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CONHECIMENTOS E ATITUDES DO PÚBLICO BRASILEIRO SOBRE O BEM-ESTAR ANIMAL NOS SISTEMAS DE PRODUÇÃO

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"Conhecimentos e Atitudes do Público Brasileiro sobre o Bem-Estar Animal nos Sistemas de Produção"

Por

MARIA CRISTINA YUNES

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RESUMO EXPANDIDO

INTRODUÇÃO

O Brasil é um dos maiores produtores e exportadores mundiais de produtos de origem animal. O aumento da competitividade dos mercados externos e a crescente demanda mundial por produtos agrícolas produzidos de forma ética vem obrigando o setor produtivo a adotar transformações em seus sistemas e métodos de produção, a fim de oferecer produtos condizentes com o esperado pela sociedade. Esta é uma excelente oportunidade para aumentar a participação brasileira nesse mercado, gerando mais renda e mais empregos. A preocupação do público em relação ao bem-estar animal tem se expressado através de ações políticas e pressão comercial e já tem provocado algumas mudanças nos sistemas de produção animal. Portanto, a aceitação dos sistemas e práticas usados na criação animal por parte da sociedade pode influenciar na sustentabilidade desses sistemas. Assim, conhecer as visões e expectativas do cidadão em relação à produção animal e a forma como os animais são tratados nestes sistemas, e identificar a importância dos atributos de qualidade oferecidos e comunicados, pode contribuir positivamente com essas mudanças. A opinião do cidadão em relação aos sistemas de produção animal tem sido relativamente pouco estudada no Brasil. Nesta tese, composta de 3 pesquisas, abordamos este tema de crescente importância, obtendo informações junto a cidadãos brasileiros, com o objetivo de conhecer e compreender suas opiniões e atitudes em relação aos sistemas e práticas de manejo utilizadas na produção animal.

MATERIAIS E MÉTODOS

Cada uma das três pesquisas foi realizada com o uso de um questionário. Dois questionários foram conduzidos de forma presencial, através da abordagem direta de participantes e um foi conduzido online, distribuído com auxílio da mídia social e *e-mail*. Os questionários, as imagens e o vídeo usados passaram por um teste antes de serem liberados. O público alvo eram pessoas de todo e qualquer público brasileiro, maiores de 18 anos, envolvidas ou não à produção animal. Todas as pesquisas foram aprovadas pelo Comitê de Ética em Experimentação com Seres Humanos.

Todos os questionários eram compostos de questões abertas e fechadas. Iniciavam com as questões demográficas e cada um deles

continha uma pergunta central relacionada ao objetivo da pesquisa. A primeira pesquisa teve por objetivo explorar as opiniões e atitudes do público brasileiro não envolvidas com a produção animal sobre os sistemas de produção animal e identificar as opiniões e atitudes específicas aos sistemas que são associados com a restrição de movimento. Para tanto o questionário mostrava imagens de sistemas opostos para a criação de uma mesma espécie e perguntava: "Qual sistema você considera mais comum no Brasil", "Qual sistema você preferiria que fosse o mais comum" e "Justifique sua preferência". A segunda pesquisa, a única realizada online, teve por objetivo identificar as opiniões e atitudes do público brasileiro envolvido ou não envolvido com a produção animal sobre o alojamento de porcas gestantes em gaiolas individuais. O respondente tinha possibilidade de ler um pequeno texto explicativo e assistir um vídeo sobre o assunto e então lhe era solicitado que respondesse se era "favorável", "indiferente" ou "contrário" ao alojamento de porcas gestantes em gaiolas individuais e que justificasse sua opção. A terceira pesquisa teve como objetivo explorar a opinião e aceitabilidade do público brasileiro sobre a edição gênica de suínos machos para prevenir o odor sexual e identificar as variáveis demográficas associadas. Neste questionário o respondente lia um breve texto sobre a castração de suínos e suas alternativas-imunocastração e edição gênica e em seguida respondia se considerava a edição gênica como uma alternativa aceitável (resposta variava de "totalmente aceitável" até "totalmente inaceitável") e o porquê de sua resposta.

As respostas fechadas dos questionários (dados quantitativos) foram analisadas estatisticamente e as respostas abertas por análise qualitativa.

RESULTADOS

Na primeira pesquisa foram analisadas as respostas de 479 participantes não envolvidos com a produção animal. A proporção dos respondentes que acreditam que o sistema mais comum no Brasil são os animais criados em sistemas de confinamento intensivo ou gaiolas variou de acordo com o tipo animal: 23% para gado de corte, 82% para frango de corte, 81% para galinhas poedeiras, 60% para porcas em gestação/parideiras. Entretanto, a maioria dos respondentes expressou preferência por sistemas ao ar-livre e livres de gaiolas. Quatro temas foram identificados nas justificativas da preferência por um determinado sistema: 'bem-estar animal', 'produção', 'qualidade do produto' e

‘questões ambientais’. As justificativas mais frequentes para expressar a preferência por sistemas ao ar livre ou sem gaiola foram aquelas relacionadas ao bem-estar dos animais, especialmente ligadas à liberdade de movimento, naturalidade e ética. Muitos relacionaram estes sistemas com uma melhor qualidade do produto. Uma minoria dos participantes indicou preferencia por sistemas confinados ou gaiolas por associarem estes com maior sanidade e produtividade. A maior parte dos respondentes (79%) afirmou ainda que os animais de produção não são bem tratados no Brasil.

A segunda pesquisa contou com 176 participantes envolvidos com a produção animal e 173 participantes não envolvidos com a produção animal, totalizando 349 respondentes. Em relação ao sistema de alojamento de porcas gestantes em gaiolas individuais, 79% dos participantes se posicionaram contra, 15% a favor e 6% indiferentes. Mais respondentes não envolvidos com a produção animal (87%) foram contra as gaiolas individuais do que respondentes envolvidos com a produção animal (69%; $p = 0.001$). Quando perguntados qual sistema eles consideravam mais comum no Brasil, 61% dos respondentes escolheram a opção ‘gaiolas individuais’, enquanto apenas 30% dos não envolvidos escolheu essa opção. Quando perguntados qual sistema eles acreditavam que deveria ser o mais comum, a opção ‘em outro sistema’ foi a mais escolhida (46%). Três grandes temas foram identificados nas justificativas apresentadas pelos respondentes: ‘bem-estar animal’, ‘produção’ e ‘qualidade do produto’. A maioria dos respondentes, envolvidos ou não com a produção animal, justificou a sua posição contrária às gaiolas abordando uma ou mais razões ligadas ao tema ‘bem-estar animal’, expressando preocupação com a liberdade, movimentação, senciência e questões éticas relacionadas aos animais. Aqueles favoráveis ao uso de gaiolas individuais justificaram com base na produtividade, facilidade de manejo e sanidade animal.

Para a terceira pesquisa foram coletadas 570 respostas de pessoas residentes no sul do Brasil. Cinquenta e seis por cento considerou aceitável a edição gênica de suínos machos para prevenção do odor sexual. A aceitabilidade foi mais baixa entre respondentes que cresceram no meio rural ($\rho = 0.02$) mas não foi influenciada pelo sexo, idade, religião, ser urbano ou rural e nem pelo nível de educação. A aceitabilidade da edição gênica foi positivamente relacionada com a percepção de benefícios ($\rho<0.0001$) e negativamente relacionada com a percepção de riscos ($\rho<0.0001$) provenientes da técnica. A aceitabilidade não foi relacionada ao conhecimento de conceitos básicos de biotecnologias da genética ($\rho<0.14$) ou à noção de questões

relacionadas à castração de suínos ou odor sexual ($\rho<0.44$), ambas baixas entre os participantes. A aceitabilidade da edição gênica foi justificada com argumentos relacionados à melhoria do bem-estar dos animais, enquanto que aqueles que não aceitaram a técnica se posicionaram contra modificações genéticas no geral. A aceitação foi em grande parte condicionada, direta ou indiretamente, à garantia da ausência de efeitos imprevistos aos seres humanos, animais e meio ambiente, e a demanda por maior esclarecimento do processo e suas consequências.

DISCUSSÃO

Nossos resultados sugerem que a maioria dos respondentes expressam preferencia por sistemas e práticas da produção animal que não causem dor ou sofrimento aos animais e que sejam ao ar-livre e livre de gaiolas, os quais foram percebidos como melhores para os animais. Estes mesmos sistemas foram associados a um sistema de produção mais próximo ao natural, com menor uso de aditivos químicos e com uma melhor qualidade do produto. O bem-estar animal, principal argumento usado entre os respondentes para justificar sua opinião, foi relacionado ao animal ter espaço suficiente para se locomover, poder expressar seu comportamento natural, ser livre de dor e sofrimento e ter algo de acesso ao seu ambiente natural.

Os respondentes demostraram um conhecimento limitado sobre os sistemas e práticas da produção animal frequentes no Brasil, especialmente as relacionadas à produção suína, como prevalências das gaiolas individuais para alojamento de porcas gestantes e castração cirúrgica de leitões para prevenção do odor sexual. Apesar de pouco informados, quando questionados, os respondentes expressaram opinião sobre o assunto e demostraram que se importam com a qualidade de vida dos animais usados na produção de alimentos. Nossos resultados também destacam valores compartilhados entre os participantes envolvidos e não envolvidos à produção animal em sua oposição ao uso de gaiolas individuais e pela preferência por um sistema outro que não é nem gaiola individual nem baia coletiva para alojar porca gestantes.

Em geral, quando questionados sobre a edição genica e devido à complexidade do tema, muitos respondentes se demostraram inseguros e preocupados quanto aos possíveis efeitos desconhecidos ou não da técnica e, portanto, apenas aceitaram a técnica quando perceberam maiores benefícios, especialmente relacionados ao bem-estar dos animais. Isso indica que as atitudes do público em relação à modificação

genética são influenciadas por julgamentos sobre os meios e os fins de cada aplicação específica.

