which may have negative consequences in terms of their ability to adapt to changes in a sustainable manner.

To our knowledge no work has reflected on how these different approaches described above used by countries when addressing animal welfare and their outcomes may provide insights into identifying possible challenges and potential solutions for emerging economies. Given the developments that have taken place in the European Union (EU) and other industrialized countries, there are lessons that could be learned and applied by emerging countries that may ease or prevent the challenges observed elsewhere. Lastly, it must be mentioned that the acceptability of the changes in food animal production systems that have taken place thus far in response to societal pressure will likely continually be subject to potential criticism by society.

The State of Farm Animal Welfare in the Emerging Countries

Emerging economies have lagged behind in addressing the role of animal welfare in farm animal production (Robins and Phillips 2011; Nielsen and Zhao 2012; Poletto and Hötzel 2012; Meng et al. 2012; Silva et al. 2011). In Brazil, increases in pig, broiler and laying chickens have been in large part achieved by the adoption of

intensive systems similar to those found in most industrialized countries, which have been associated with numerous welfare problems, particularly with respect to restriction of movement (Poletto and Hötzel 2012). Potential solutions to these problems may be, in part, adapted from science-based solutions that have gained social acceptance in other countries. However, it must also be recognized that additional problems might be present that are unique to a region (or country), such as reliance on unskilled labor and long transport routes through regions that have poor infrastructure (e.g. roads) in adverse climatic conditions (excessive heat) and poor slaughter conditions. Within Brazil, Chile and Uruguay science has begun to inform policy changes on the conditions required for humane slaughter, but much more work is needed (Paranhos da Costa et al. 2012).

In Brazil ruminants are reared mostly in grazing systems (IBGE 2009). Relatively less work has been done evaluating the presence of any inherent welfare problems within the system (Fraser 2008b). The growing desire by society for livestock production systems to comply with environmental demands (Steinfeld et al. 2006) may also place additional pressure on farmers within emerging countries to adopt more intensive, landless ruminant systems. For example, confinement beef operations in Brazil are estimated to have almost doubled in the last decade (Millen et al. 2011). However, we caution changes that are associated with a negative trade-off, i.e. solve one problem but create another. Given the challenges regarding social acceptability of intensive housing systems by many countries (Thompson et al. 2011) we caution transitions that may be argued to be good for the environment but are associated with restriction of movement. In addition, the adoption of high production breeds adapted to temperate climates, without consideration for the animals' natural capacity to cope with the diseases and thermal challenges typical of tropical or subtropical climates will lead to compromised welfare and reduced production (Costa et al. 2013; Eisler et al. 2014).

China's position as the leading producer of pork may uniquely position this country to influence global policies governing the housing and care for pigs (Wang 2006). Unfortunately there is little information available as to the role farm animal welfare will play within this country, particularly in terms of standards. A recent commentary provided by Nielsen and Zhao (2012) reports that even small improvements in animal welfare will likely have a profound impact on the welfare of farm animals in China.

Brazil's initiative to officially consider animal welfare began when regulation was introduced by the Ministry of Agriculture, Livestock and Food Supply in 2008 (MAPA 2008), followed by the establishment in 2011 of a technical committee, responsible for the development of animal welfare standards (MAPA 2011). More recent discussions have called for improved standards and legislation pertaining to the transport and slaughter of farm animals. Despite these laudable efforts changes targeted specifically at the housing, care and management of animals on Brazilian farms have been limited and fail to take into consideration societal attitudes towards animals. A key example showing this narrow view is found within the "Protocol for Animal Welfare for Poultry Hens" published in 2008 by the Brazilian Union of Poultry Producers (UBA 2008). The document suggests a recommended space allowance for caged hens of 375 cm²/bird (white breeds) to 450 cm²/bird (red

breeds); before this caging system was banned space allowance in the EU was 550 cm²/bird. This apparent desire to be aligned with industry is also seen in the 2011 government initiative that resulted in the establishment of the “Permanent Technical Committee on Animal Welfare.” This committee which has been given the mandate to propose standards and technical recommendations of good practice for animal welfare (MAPA 2011) includes government officials and industry representatives but does not include members of the public.