CONCLUSÕES

Nossos resultados sugerem que, apesar de terem pouco conhecimento sobre os sistemas e práticas de produção animal amplamente utilizados no Brasil, os cidadãos brasileiros estão interessados na qualidade de vida dos animais de produção. Apresentam também evidências de que as atuais práticas de produção animal associadas à restrição de movimento não se alinham às expectativas da sociedade. Os benefícios percebidos para o bem-estar animal podem aumentar o apoio público à edição gênica, mas os riscos associados à tecnologia também devem ser transparentes aos cidadãos. A indústria deve considerar as atitudes e expectativas dos cidadãos brasileiros em relação ao bem-estar animal para desenvolver soluções apropriadas para todas as partes interessadas e para os animais, caso contrário, essas iniciativas podem não ser sustentáveis.

Palavras-chave: Produção animal. Bem-estar Animal. Sistemas de alojamento. Edição gênica. Opinião do público.

ABSTRACT

Production systems have been modified and intensified for more food production resulting in the industrialization of livestock systems. This means production of animals in smaller spaces, with the aid of antibiotics, food additives and genetic selection for high production rates. Brazil is one of the world's largest producers and exporters of animal products; the importance of livestock farming for the country's economic performance and job creation is unquestionable. However, there is a growing demand for animal food products originating from ethical agricultural systems, which means that people are concern with how their food is produced and how this may affect consumers, producers, the environment and the animals. Therefore, social acceptability of the current practices used on livestock production is an item to be considered in the sustainability of these systems. We addressed this issue of growing importance, bringing some insights on Brazilian citizens' views and expectations regarding issues related to the animal industry in three surveys. All surveys were carried out with the help of questionnaires and included closed and open questions. Participants were recruited through direct approach, *e-mail* and social media. The first survey aimed to explore the beliefs and attitudes of Brazilians citizens not associated with livestock production towards farm animal production systems and to identify the specific beliefs and attitudes towards systems that are associated with restriction of movement. Most of our participants preferred farm animal production systems that provide greater freedom of movement, which aligned with their perception that these systems are better for the animal. The second survey aimed to investigate the views of Brazilians associated or not with livestock production on the use of individual gestation stall housing for sows. Most participants of both groups were opposed to individual stalls. Results highlight the shared values between participants associated with livestock production and those that are not and highlight that opposition to gestation stalls for sows reflects an ethical position regarding the treatment of livestock and should not be interpreted as support for group housing in confined systems. The third survey aimed to explore public opinion and acceptability of gene edition of male pigs to prevent boar taint and identify the associated demographic variables. More than half of participants considered the biotechnology presented as acceptable. In general, rejection was related to a widespread opposition to genetic modification and perceived loss of naturalness, rather than any issue specific to the application under discussion; acceptance, in

contrast, was justified by perceived improvements in animal welfare. However, acceptance was in great part conditioned, directly or indirectly, to assurance of absence of unforeseen harm to humans, animals and the environment, and a demand for greater clarification of the process and its consequences. Our findings suggest that Brazilian citizens are interested in the quality of life of farm animals, despite having low awareness regarding livestock production practices widely used in Brazil. The industry should consider Brazilian citizens´ attitudes and expectations regarding farm animal welfare to develop appropriate solutions for all stakeholders and for the animals otherwise these initiatives may not be sustainable.

Keywords: Livestock production. Animal welfare. Housing systems. Gene edition. Public opinion.

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1 INTRODUCTION

Agricultural food production has been under enormous pressure due to the need to feed a growing human population, which has led to several situations that affect the ecosystem through loss of soil fertility, reduced water supplies, pesticides pollution and threats to biodiversity (TILMAN et al., 2011), all at a high expense of external energy (PIMENTEL et al., 2005). All these factors undermine the resilience of agro-ecosystems and threaten its sustainability. To achieve sustainability, agriculture should consider preservation of natural resources, especially soil and water, depend on a minimum of external inputs, make a more efficient use of non-renewable resources, and be able to recover from disturbances caused by cultivation or the climate; at the same time, it should be economically and socially viable, improving the quality of life and satisfying human needs (ALTIERI, 2002; PIMENTEL et al., 2005).

Brazil is one of the world's largest producers and exporters of animal products (FAO, 2014). The importance of livestock farming for the country's economic performance and job creation is unquestionable. However, there is a growing demand for food produced in ethical agricultural systems. The public is increasingly concerned with how their food is produced and the manner in which this may affect consumers, producers, the environment and the animals. As a component of the social aspect of sustainability, society's values and expectations regarding farm animal welfare should be integrated into the food production sectors, because only then will this sector have the support of the society and governments (KRYSTALLIS et al., 2009; VERBEKE et al., 2010; VON KEYSERLINGK et al., 2013). Therefore, in order to achieve societal acceptability, animal industry should encompass its ethical concerns (BOOGAARD et al., 2008). Animal welfare is a crescent ethical concern that challenges agriculture today (STEINFELD et al., 2006; GARNETT et al., 2013; HÖTZEL, 2014) and thus, it is considered one of the main issues within sustainability of livestock production systems (ROLLIN, 2006; FRASER, 2008).

Livestock production practices vary widely. The public often expresses negative attitudes towards housing systems that limit movement and natural behaviour, and that cause harm and suffering to the animals. Many of those practices have been questioned. For instance, intensive confinement and cage systems are one of the main concerns and therefore, hens, broilers and pigs are the top three farm animals perceived to have the poorest welfare (EUROBAROMETER,

2007). Other main concern among lay citizens is pain caused by human intervention (VANHONACKER et al., 2008; CARDOSO et al., 2017a) as for example piglets' (FREDRIKSEN et al., 2011; MANCINI et al., 2017) and cattle's (TEIXEIRA et al., 2018) castration without anaesthesia.

Several biotechnologies of common use in animal industry are also seen as controversial by the public. One emerging technology in animal industry is the gene edition of farm animal. Supporters of this technology have been promising improvements in animal welfare, for example in the sense that it would be possible to produce pigs born "genetically castrated" (SONSTEGARD et al., 2016). However, and despite its possible benefits, gene edition is a novel gene modification technology, and as such it raises fear and doubts regarding potential health, environmental and ethical implications, especially when applied to food animal production (GASKELL et al., 2006; MORA et al., 2012).

Public concerns regarding animal welfare have been expressed through political actions and commercial pressure and has already caused some changes in animal production systems (TONSOR et al., 2010). Increased competitiveness in external markets and greater consumer awareness have forced the livestock industries to adopt changes in their production methods and systems to offer products consistent with what is expected by society. To contribute positively to these changes, it is important to be aware of citizens´ views and expectations in relation to animal welfare in these systems, and to identify the importance of available and communicated to society (VON KEYSERLINGK et al., 2015).

Citizens' opinions towards animal production systems have been relatively less studied in development countries than in European and North-American countries (CLARK et al., 2016). This thesis addresses this issue of growing importance, bringing some insights on Brazilian citizens views and expectations regarding the most common systems and practices used in animal food production in the country. Furthermore, it also brings to the discussion the gene edition of farm animals, a biotechnology in development that has a great potential to be inserted in the market and may affect animals, producers and the society.

This thesis presents a literature review, three studies and a general discussion. It starts with a literature review (Animal welfare: views and attitudes of stakeholders associated or not with livestock production), that addresses fundamental themes for understanding the relationship between society and animal welfare in food production

systems, and is going to be submitted for publication as a review paper in a scientific journal. The first study (Brazilian Citizens' Opinions and Attitudes about Farm Animal Production Systems), discusses the opinions and attitudes of the Brazilian public regarding breeding systems for pigs, poultry and cattle used in food production. This paper has been published (YUNES et al., 2017). The second study (Restricting the ability of sows to move: A source of concern for some Brazilians), deals with the visions of the Brazilian public regarding the housing of pregnant sows in individual cages. This is a submitted paper (YUNES et al., submitted). The third study (Is gene edition of male pigs an acceptable alternative to surgical castration), is a survey on opinion of south Brazilian citizens regarding the acceptability of gene edition of male pigs to prevent boar taint. This last paper is in preparation for publication. The thesis finalizes with a general discussion that encompasses the main views and expectations of our respondents regarding the animal welfare on livestock production systems.

1.1 OBJECTIVES

1.1.1 General Objectives

To assess Brazilian citizens' views and expectations regarding the most common systems and practices used in animal food production in the country and to the use of gene edition in a farm animal species. To identify the underlying reasons for public acceptance or rejection of these systems, practices and technology, and investigate the influence of demographic variables.

1.1.2 Specific Objectives

1. To investigate the beliefs and attitudes of Brazilians not associated with livestock production towards beef cattle, sows and poultry production in Brazil, and the underlying reasons. A secondary aim of this study was to identify the specific beliefs and attitudes towards systems that are associated with restriction of movement;

2. To explore and contrast the views of Brazilian citizens associated or not with livestock production, on the use of individual gestation stall housing for sows;

3. To explore Brazilian citizens' acceptability of gene edition of male pigs for prevention of boar taint, perceptions of risks and benefits, and the underlying reasons; to identify demographic aspects that may influence acceptability.

2 ANIMAL WELFARE: VIEWS AND ATTITUDES OF STAKEHOLDERS ASSOCIATED OR NOT WITH LIVESTOCK PRODUCTION

2.1 ANIMAL WELFARE

2.1.1 Brief history and concept

Food production systems have been modified and intensified after the Second World War in the context of industrialization and urbanization. All this happened in response to the need for more food production, added by new possibilities given the discovery of antibiotics and additives, genetics and chemical fertilizers (ROLLIN, 1995b; FRASER, 2008). The intensification of animal production brought consequences for the welfare of the animals involved. Animals raised in industrial farms have been genetically selected for high production. These animals are fed and housed in smaller spaces and in greater numbers than it would be in less intensive conditions, and in ways that lead them to develop at faster growth rates (FRASER, 2008). These conditions increased the incidence of death and diseases spreading among the animals, reduced or even eliminated their access to natural environments, as well as their potential to express their natural behaviours (D'SILVA, 2006; MCLEOD-KILMURRAY, 2012). It is recognized that intensive production systems cause more animal welfare problems than extensive systems (TUYTTENS et al., 2008).

Public concern over the welfare of farm animals gained evidence among society from the publication of the book names 'Animal Machines' by Ruth Harrison in 1964, denouncing such systems. The repercussion of this book led the British government to create a committee - Brambell's Committee, that in its report identified five essential freedoms that farm animals should enjoy: freedom to turn around, get up, lie down, scratch and stretch completely its members (VAN DE WEERD et al., 2008). Following on these developments, years later the Farm Animal Welfare Council (FAWC) built up and proposed minimum standards, also called five freedoms, which should be followed to ensure the welfare of animals in livestock systems. The five FAWC freedoms propose that animals should be free from hunger and thirst, from pain and disease, from discomfort, from fear and distress, as well as free to express their natural behaviour (FAWC, 2012).

Since then, the concepts of animal welfare have been widely debated by industry, activists, philosophers and the international scientific community. It has been proposed that animal welfare refers to the individual's ability to adapt to the environment where it is inserted; that animal welfare is something that can be measured scientifically, and that ranges from very good to very poor (BROOM, 1986; BROOM, 2011). Animal welfare is also conceptualized based on the affective state of the animals (DUNCAN, 2004). Another well-accepted conceptual line deals with animal welfare within a multidimensional approach, and encompasses the natural life, affective state and biological functioning of animals (FRASER et al., 1997). Thus, a good state of welfare could only be achieved when elements of natural life (such as fresh air and the ability to express natural and innate behaviours), affective needs (free from intense negative states such as pain and fear and being able of fell positive emotions) and the normal biological functioning (growth, health) of the animals are contemplated.

While BROOM (1991) proposes that animal welfare can be measured by indicators of the biological and behavioural status of animals, FRASER et al. (1997) add that people's moral and ethical values regarding animals and food production cannot be separated from the concept of animal welfare. Thus, their definition of animal welfare includes what they identify as the main concerns of people when questioned about the quality of life of farm animals: natural life, affective state and biological functioning. In this sense animal welfare, besides being a science, is also a human perception and it is on this basis that actions are taken in this regard.

The World Organization for Animal Health, in its role as an international standard-setting body for animal health issues, proposed a definition that encompasses most of the elements discussed above: “Animal welfare means how an animal is coping with the conditions in which it lives. An animal is in a good state of welfare if (as indicated by scientific evidence): it is healthy, comfortable, well nourished, safe, able to express innate behaviour, and if it is not suffering from unpleasant states such as pain, fear, and distress. Good animal welfare requires disease prevention and appropriate veterinary treatment, shelter, management and nutrition, humane handling and humane slaughter or killing. Animal welfare refers to the state of the animal; the treatment that an animal receives is covered by other terms such as animal care, animal husbandry, and humane treatment" (BAYVEL, 2004; OIE, 2017). All OIE member countries should then base their animal welfare actions upon this definition.

2.1.2 Animal welfare and the sustainability of agricultural production systems

Agricultural food production has been under an enormous pressure due to the need for feeding a growing human population, which has led to several situations that affected the ecosystem through loss of soil fertility, reduced water supplies, pesticides pollution and threat to biodiversity (TILMAN et al., 2011), all at a high expense of external energy (PIMENTEL et al., 2005). All these factors undermine the resilience of agro-ecosystems and threaten its sustainability. To achieve sustainability, agriculture should consider preservation of natural resources, especially soil and water, depend on a minimum of external inputs, make a more efficient use of non-renewable resources, and be able to recover from disturbances caused by cultivation or the climate; at the same time, it should be economically and socially viable, improving the quality of life and satisfying human needs (ALTIERI, 2002; PIMENTEL et al., 2005).

Many have proposed sustainable intensification of animal production as the only alternative to provide animal protein to a rapid growing human population (FOLEY et al., 2011; TILMAN et al., 2011; GODFRAY et al., 2014). It includes adopting a series of technical, political and technology transfer strategies to increase productivity while minimizing negative environmental impacts; for animal production, it means an emphasis on the production on monogastrics in intensive housing systems (STEINFELD et al., 2006; GARNETT et al., 2013).

However, many of the practices used in intensive poultry, pig and cattle farming are questioned by the public (CENTNER, 2010; PRICKETT et al., 2010; BOOGAARD et al., 2011a; HÖTZEL et al., 2017; SATO et al., 2017). In several countries of Europe and North America, research has helped identify the knowledge, views and attitudes of the public towards the systems and practices used in farm animal production, which has collaborated on political decision-making in these countries (VON KEYSERLINGK; HÖTZEL, 2015). For example, results of a survey with almost 28,000 citizens in 28 European Union (EU) countries indicate that the European public believes that farm animal welfare is of great importance (94%) and that it should be better protected than it was at the time (82%) (EUROBAROMETER, 2015). A previous version of this survey (EUROBAROMETER, 2007) showed that 89% of the European public believed that similar farm animal welfare standards should be applied to animal products imported

from other countries. In general, European citizens tend to express preferences for systems they consider “natural", such as those with outdoor access (BOOGAARD et al., 2011a; MIELE et al., 2011). European citizens oppose to farming systems that limit the movements of the animals, positioning themselves strongly against confinement (ELLIS et al., 2009; BOOGAARD et al., 2011a; MIELE et al., 2011). Research conducted in Canada and United States have also indicated widespread opposition to practices perceived as unnatural, such as tail docking in dairy cows (WEARY et al., 2011), early separation of dairy calf from its mother (VENTURA et al., 2013) and intensive confinement of dairy cows (SCHUPPLI et al., 2014). They also consider natural behaviours and access to outdoor areas more important than access to shelter, socialization, and comfortable bedding (PRICKETT et al., 2010). However, it is important to consider that different segments of the public hold different views on these issues (DE JONGE et al., 2013; HEERWAGEN et al., 2014; GRUNERT et al., 2018). For example, in a survey conducted in the Netherlands six groups of citizens were identified according to their attitude towards animal welfare, and only four of those scored animal welfare as one of the three most important attributes of the animal product (MEUWISSEN et al., 2007).

In Brazil, this issue has been less explored. A survey with 481 consumers in Brazil, most respondents said they had no knowledge of poultry production systems; after being presented with images of two different systems, over 90% of respondents related outdoor system with high animal welfare and 76% related intensive confinement with poor animal welfare; also 89% of them related higher animal welfare with better quality product (BONAMIGO et al., 2012). Other surveys with Brazilian citizens also detected a low level of knowledge about the practices adopted in animal production systems (DE BARCELLOS et al., 2011b; LUGNANI DE SOUZA et al., 2013; CARDOSO et al., 2017a; PACKER et al., 2017); however, they also identified some informed Brazilian consumers, who tend to assign value to animal welfare and to relate high animal welfare standards with higher quality products (DE BARCELLOS et al., 2011b; LUGNANI DE SOUZA et al., 2013).

Animal welfare is increasingly considered an important societal ethical concern and therefore, there is a need to integrated animal welfare within the concept of sustainable agriculture. instead of having it to compete with environmental issues (ROLLIN, 2006; FRASER, 2008; LAWRENCE, 2008; HÖTZEL, 2014). As a component of the social aspect of sustainability, society’s values and expectations

regarding farm animal welfare should be integrated into the food production sectors, because only then this sector will have the support of the society and governments (KRYSTALLIS et al., 2009; VERBEKE et al., 2010; VON KEYSERLINGK et al., 2013). After all, in the long-term, sustainability depends on the solution of the social problems that are constantly emerging. Sustainability is a continuous adjustment process, and as so, new and current problems need to be addressed (TAINTER, 2011).

2.1.3 Regulatory measures and industry actions around the world

Many countries have implemented laws regulating the treatment of farm animals used for agricultural production, specifying with details the methods used in handling and housing animals, including banned practices. In Europe, regulation through laws has been the main approach used to ensure minimum welfare conditions are met for farm animals; meanwhile, higher animal welfare standards are increasingly encouraged by the market through certification programs (BLANDFORD et al., 2014). The first EU directive enacted in 1986 and concerned the welfare of laying hens; since then, a detailed set of directives has been adopted on husbandry, transport and slaughter of farm animals and there are specific regulations for laying hens, calves, pigs and broilers (VON KEYSERLINGK; HÖTZEL, 2015). Farm animal confinement in conventional cages is banned in the EU since 2012 (STEVENSON, 2012). Each EU Member State has its own legislation that must at minimum comply with EU requirements, while some countries such as Germany, set standards beyond requirements. Furthermore, some countries outside the EU, such as Norway and Switzerland have strict requirements (TOMASELLI, 2003).

In the United States (US), private sector initiatives to change farming systems have been more prominent than legislative initiatives, although there is a growing trend for law regulation (BLANDFORD; HARVEY, 2014). The private sector has triggered most farm animal welfare programs currently active in the US. Major retailers, food services groups and animal producers have developed and implemented animal welfare standards. US producer groups, like the North American Meat Institute (NAMI, 2017) and the United Egg Producers (UEP, 2016a) have developed voluntarily welfare guidelines for the handling of animals. Additionally, within the last decade there has been an increase in legislative activity at the state level. Until 2018, 10 states had passed laws prohibiting the use of conventional cages housing in

farming systems, and many others are currently discussing similar laws (ASPCA, 2018).