Industry driven solutions that fail to incorporate broad stakeholder input may also be at great risk of being unsustainable in the longer term. Take for example a recent attempt by the United Egg Producers (UEP)—a producer trade association representing in excess of 90 % of US egg production industry—to implement animal welfare standards (UEP 2010). Failure to include input from the broader public and influential animal advocacy organizations created suspicion and has done little to assuage public concerns. Upon reflection UEP took the unprecedented step of partnering with the Humane Society of the United States, a large animal advocacy group (Mench et al. 2011). These two organizations agreed to jointly seek federal regulation focusing on the welfare of laying hens, that if passed would codify many of the management practices set out in the original UEP standards published in 2000, but also outlaw conventional cages (HSUS 2011). In particular it was agreed that the alternative housing systems would emphasize natural behaviors, which were of particular concern to the humane movement (Mench et al. 2011). Although the original agreement between these two organization was not renewed in 2014 it is suffice to say that UEP has, and continues, to invest in identifying viable alternative housing designs. This example provides clear evidence that failure to engage all stakeholders can result in emotional turmoil for all stakeholders, including the farmers, different parts of the supply chain and the general public. We strongly advocate that public consultation be a priority when animal industries look to developing sustainable solutions.

Stakeholder Engagements and the Role of Science in Policy Reform

To support the necessary change in farm animal production within emerging countries we see great need for concerted efforts by both the social and natural science research communities, and the associated governmental support to fund research. In the case of Brazil, there is solid evidence that it is able to respond to similar challenges; for instance, the environmental concerns and associated debate regarding preservation of the Amazon rain forest have resulted in science-based changes in governmental policies aimed at promoting sustainable practices (Galford et al. 2013).

Previous work from the industrialized countries has shown broad public support for farm animal welfare reform. When interviewed, European citizens report strong preferences for natural environments (Maria 2006; Boogaard et al. 2008; Boogaard et al. 2011a; de Jonge and van Trijp 2013) combined with a strong opposition to production systems that greatly restrict the movements of animals (Lassen et al. 2006; Boogaard et al. 2011b; Miele et al. 2011). Although less research has addressed the views of North Americans, results from a telephone survey show

support for natural behavior, particularly regarding access to the outdoors (Prickett et al. 2010). In addition, using an Internet based platform that made use of mixed methods approach (e.g. quantitative and qualitative responses), participants indicated broad opposition to practices perceived as unnatural such as tail docking in dairy cattle (Weary et al. 2011) and early cow-calf separation (Ventura et al. 2013).

Citizens and farmers differ in the relative importance they ascribe to the animals' ability to engage in natural behavior, pain and stress (Te Velde et al. 2002; Vanhonacker et al. 2008). Contrary to citizens' views (Vanhonacker et al. 2009; Fredriksen et al. 2011), farmers (Te Velde et al. 2002; Tuytens et al. 2010; Spooner et al. 2014) and industry specialists (Cantrell et al. 2013) tend to associate animal welfare mainly from the perspective of the animal's health and biological functioning. For instance, farmers consider surgical castration in piglets without anesthesia an acceptable practice (Tuytens et al. 2012; Spooner et al. 2012). Further evidence of the disconnect is provided by a survey of over 25,000 Europeans citizens who stated that they regard farmers as primary individuals responsible for ensuring farm animal welfare (Eurobarometer 2007). However, work undertaken in the Netherlands reported resistance by farmers to acknowledge any shared values with citizens, in essence discounting the values of urban-citizens by stating that they were ignorant of farm practices (Benard and de Cock Buning 2013).

Different stakeholders also tend to have different, usually negative opinions regarding each other's views on husbandry practices. For example, Danish veterinarians believed that farmers prioritize production and profit, while farmers claimed to value teamwork and animal welfare more (Kristensen and Enevoldsen 2008). Particularly worrisome is that some rural extension specialists working in southern Brazil justified not offering information on the benefits of pain relief to farmers when dehorning calves on the basis that neither they themselves nor their farmer clients believed that dehorning is painful (Hötzel and Sneddon 2013). A follow up study, involving interviews with farmers, completed in the same region, however, provides additional insights on farmer beliefs on this topic; farmers acknowledged that dehorning was painful (Cardoso et al. 2014). Differences in views between stakeholders were also identified by Ventura et al. (2013), who reported that some citizens who opposed cow calf separation at birth justified their position by blaming producers for exploiting animals and seeking productivity over welfare.

Efforts focusing on facilitating consensus-building between all of the key players in animal agriculture, including farmers, citizens, government, and industry representatives on animal welfare issues must become a priority (Poletto and Hötzel 2012). Failure to do so may result in lost opportunities that may have serious repercussions for all stakeholders, including those whose livelihood depends on the success of the food animal industries.

Previous work indicates that similar criticisms may be voiced from citizens living in developing countries as they become more aware of confinement housing and potentially contentious husbandry practices. For example, (Bonamigo et al. 2012) surveyed approximately 500 individuals in southern Brazil and found that about 70 % were unaware of the primary poultry production systems; yet, after being

shown photos of different systems over 90 % of the participants associated free range poultry production with high welfare and 76 % associated conventional confinement housing of poultry with poor welfare. However, Schnettler et al. (2009) report that although animal welfare was perceived to be a desirable attribute by Chilean consumers they were not willing to pay more for this attribute. These findings are similar to those from consumer attitude surveys undertaken in Europe that indicate that food safety is frequently the highest priority for consumers when asked (Ingenbleek and Immink 2011; Vanhonacker et al. 2008) but that point-of-sale price is their highest priority when they purchase (Harvey and Hubbard 2013). Recent work from China, however, indicates that urban consumers appear to embrace confinement housing for pigs (De Barcellos et al. 2013) and prefer to support farms that emphasize food safety. Given that traditional swine production practices in China are comprised of rural back yard holdings, it is not surprising that in this context urban consumers equated modern production facilities with increased food safety. Whether the citizens of China will continue to support confinement pig housing in the long run remains to be seen, particularly in light of the work described above (Bonamigo et al. 2012) that indicated less support of confinement systems as citizens became more informed. We also strongly caution the use of consumer purchasing behavior findings to justify inaction when faced with decisions regarding a particular animal husbandry practice. Relying on consumers to pay for improved welfare has been deemed to be unfair (and not socially sustainable) given that the consumer is largely uninformed of food production practices (Appleby et al. 2003).

Given that in many emerging countries the field of animal welfare science is relatively new, we argue that there are numerous gaps within the existing literature, including identifying cultural issues relevant to the treatment of animals (Nielsen and Zhao 2012; Poletto and Hötzel 2012). Furthermore, standard management practices found on most intensive swine and poultry production units, but also now encompassing dairy and beef farms in many emerging economies, have been largely adopted from the industrialized countries, but are now being questioned by the public (Centner 2010; Crony and Anthony 2011). Thus, when one looks for precedents to help guide the emerging countries as they move to increase their animal production capabilities, it seems obvious that the adoption of production systems that have failed to resonate with societal values elsewhere are at great risk of being unsustainable.

The social importance of livestock production to society in developing countries (FAO 2009) must not be overlooked. For example, in Brazil agriculture represents about 22 % of the GDP, and the livestock sector accounts for 29.6 % of this share (IBGE 2012). More than 16 M people over the age of 10 (approximately 19 % of Brazil's total population) state agriculture as their primary occupation, with the largest proportion working in the livestock sector (IBGE 2009). Furthermore, in Brazil (IBGE 2009), as is the case in many other emerging countries, family farms care for a large percentage of farm animals, and thus play an integral role in economic and social sustainability of farming (FAO 2014). We see great need that this sector is included as an active stakeholder in discussions pertaining to the inclusion of animal welfare standards at the farm level and in policy development. It

is clear that solutions will need to be tailored and culturally relevant and science must play a key role in supporting this area.

Conclusions: A Possible Roadmap Moving Forward

The fate of food animal production in emerging economies is at a crossroads. There is great risk that the animal agriculture sectors within these countries will become unsustainable if their citizens, as well as present and future export markets, begin to actively question farm husbandry practices. It has been shown that criticism towards rearing practices that influence animal welfare increases as societies become more urban and more aware of the rearing practices (Bonamigo et al. 2012; Tuytens et al. 2011; Eurobarometer 2007). An additional challenge facing the emerging countries is that when animal welfare reform is demanded the timeline provided to the food animal industries will likely not be the half-century afforded to Europe, thus increasing the economic risk to farmers and others in the supply chain, due to expenses such as reduced export markets and costs associated with retrofitting socially unacceptable facilities.

We encourage a multifaceted approach to address these issues. Firstly, in the short term, animal industry groups must quickly work to implement proven animal welfare solutions. In the medium term, governmental organizations need to invest in much needed research, tailored to local environmental and cultural conditions. For instance, in Brazil, as in many emerging countries, farm workers largely represent the sector of society that receives minimal education. Natural and social science research must be a priority, as both will be needed to guide policy reform and to provide practical, socially acceptable solutions to animal welfare issues, especially those that affect many animals, and cause considerable pain and suffering and fail to facilitate natural behavior. In particular, we see opportunities to create systems that promote animal welfare but also take advantage of a country's landscape and climate, or other year-round grazing systems for dairy and beef cattle. Thirdly, active engagement of all stakeholders, including agribusiness and associated professionals, farmers, and citizens not involved in animal production, when discussing animal welfare standards, will be paramount; in its absence, decisions may be made in other arenas, without any input from science and the people whose livelihood depends on agriculture. Throughout this process the training of highly qualified individuals will be key to facilitate the transformational shift needed to address farm animal welfare. Lastly, for food animal production systems in the emerging countries to be sustainable they must be economically viable, environmentally sound and socially acceptable, including assurance of high standards of animal welfare (Garnett et al. 2013; von Keyserlingk et al. 2013; Hötzel 2014).

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