Other countries have adopted codes of practice to change farm animal production practices. For example, conventional cages systems were prohibited in New Zealand since 2015 by the Code of Welfare established in 2010 (MPI, 2015). The Canadian swine industry established a Code of Practice for the care and handling of pigs, which includes phasing out the use of gestation stalls housing for sows. The Code developed by the National Farm Animal Care Council requires all new facilities or replacements of existing units after July 2014 operate as group housing system (NATIONAL FARM ANIMAL CARE COUNCIL, 2014). In Australia, after several years of research on alternative systems for gestating sows' housing, starting 2017 the swine industry voluntarily agreed to change all conventional gestation stalls for group housing or stalls with more space allowing the animal to turn around (AUSTRALIANPORK, 2018). Similarly, in South Africa, the South African Association of Pork Producers also expect to end the practice by 2020 (SAPPO, 2011; SAPPO, 2013).

Animal welfare in Brazil was officially considered through a regulation introduced by the Ministry of Agriculture, Livestock and Food Supply in 2008 (MAPA, 2008). In 2011, the "Permanent Technical Committee on Animal Welfare" was established with the goal of developing standards and technical recommendations of good practice for animal welfare (MAPA, 2011). Since then, discussions on transport and slaughter of farm animals have called for improved standards and legislation. This committee includes government officials and industry representatives, but it does not include members of the public (VON KEYSERLINGK; HÖTZEL, 2015).

Along with these regulatory measures, the industry has responded with some changes as a measure to strengthen the confidence of its consumers. Some US and EU fast food chains like McDonald's, Wendy's and Burger King started to demand animal welfare standards from their animal products' suppliers, committing initially to purchase a percentage of cage free pork and eggs to use in its restaurants (MAILONLINE, 2012). Supermarket chains also adopted this policy (WILCOX, 2016; FOODLION, 2016). In January 2014, the largest US pork processors reaffirmed their commitment to phase out the use of gestation stalls housing in their supply chains (SMITHFIELD FOODS, 2014; TYSON FOODS, 2014). In Mexico, since 2014, major food companies are committing to buy 100% cage-free eggs in a few years'

time (HSI, 2015). McDonald's reaffirmed for the next decade this same commitment for their Canada and US chains (AP, 2015).

In the last five years, some sectors within the Brazilian industry have also indicated recognizing attitude changes towards farm animal welfare among the Brazilian public. Many marketing campaigns have valued practices that citizens expect from animal production systems, such as raising farm animals in "natural environments", and associations between animal health and product quality (for example, https://www.youtube.com/watch?v=OiFvPw2hpnE&feature=em-subs_digest). Actions towards the transition from gestation stalls to group housing launched by multinational retail chains and processors that are operating in Brazil, even if timidly, are already reverberating in the country. For example, Arcos Dourados, McDonald's supplier in Brazil, and Nestle have announced that their local suppliers will have to adopt collective housing systems in the coming years (SUINOCULTURAINDUSTRIAL, 2014). BRF, JBS and Aurora Alimentos, the largest integrators of domestic pig production, announced that they will phase out the confinement of sows in gestation stalls by 2026 (HSIBRASIL, 2015b). In last December, the largest bakery company in Latin America, announced the commitment to ban the use of battery cages for laying hens on their egg supply chain in Brazil and around the world by 2025 (HSIBRASIL, 2015a).

2.2 BELIEFS, ATTITUDES AND PERCEPTIONS OF CITIZENS, CONSUMERS AND STAKEHOLDERS ASSOCIATED WITH ANIMAL PRODUCTION

2.2.1 Beliefs, attitudes and perceptions

To discuss the beliefs, attitudes and perceptions of the different stakeholders interested in farm animal production, some definitions are required. Beliefs and attitudes are strongly related to people's behaviours (AJZEN, 1991), therefore they are an interesting way to understand how individuals behave and how they justify or position themselves in relation to their actions (FAGUNDES, 2012). Beliefs are based on the information that an individual has about an object, which they connect the object to some attribute. The object of a belief can be a person, a group of people, an institution, an event, a behaviour; the associated attribute can be any object, trace, property, feature, quality, outcome or event (FISHBEIN et al., 1975). According the same authors, attitudes refer to the evaluation, positive, negative or neutral, that an individual

makes of objects, people and events, or of some of their attributes. Attitudes are composed of beliefs (cognitive), feelings (affective) and action trends (behaviour). Thus, attitudes are formed as a result of learning and of direct experiences with people or situations and help to define how an individual feel and react to a certain situation or object. Attitudes come with different strengths, they influence our decisions, guide our behaviour and impact our selective memories; like most things that are learned or influenced by experience, they can be measured and changed (PICKENS, 2005). Attitudes cannot be observed directly, but can be inferred from the individuals' self-reports and behaviours (SCHWARZ, 2008).

The attitudes of an individual are also influenced by his social environment, just as his social environment is influenced by his attitudes; these interactions can cause conflicts between the attitude and the individuals' behaviour (PICKENS, 2005). For example, a survey investigating purchase habits of sustainable products identified two groups of consumers. One group had a favourable attitude towards sustainable products, but did not purchase this products due to the lack of availability of these products on the market. The other group of consumers had no favourable attitude towards sustainable products, yet they still intended to buy them; purchase intention, despite poor attitude, was explained by the influence of the social environment, i.e. the need to follow social norms and meet the expectation of third parties (VERMEIR et al., 2006).

These conflicts can lead to an inconsistency between two or more attitudes or between attitudes and behaviour of an individual, which is known as cognitive dissonance (FISHBEIN; AJZEN, 1975). According to these authors, two factors affect the strength of the dissonance: the number of dissonant attitudes/behaviours and the importance attached to each of them. There are three ways to eliminate dissonance: to reduce or forget the importance of the attitudes/behaviours in conflict (dissonant), to add new information or beliefs that will increase consonance, and to change or remove the conflicting attitude or behaviour. The dissonance can result in some ego defence mechanisms as rationalization or denial of evidence. Denial is the refusal to accept a fact or reality, acting as if a painful event, thought or feeling does not exist. The more rooted in the individual's behaviour an attitude is, the stronger the reaction to deny opposing attitudes, resisting to the information about which they do not want to think, avoiding the emergence of conflict and the break off old habits (FISHBEIN; AJZEN, 1975).

The process by which an individual select, organizes and interprets sensations to produce a meaningful experience of the world is called perception (PICKENS, 2005). Perceptions are related to attitudes. That is to say that when a person is exposed to a situation or stimulus, she interprets it as something meaningful to her based on her previous experiences, motivations, interests, and expectations. Therefore, given that perception is strongly influenced by the personal characteristics of the perceiving individual, what an individual interprets or perceives may be considerably different from reality (PICKENS, 2005). The individual's awareness and acceptance of a stimulus plays an important role in the process of perception. Receptivity to a stimulus is highly selective and can be modulated by beliefs, attitudes and motivations, as well as by the individual's personality (ASSAEL, 1984). The individual selects the stimuli that satisfy his immediate needs and may disregard those that can cause him psychological anxiety. People are selective in what they perceive and normally filter the information based on their ability to assimilate new content in combination with their preconceived ideas (PICKENS, 2005).

2.2.2 The individual as citizen and as consumer

The concept of the citizen has been used as an expression of equality, to eliminate differences between human beings (we all are citizens, therefore, we all are equal); more narrowly, the concept refers to individuals who have public responsibility, including the right to participate in political decisions (DALLAN, 1984). The citizen carries a moral point of view, perceiving himself as an equal member among many, and is involved in the activity of cooperation within a community for mutual benefit. He recognizes not only his rights and responsibilities, but also those of others. His moral values are independent of economic values. Citizenship should be considered as a historical process, based on rights and institutions. The practice of citizenship is related to the establishment of a democratic society, considering democracy not only as a political regime, but also as a form of sociability that fits into social spaces (DALLAN, 1984). Citizenship requires not only knowledge and information but political participation, cultural engagement, activism, among other attitudes and actions related to the transformation of the individual into a global citizen and a socially responsible agent (GIROUX, 2004). Voting is the decisive way for citizens to participate in the destinies of politics; but there are other behaviours related to the role of citizen that allow him to control the

collective decisions that affect his life – such as writing letters and petitions, organizing in pressure groups, voluntary associations, among others – in order to give voice to certain concerns towards society as a whole (DALLAN, 1984).

A consumer is defined by economists as an individual who buys (spends money) and by nutritionists and health professionals as an individual who eats the product in question (KNEAFSEY et al., 2008). Unlike citizens, who find expression on all aspects of the cultural, social, political and economic life of the public sphere, consumers' means of expression are restricted to the marketplace (LEWIS et al., 2003). A consumer's activity consists in the act of selecting and buying products in a market where items from several origins compete for space on the shelves (HILMES, 2004). Consumers' behaviour tends to vary over time, it is individualistic, motivated by the desire to maximize satisfaction and preference; their values are interpreted as prices (willingness and ability to pay) (PARTRIDGE, 2003).

The consumer is more concerned with the price, flavour and nutrient content of food, and only takes his needs into account (BENNETT et al., 1996); the citizen is also concerned with issues such as place of origin, environmental protection, animal welfare and fair trade (SAGOFF, 1998). The consumer could hardly suggest market changes that would allow all people access to nutritious food at a price they can afford; as a citizen, the options and even the choices open up considerably (CAROLAN, 2014).

2.2.3 The citizen, the consumer and the animal industry

After the Industrial Revolution, in parallel with the strong industrialization of agriculture, people came to be presented with a greater variety of food products and situations that turned food choice into a difficult decision (CONNORS et al., 2001). For example, the complexity of the issues surrounding meat consumption today is extensive; people need to consider personal and family health, financial, social, environmental and animal welfare issues, which in turn are influenced by a variety of factors, including their sociodemographic characteristics (CLONAN et al., 2015).

Values (i.e. defined as enduring beliefs that guide and motivate behaviour, assist in conflict resolution and decision making) are identified as important in food choice, providing guidelines for eating behaviour (HITLIN et al., 2004). A study on consumer values related to food choice (CONNORS et al., 2001) identified five major values,

including flavour, health, cost, time and social relationships, and some secondary values, including ethics. This same study also identified that the consumer's attitude towards a specific issue is susceptible to change or even annulled, if this attitude responds to conflicting issues. For example, if in the given moment that the consumer is pleasured eating meat he relates the meat to the life of the animal, he may have his attitude modified or annulled; another example is if at the time of purchase, the consumer relates the price of the product to his earnings.

The relationship between the views of citizens and their behaviour as consumers was found to be quite weak and did not appear to greatly or systematically influence meat-buying habits (VERBEKE et al., 2010). The now well accepted consumer "attitude-behaviour gap" suggests a weak link between the individuals' beliefs and their buying actions (SHEERAN, 2002; LAGERKVIST et al., 2011; CLARK et al., 2017). This attitude-behaviour gap refers in particular to the purchase of food of animal origin, for two reasons: first, consumers avoid linking the animal to the food produced by it or from it; second, consumers generally lack knowledge about animal production systems (SCHRÖDER et al., 2004). Citizens of urban areas in the Netherlands stated that they preferred to deny the subject of animal welfare in intensive livestock farming (BENARD et al., 2013). Denial is a well-known strategy of the individual to stay aloof and thus deal with his ambiguity (TE VELDE et al., 2002; SERPELL, 2004). Individuals seem to live in 'wilful blindness', i.e. they are wilfully blind to what they know, or 'conveniently forget' that there is something they must know; this is how individuals seek to avoid changes in their lives that could harm them (GJERRIS, 2015; BELL et al., 2017). By not reflecting on intensive animal production, the individual continues to eat meat without concern for the effects of these systems on the animals, the environment and climate (BENARD; DE COCK BUNING, 2013). This is what allows them to see themselves as moral beings, although the lack of reaction to the effects of their actions, according to Gjerris (2015), tells another story.

Researches in European countries have shown that although consumers have a number of concerns about animal production systems, they recognise not relating or relating little these concerns to their buying behaviour (VERBEKE et al., 2000; NGAPO et al., 2004). The fact that people are concerned about animal welfare and other aspects of animal production is not inconsistent with the fact that this concern affects only occasionally their buying behaviour (GRUNERT, 2006). For example, although 74% of Europeans interviewed say that they

believe that buying products from animal welfare systems would have a positive impact on them, 60% of them are willing to pay only 5% more for this product (EUROBAROMETER, 2007). This same pattern is corroborated in many other studies analysing the consumers' intention to pay more for animal products with attributes of animal welfare (CARLSSON et al., 2007; LILJENSTOLPE, 2008; TONSOR et al., 2009; LUSK et al., 2011).

According to Aarts and Te Velde (2001), people tend to respond survey questionnaires as citizens rather than as consumers; and in this role, they pay more attention to animal welfare than when in the market as consumer. A survey of consumers' willingness to pay for better food safety standards in restaurants found that when participants responded in their role as citizens they were more willing to pay than when responding in their role as consumers (ALPHONCE et al., 2014). Other studies have found similar results (CURTIS et al., 2002; WISER, 2007), indicating a support for regulatory initiatives, even at some cost, what they would intentionally not pay to avoid as consumers (ALPHONCE et al., 2014). However, the weak relationship between negative attitudes towards production systems and buying behaviour does not necessarily mean that this attitude does not influence other behaviours. For example, in a survey in Australia, 60% of participants said that they consider animal welfare as issue of great importance; they also stated that this attribute does not influence their food animal products buying habits but influences their willingness to engage in community behaviours, such as working as an activist, donating money to animal welfare non-governmental organizations (NGOs), or writing letters to newspapers and politicians (COLEMAN et al., 2005).

Given that, as consumers, people buy and are listened in supermarkets, and as citizens they participate in political processes and public opinion formation (GRUNERT, 2005), relying on consumer surveys that focus on buying context may underestimate public support for new regulations in the food industry (ALPHONCE et al., 2014). The striking changes in animal welfare regulation in the last decade in the US are an example of this scenario. In 2008 in California, US, there was a major campaign by animal welfare NGOs (HSUS, 2008) in favour of a referendum (Proposition 2) to prohibit the confinement of production animals in conventional cages; because of this, citizens took notice of this practice of the animal industry, and stood in favour of the change, through their vote. This electoral initiative of 2008, approved with 63.4% of votes was promulgated as a Law to Prevent Animal Cruelty in Production and prohibits, since January 2015, the confinement of farm

animals for most of the day in ways that do not allow the animal to turn freely, lie down, get up and fully extend their limbs (LAO, 2008). Regulatory and commercial initiatives of this type can create considerable problems for producers, who are not always able to adapt to the required system, either because of time or investment power, or because their product ends up with a price above the traditional market. In 2010, as a measure to protect local producers, California also instituted by law that, from January 2015, all eggs sold in the state must be produced in compliance with Proposition 2 (LAO, 2010). These decisions triggered a series of rapid regulatory changes in various states of the United States (CENTNER, 2010); Washington passed a legislation in 2011 phasing out battery cages; Maine in 2009 and Rodhe Island in 2011 banned by legislation the use of calf and sows' cages; and Michigan in 2009 passed a legislation and Ohio in 2010 a regulation restricting the use of conventional cages of calves, sows and laying hens (HSI, 2014; BALLOTPEDIA, 2016; ASPCA, 2018). Massachusetts implemented stronger laws trough a ballot measure in 2016, which banned the use of battery cages, gestation crates and veal crates and outlawed the in-state sale of products from any of these confinement systems (ASPCA, 2018).

2.2.4 Lay citizens' disconnection with the reality of animal production systems

Despite the high levels of concern people show towards farm animal welfare (EUROBAROMETER, 2007; PRICKETT et al., 2010; MCKENDREE et al., 2014; YOU et al., 2014), most people are not aware of how animals are reared in production systems (NORWOOD et al., 2011; CARDOSO et al., 2017a), and devote little or no thought to the quality of life of farm animals they consume as food (NAALD et al., 2011). In recent years, people have disconnected from the reality of how their food is produced, processed and marketed (ROLLIN, 1995a; SCHNEIDER, 2009). This disconnect is the result of the complex interaction of several important processes, including urbanization, agricultural industrialization, the growth of processor and food retail power, the contentious governance of international trade, as well as changing lifestyles, expectations and consumer practices. It also results from modern production processes that are increasingly complex and less transparent to the consumer (KNEAFSEY et al., 2008). The transparency that industry very often calls out is very limited to inform the consumer about country of origin and country of packing

(MEUWISSEN et al., 2003). Indeed, the agricultural processes and system are usually misreported in the media (RUTH et al., 2005).

However, increased educational level lead to increased public concerns about how, where, and by whom the foods we consume are produced, processed, packaged, and presented (HUGHES, 1995); in addition to seeking food safety, consumers also hope to eliminate or lessen the guilt related to on how food animal products are produced and prepared for consumption. Still, according to the author, these increased educational levels do not necessarily mean that people have a better understanding of animal production. Production systems have changed in such a way that they fail to take sufficient regard of consumer preferences, societal values, or sustainability; instead they often rely on images of 'family farming' to keep consumers misinformed (SCHNEIDER, 2009). Thus, the animal industries do not always act openly and honestly about the way animals are treated. This situation seriously impairs industries' image, generates distrust on the part of the public and sometimes results in important effects for those involved, once transparency is currently highly desired by consumers (GOODWIN et al., 2011; PAPAOIKONOMOU et al., 2011). In fact, many of the changes in the productive systems of large companies (see item 1.2) were announced shortly after media scandals, usually organized or stimulated by animal protection organizations.

Animal welfare is an attribute of trust, which means that it cannot be directly observed by the consumer at the time of purchase. Therefore, the consumer depends on external information and must rely on sources of information (VERBEKE et al., 2007). Because most people in urban societies learn about food production systems through scandals reported by the media, and because of their disconnection from these productive processes, people are often not able to judge or evaluate them (KNEAFSEY et al., 2008). Information from the media can affect food choice by influencing consumer knowledge, shaping their attitudes and redirecting his decisions (VERBEKE et al., 2007). In addition, these food scandals typically carry a greater burden on an individual at the time of purchase than positive or favourable news (CHANG et al., 1991; VERBEKE et al., 2001), and it is easier for consumers to believe that companies are unethical rather than ethical (FOLKES et al., 1999). A survey with more than 800 consumers concluded that they did not really trust anyone to give them unbiased and objective information about their food (DUFFY et al., 2005). Others also have shown low trust in most sources of information regarding animal welfare (WOLF et al., 2016). Also, the industry's attempt to restrict public access to images of

production systems that may influence their opinions can have opposite effects, reducing citizens' confidence in producers (ROBBINS et al., 2016).

Survey participants often admit lack of knowledge about current production practices, but also express interest in obtaining knowledge (SPOONER et al., 2014a; CARDOSO et al., 2017a). Participants of a survey in Belgium stated that there was little information available on animal welfare at the time of purchase process (VANHONACKER et al., 2010). These same participants were in favour of a label on the product focused specifically and exclusively on animal welfare, and in a transparent way to communicate this information. Consumers' desire for better product labelling was also found in several studies, with many reporting misinformation, lack of clarity and distrust on existing labels (NGAPO et al., 2004; UUSITALO et al., 2004; VERBEKE, 2009; LUGNANI DE SOUZA et al., 2013).

Knowing the primary sources of information is important to comprehend to whom the public rely as guidance on animal welfare issues (MCKENDREE et al., 2014). Tonsor and Wolf (2010) suggested that the public's credibility of the source of the information related to animal welfare is particularly influential in the decision to support changes through voting. When asking about sources of information, respondents normally ask for credible and understandable information (VANHONACKER et al., 2010). A survey found that 56% of the participants did not have a source of information on animal welfare, and of those who had, most relied on information coming from animal protection groups (MCKENDREE et al., 2014). Others found a lack of trust in information coming from governmental and food industry sources (HARPER et al., 2002). Belgian respondents would prefer the information to come from a source free of personal interests, such as government (VANHONACKER et al., 2010).

2.2.5 Differences and convergences between lay citizens and stakeholders associated with livestock production

As discussed earlier, people show a diversity of opinions, preferences and concerns on the way animals used for food production are cared for, and regarding animal welfare, productivity and food quality. This diversity of opinions exists also among people with different degrees of association with animal production (TE VELDE et al., 2002; DOCKÈS et al., 2006; LASSEN et al., 2006b; BOCK et al., 2007; DE ROOIJ et al., 2010; CANTRELL et al., 2013). In general,

people not associated with animal production have a more negative perception about the quality of life of farm animals in productive systems than those associated with animal production (VANHONACKER et al., 2008; COLEMAN et al., 2016). Approximately 83% of Europeans surveyed evaluated the welfare of farm animals reared in the EU as being moderate to very poor and 78% strongly agreed that more action is needed to improve the quality of life of these animals (EUROBAROMETER, 2007). Producers, on the other hand, generally assess the welfare of their animals as very good (TE VELDE et al., 2002; BENARD; DE COCK BUNING, 2013).

The differences between the groups also occur in issues identified as important to ensure animal welfare. Lay citizens tend to associate well-being with space for the animal to move and freedom to express its natural behaviours (LASSEN et al., 2006b; VANHONACKER et al., 2008; CARDOSO et al., 2016b). Access to free-range and to pasture is also important for this group of people (ELLIS et al., 2009; MIELE et al., 2011; CARDOSO et al., 2017b), which also rejects practices that cause pain (FREDRIKSEN et al., 2011; ROBBINS et al., 2016; CARDOSO et al., 2017a). Stakeholders associated with animal production tend to give more emphasis to health and to the biological functioning of the animal (LASSEN et al., 2006b; SPOONER et al., 2012; DUIJVESTEIJN et al., 2014; TUYTTENS et al., 2014), features that directly impact productivity. Although they recognize the ability of animals to feel pain, they argue that some practices are essential to guarantee production (VANHONACKER et al., 2008; PHILLIPS et al., 2009; SPOONER et al., 2012; CARDOSO et al., 2016b). In addition, stakeholders believe in technology and intensification as a way to reduce costs (HORLINGS et al., 2010; HÖTZEL et al., 2013). However, there are exceptions to this latter view; for example, a survey with milk producers in Sweden (HANSSON et al., 2016) concludes that although the profitability of the business is important, treating their animals appropriately and consequently caring for the animals' feeling of happiness are equally or even more important than profit. In fact, veterinarians often overestimate the emphasis producers give to cost when deciding to opt for animal-friendly practices (BERNIERI, 2016; CARDOSO et al., 2016c; HAMBLETON et al., 2017).

Additionally, some surveys also show that people associated and not associated with animal production have conflicting views of each other. The first criticism of lay citizens has been usually directed at farmers/producers, who have been pointed as "guilty" in this history. Surveys shows that Danish pig producers presented themselves as

naturally involved with animals and their needs, and reported felling misunderstood in being portrayed by lay citizens as indifferent to the animals' needs (BOCK; VAN HUIK, 2007); farmers from The Netherlands also reported feeling uncomfortable with accusations of mistreating animals (TE VELDE et al., 2002). In other surveys, producers considered citizens ignorant of animal production systems and practices, and justified that citizens negative opinions are usually based on their limited knowledge about farm animals (HOLLOWAY, 2004; BENARD; DE COCK BUNING, 2013). A few points of consensus and a very limited amount of shared values between urban citizens and pig producers were identified (BENARD; DE COCK BUNING, 2013).

In this conflict, the animal industries took the side of the citizens, and began to demand changes from their producers (AP, 2015; HSI, 2015). This was undertaken as a strategy to gain the confidence of their consumers, as the public often relate the industry's interest in animal welfare as being economic and profit oriented (KENDALL et al., 2006). However, although the industry normally claims to encompass the five freedom principles for farm animals into their animal production systems (e.g., BRF, 2018), they limit their animal-welfare oriented actions to provision of water and feed, maintaining high standards of health and biosecurity, and some initiatives to ban highly restrictive housing (SUINOCULTURAINDUSTRIAL, 2014; HSIBRASIL, 2015b). Other aspects of the production systems that limit the expression of natural behaviour and impact the freedoms "from pain, from discomfort, and stress" have received some shy attention, limited to local initiatives and specific practices. One example is the call for banning the killing of male chicks (UEP, 2016b), and castration of male piglets (DE BRIYNE et al., 2016).

2.3 CONCLUDING REMARKS

Society's perceptions of animal production play a large role in the future of the industry. The treatment given to farm animals used in animal production is an issue that increasingly calls for attention as people are becoming more interested in the ways at which animal derived food is produced. The quality of food is also measured by the ethics of its production, including the consequences impinged upon the animals, the environment, producers and consumers. Although people report little knowledge on animal production systems and practices, they consider animal welfare as an important issue to be addressed and

usually show preference for systems where animals have space and freedom to express their natural behaviours, and do reject the use of practices that cause harm and suffering to the animals.

Little yet is known about the views and preferences of Brazilians citizens regarding farm animal welfare or food animal production systems. Brazilians are believed to have limited knowledge of current animal industry practices and it is expected that they will not have a positive view when informed about them. It is likely that Brazilians' opinion is not different from those presented by people of North America or European countries, were the subject has been extensively studied and debated among all stakeholders. Considering the distinction between citizens and consumers, special attention should be given to citizens' concerns, as they make up most of the decision makers, voters, and supporters for legislative policies and procedures. Additionally, there is no information on how Brazilians may react to the changes already introduced in our animal production system through requirements from international retailers and NOGs, such as group housing for gestation sows.

3 BRAZILIAN CITIZENS' OPINIONS AND ATTITUDES ABOUT FARM ANIMAL PRODUCTION SYSTEMS

ABSTRACT

The inclusion of societal input is needed for food animal production industries to retain their "social license to operate"; failure to engage with the public on this topic risks the long-term sustainability of these industries. The primary aim of this study was to explore the beliefs and attitudes of Brazilians citizens not associated with livestock production towards farm animal production. A related secondary aim was to identify the specific beliefs and attitudes towards systems that are associated with restriction of movement. Each participant was shown pictures representing two of five possible major food animal industries (laying hens, beef cattle, pregnant sows, lactating sows, and poultry meat). Participants were presented a six pages survey that included demographic questions plus two sets of two pictures and a series of questions pertaining to the pictures. Each set of pictures represented a particular industry where one picture represented a housing type that is associated with behavioural restrictions and the other picture represented a system that allowed for a greater degree of movement. Participants were asked their perceptions on the prevalence of each system in Brazil, then their preference of one picture vs. the other, and the reasons justifying their preference. Immediately following, the participant repeated the same exercise with the second set of two pictures representing another industry followed by the same series of questions as described above. Quantitative data were analysed with mixed effects logistic regression, and qualitative responses were coded into themes. The proportion of participants that believed animals are reared in confinement varied by animal production type: 23% (beef cattle), 82% (poultry), 81% (laying hens), and 60% (swine). A large majority (79%) stated that farm animals are not well-treated in Brazil. Overall, participants preferred systems that were not associated with behavioural restriction. The preference for free-range or cage-free systems was justified based on the following reasons: naturalness, animals' freedom to move, and ethics. A minority of participants indicated a preference for more restrictive systems, citing reasons associated with food security and food safety, increased productivity and hygiene. Our results suggest that the majority of our participants, preferred farm animal production systems that provide greater freedom of movement, which aligned with their perception that these systems are better for the animal. Our results provide some evidence that the current farm animal housing practices

that are associated with restriction of movement, which are gaining traction in Brazil, may not align with societal expectations.

Keywords: Animal welfare. Ethics. Livestock production. Qualitative research. Survey

3.1 INTRODUCTION

In many developed and developing countries, familiarity and knowledge about farm animal production systems has decreased among the general public due in part to the growing distance between locations where agriculture practices take place and where the majority of consumers live (MARIE, 2006; FRASER, 2008; SCHNEIDER, 2009). In addition to urbanization, some also argue that media and advertisements (BORKFELT et al., 2015) that reinforce the historical romantic view of agriculture (FRASER, 2008) also contribute to the growing lack of knowledge of modern agricultural production practices. This disconnect may explain why the lay public, when confronted with the realities of the intensive animal industries, frequently express negative attitudes towards them (VERBEKE et al., 1999; GRUNERT, 2006; KRYSTALLIS et al., 2009; HÖTZEL et al., 2017).

Livestock production practices vary widely, with specific practices viewed by the public as more or less favourable depending on what aspect is being questioned. For instance, the main animal welfare concerns raised by the public regarding the use of confinement (no outdoor access) and cage systems for farm animals are that they prevent animals from moving freely, provide inappropriate social contact, and are frequently associated with a barren environment with no outdoor access (EUROBAROMETER, 2007; BOOGAARD et al., 2011b; MIELE et al., 2011; SPOONER et al., 2012; YOU et al., 2014; CARDOSO et al., 2016b). European citizens identified caged hens, broilers and pigs as the top three farm animals they believed to have the poorest welfare (EUROBAROMETER, 2007). Similarly, New Zealand citizens (MAF, 2011) specifically identified these three farm animals as requiring the most improvement in terms of animal welfare standards and in need of legal protection.

Farm animal welfare issues have often been viewed to be a consequence of conflict between producers and citizens/consumers. Citizens' attitudes towards different food production systems are not only dependent on rational assessment of risks, benefits, economics, and nutrition, but also reflect ethical and moral considerations (PERHAC,

1998; BOOGAARD et al., 2011a). Positive responses from farm animal producers and retailers to society's concerns about controversial agricultural practices have led to some changes in livestock production practices in several countries (BAYVEL, 2004). Policy makers and industry stakeholders in some countries have also begun to consult the public in the process of defining acceptable livestock welfare standards (ROWE et al., 2000).

It has been argued that Brazilian lay citizens have little knowledge of animal production systems (DE BARCELLOS et al., 2011b; BONAMIGO et al., 2012). However, lack of knowledge does not mean that they have no concerns or negative attitudes toward current animal production practices and systems. For example, urban Brazilians were reported to be concerned with food quality, view food additives, hormones and pesticides as hazards (BEHRENS et al., 2010; KHER et al., 2013; HÖTZEL et al., 2017) and have negative attitudes towards genetically-modified food, based on perceptions of risk and lack of naturalness (GUIVANT et al., 2015; RIBEIRO et al., 2016). Several studies on public views of farm animal's production systems have been undertaken in Europe and North America (BOOGAARD et al., 2006; MIELE et al., 2011; VENTURA et al., 2013; SPOONER et al., 2014b; RYAN et al., 2015; CARDOSO et al., 2016a). This issue, however, has received considerably less attention in Brazil, a leading food animal producing country and a large urban consumer market (IBGE, 2011; VON KEYSERLINGK; HÖTZEL, 2015).

The primary aim of this study was to explore the beliefs and attitudes of Brazilians not associated with livestock production towards farm animal production, and the underlying reasons. A secondary aim was to identify the specific beliefs and attitudes towards systems that are associated with restriction of movement.

3.2 MATERIALS AND METHODS

This study was approved by Ethics Committee on Experimentation of the Santa Catarina State University 1.111.587 (22/06/2015).

3.2.1Participants' Recruitment

Participants were recruited exclusively through direct approach at locations known to be associated with intense movement of people or waiting times, such as technical and scientific events and fairs, the local

airport and interstate bus terminal in Florianópolis, Santa Catarina. These venues provided the opportunity to identify participants of both sexes, of different ages and geographic backgrounds. To increase the diversity of public opinions we tried, whenever possible, to achieve a balanced distribution between participants' sex and ages.

Participants were approached randomly and asked to voluntarily participate in the survey. Conditions to participate in the research were that the participant was at least 18 years old, a Brazilian citizen and was available and interested in voluntarily answering a short questionnaire covering the general theme "animal production". Each participant received a consent form that they were asked to read and if they agreed to participate were required to sign before they began the survey that was 6 pages long and included a total of 19 questions and two sets of two images. The identity of the participants was not required.

3.2.2 Description of the Survey

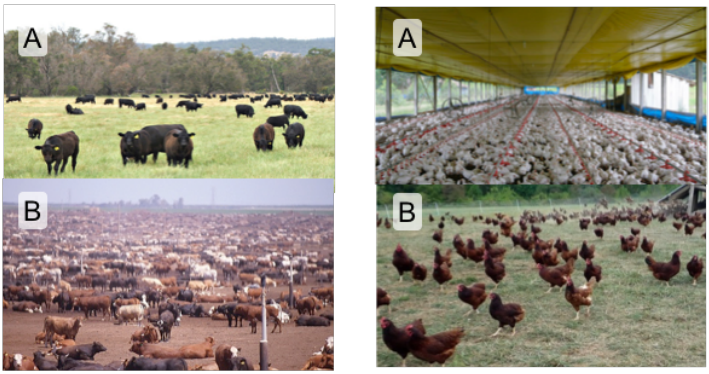
Data collection was conducted during the months of September 2014 to June 2015.

The first questions addressed participants' socio-demographic information relating to sex (male, female), age (18–25, 26–35, 36–45, 46–55, 56–65, over 66 years), education (elementary school, high school, or higher education), the region of Brazil which they viewed to be their primary residence (south, southeast, north, northeast, midwest), whether they lived in a rural area, small town (up to 20,000 inhabitants), medium town (from 20,000 a 100,000 inhabitants), large city (more than 100,000 inhabitants), or metropolis (more than one million inhabitants), if they had ever lived outside the country (yes, no), and their level of association with livestock production ("not associated"– no ties with the animal industries – or "associated"– any ties with the animal industries such as veterinarian, livestock production professional, consultant/manager, producer, student or faculty in any field of animal agriculture). Participants were also asked how informed they considered themselves to be regarding animal production (very informed, somewhat informed, intermediate, somewhat uninformed, totally uninformed); their main sources of information about raising animals used for food production (multiple choice: internet, TV or radio (general programs), TV or radio (rural programs), newspaper (printed or electronic), specialized magazines, animal protection society websites, university, friends, other); if they consumed animal products (yes, no); if they considered farm animals in Brazil to be well-treated (yes, no); and

finally, how much they cared about the quality of life of the animals used in food production (very, intermediate, not at all).

Two pages with two images each were presented to each participant but separated by three questions that were repeated after each set of pictures. Each page showed a set of two images showing the same species but in two different production systems: free-range beef cattle and beef cattle in intensive open-air confinement (feedlot); free-range broilers or broilers in intensive indoor confinement; free-range laying hens or layers in battery cages; free-range farrowing sows or sows in farrowing cages; and, group housed gestating sows or gestating sows in individual cages. Each respondent compared one example of a non-confined system with a confined cage-free system for the same species (either beef cattle or poultry, Figure 1a) and one example of cage-free system with a caged system for a second species (either laying hens, gestating sows, or farrowing sows, Figure 1b). The order of the images was randomized so that each set of paired images (cases) appeared 50% of the time either as the first or second. After each set of paired images the respondent was asked to indicate their knowledge of the prevalence of these systems ("In your opinion, which of these situations is the most common in commercial production in Brazil?" and offered as answer with choices "A", "B", "both are equally common in Brazil", "neither is common in Brazil" and "I do not know"). The respondent was then asked to indicate their preference for one of the two systems ("Which situation would you like to be the more common in animal production in Brazil?" with the answer options "A" and "B"). Finally, the respondent was asked to justify their preference with an open answer ("Please justify briefly why you prefer the livestock system you indicated above").

a.



b.

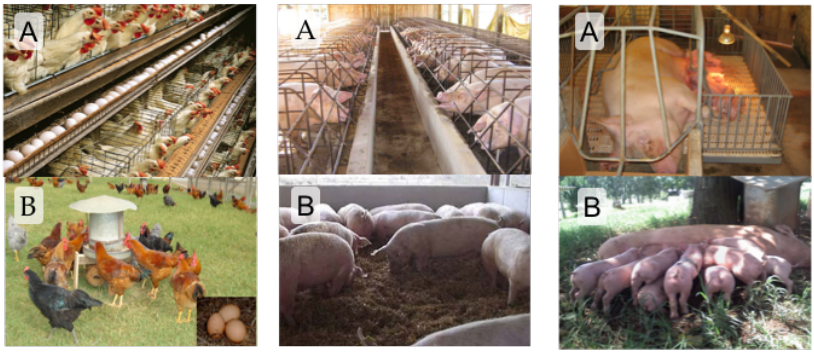


Figure 1. Each respondent was presented with a series of photos (a) one example of a non-confined system and a confined cage-free system for the same species (either beef cattle or poultry), and (b) one example of a cage-free system and a caged system for a second species (either laying hens, gestating sows, or farrowing sows). The order of the photos was randomized so that each set of paired photos appeared 50% of the time either as the first or second. In each case respondents were asked "which situation (A or B) would you like to be the more common in animal production in Brazil?"

The entire questionnaire was initially tested using 20 randomly recruited participants, with their responses used to refine the questionnaire prior to release. The images used in the questionnaire were also tested to ensure that they represented the issue we intended to

address and avoid examples that participants may have considered "extreme" of a given situation. To ensure that images followed this criterion, six people (three experts in animal production and three lay people) were consulted. Images that were considered to convey a typical example of a given production system were selected for use. After the initial testing, we concluded that presenting two cases yielded the most detailed answers and justifications. In contrast, when we provided three or more cases many respondents answered subsequent questions with phrases such as "same as previous", or "same reason".

3.2.3 Data Analyses

Approximately 100 responses were collected for each case, totaling 612 questionnaires, which were considered complete if the respondent completed the entire questionnaire. Participants with any level of association with livestock production were excluded from the current analysis, resulting in a final sample of 479 completed questionnaires.

To analyse the quantitative data, we used a mixed effects logistic regression that was fitted accounting for the random effect of region. Two models were fitted: one assessed respondents' preference for cage or cage-free systems, and the other the preference for confined or free-range systems as response variables. Explanatory variables were screened using univariable analysis, with variable having a $p < 0.2$ included in the final multivariable models. Models were reduced using manual stepwise backward elimination using a $p < 0.05$ as threshold for keeping the predictors in the model. Explanatory variables tested were: sex, age, education, rural or urban living, how informed respondents considered themselves to be regarding animal production, if they considered farm animals in Brazil to be well-treated, and how much they cared about the quality of life of the animals used in food production. Logistic regressions were fitted using lme4 package (BATES et al., 2014) on R (R_CORE_TEAM, 2017).

Open answers were analysed using qualitative analyses, based on the method described by Huberman (HUBERMAN et al., 1994), which has three stages completed in the following order: data reduction (information is coded finding themes), data display (organization of the information permitting to reach conclusions) and conclusion drawing and verification (noting of patterns and themes and using confirmatory tactics such as triangulation between three readers). To ensure that the coding of themes was appropriate to the proposed objectives, and

therefore valid (i.e., that it represented all content displayed on the information collected), first three readers analysed 20 random responses, turning them into codes used to identify themes. The three readers then compared their results and discussed any discrepancies and ambiguities until agreement was reached. Two readers then coded the first 100 answers to ensure agreement. From that point on the lead author undertook the remaining encodings with the codes organized, counted and grouped into major themes.

Twelve codes were identified from the responses presented by participants to justify their preference for a given image within a case, which were grouped into four themes: “animal welfare”, “production”, “product quality” and “environmental issues”. The theme “animal welfare” comprised codes related to the quality of life of animals: freedom (including aspects such as the ability to move and issues related to amount of space provided to the animal or movement), natural life (related to expression of natural behaviours and the natural habitat of the animal), sentience (the ability of animals to express positive and negative feelings), animal health (physical and biological), animal stress (physiological or psychological), quality of feed offered to animals, and ethics (related to the respondent’s values regarding the use of animals by humans, references to the system as “cruel” or “inhuman”, or claims of the existence of better alternatives for animal production).

The theme “production” comprised codes related to the productive systems, including naturalness (the production system should be as natural as possible), productivity (efficiency of the system, the cost of the resulting product to consumers, or the area needed for animal production), control (referring to management, hygiene, animal health, and diseases), and ethics (participants expressed values regarding food production and food supply to the human population). The theme “product quality” included two codes: inputs used in production of food to humans and animal food (including pesticides, hormones and antibiotics), and human health (references to the influence of the resulting food product on human health). The theme “environmental issues” included possible benefits or risks of the particular production system on the environment.

On some occasions, the topics coded under naturalness and inputs were not related to any theme, as some participants gave short answers, like “more natural” or “less hormones”; respondents did not explain if this concern referred to the animal, the system, the quality of the products, or the environment.

Quotes were translated to English by the first and last author.

3.3 RESULTS

The demographics of participants (n = 479) are reported in Table 1. We did not recruit any participant that identified himself or herself as illiterate. Six participants did not consume animal products. Most participants (79%) considered that farm animals are not well-treated in Brazil. For 39% of the participants, farm animal welfare was stated to be a major concern and for 52%, it was viewed to be of some concern.

Table 1 - Demographics of survey participants and of Brazilians according to latest Brazilian Institute of Geography and Statistics (IBGE) census (IBGE, 2011).

Demographics	Participants N (%)	IBGE Census Data (%)
Sex		
Female	255 (53)	51
Male	224 (47)	49
Age		
18–25	134 (28)	19
26–35	128 (27)	24
36–45	82 (17)	20
46–55	73 (15)	16
56–65	45 (9)	11
66 or more	17 (4)	10
Education		
Primary school	6 (1)	49
High school	140 (29)	15
University education	333 (70)	36
Region of residence within Brazil		
South	314 (66)	15
Southeast	103 (22)	42
North	15 (3)	7
Northeast	19 (4)	28
Midwest	21 (4)	7
Area of residence		
Rural/city up to 20,000	72 (15)	16
Urban	407 (85)	84

In terms of how informed participants considered themselves to be about animal production, 36 (7%) said very informed, 151 (31%) somewhat informed, 164 (34%) intermediate, 95 (20%) somewhat uninformed, and 36 (8%) totally uninformed. Participants indicated the following when asked specifically about their main sources of information on farm animal rearing: Internet (65%), TV and radio (38%), friends (35%), newspapers (18%), specialized magazines (14%), universities (12%), and websites of animal protection societies (9%).

The proportion of participants that believed that farm animals in Brazil are reared in intensive confinement or caged systems varied by animal industry: 23% for beef cattle, 82% for poultry, 81% for laying hens, 56% for gestating sows, and 63% for farrowing sows. When asked about their preferred system, 87% chose free-range systems and 78% chose cage-free systems. The only variable tested that showed a significant relationship with the preference for the system was opinion regarding the quality of treatment of farm animals in Brazil: respondents who thought that animals are not well-treated in Brazil had a stronger preference ($p < 0.05$) for cage-free over the caged systems and free-range over the confined systems (OR = 3.43; 95% confidence interval: 2.10–5.59, and OR = 3.8 95% confidence interval: 1.92–7.27, respectively).

3.3.1 Reasons to Justify the Preference for a Given Image

Examples are presented followed by the number of the respondent (R) and the image chosen within brackets. The frequency of the themes identified in the responses are summarised in Table 2.

Table 2 - Emerging themes in response to the question, "Please justify your preference on the livestock production system chosen in the previous answer." Questionnaire was applied between September 2014 and June 2015, n = 479 Brazilian participants.

Participants (*n* =479)	**Free-Range (*n* = 437 [1])**	**Confinement (*n* = 42 [1])**	**Cage-Free (*n* = 382 [1])**	**Cage (*n* = 97 [1])**
Themes [2]				
Animal welfare	317 (68%)	7 (15%)	280 (71%)	20 (19%)
Production	73 (16%)	27 (59%)	53 (13%)	69 (65%)
Product quality	65 (14%)	8 (17%)	57 (14%)	13 (12%)
Environmental issues	12 (2%)	4 (9%)	7 (2%)	4 (4%)
Total	**467**	**46**	**401**	**106**

[1]Participants that chose a given system; [2]Number of times a given theme was mentioned by participants and the percentage it represents for each group (free-range, confinement, cage-free and cage).

Animal Welfare

The main reason offered by participants justifying their preference for free-range or cage-free systems was the animals' freedom: *Cattle should live free on pasture* (R34 (free-range beef cattle)); *Because animals are raised with more freedom* (R320 (free-range poultry)). Freedom was also implied in the context of sufficient

space for animals to walk or to move around: *More space for animals to move around* (R109 (cage-free gestating sows)). Some respondents associated freedom with lack of stress, healthier animals, and better product quality: *Animals are free, quiet in their habitat, without suffering stress* (R467 (free-range poultry)); *I think that free animals are healthier* (R67 (cage-free laying hens)); *In the chosen image animals are free, producing better eggs, and the animals themselves are in better shape* (R45 (cage-free laying hens)).

Many participants considered that animals should have the opportunity to live either in a natural way or in their natural habitat: *it is the natural habitat of animals* (R318 (cage-free farrowing sows)); *a life closer to their natural environment may be better for the animals* (R466 (free-range poultry)). Many participants also associated a natural life with freedom from stress and better product quality: *The animals are less stressed living naturally, resulting in products of greater nutritional quality* (R338 (free-range poultry)); *I believe that farm animals raised in open environments, closer to nature, produce food of better quality, and the animals will have a better quality of life* (R78 (cage-free laying hens)); *I think it is closer to the natural habitat, causing less stress to the animals, and consequently reducing (the use of) harmful chemical inputs and mistreatment* (R449 (free-range poultry)).

Some participants argued that animals deserve respect and must be well-treated: *it is fairer to the animals and to consumers* (R445 (free-range poultry)); *I think it is more humane, more natural, and less cruel* (R338 (free-range cattle)); *Because animals do not deserve to be mistreated* (R444 (cage-free gestating sows)).

A few participants associated confined or caged systems with good welfare, e.g., animals being well cared for, free of stress or free of diseases: *better treatment and feeding* (R412 (caged gestating sows)); *An appropriate place to raise piglets* (R165 (caged farrowing sows)).

Product Quality is a Desired Outcome of Livestock Production Systems

Besides perceiving an association between animal welfare and product quality, participants were concerned about the influence of the quality of food offered to the animals, the use of chemical inputs and potential residues on the food produced, and the hygiene of the system, on human health.

The quality of the animals' feed was a salient topic among participants that preferred free-range cattle, who emphasized the relation between animals' feed and product quality and showed a preference for providing feed to the animals that was free of chemicals: *when we*

consume the product of these animals we are also ingesting what they ingested (R392 (free-range poultry)); *The meat we eat nowadays (reflects) more concentrate feed than actual meat* (R244 (cage-free laying hens)); *The way animals are fed with chemical inputs that bring us health problem* (R72 (cage-free farrowing sows)). Many expressed concerns about the use of chemical or veterinary drug residues on their food: *Because of the excessive use of hormones and the non-organic fattening system* (R193 (cage-free farrowing sows)); *Because it is a better product for our health, with less use of substances during its production that may make us sick. And because I think they are tastier* (R290 (free-range poultry)); *Animals develop naturally, producing healthier meat* (R277 (cage-free laying hens)).

For some participants, good hygiene practices were a requirement for product quality; many related caged and confined systems with better hygiene and disease control: *Because (on confined systems) diseases, hygiene can be controlled* (R300 (confined poultry)); *Apparently it (the confined system) is more hygienic, conveys greater security and confidence for human consumption* (R130 (caged farrowing sows)).

The concern with hygiene was especially salient in the case of swine production, with caged systems often associated with better hygiene: *better vaccination care, better sanitary control* (R459 (caged gestating sows)); *Because there is more surveillance and control, and therefore, more hygiene and a healthier life* (R124 (caged gestating sows)). The same concerns with hygiene were also evident among some participants that preferred cage-free systems: *Less confinement, though I do not know how the hygiene issue would be solved* (R90 (cage-free gestating sows)); *It is obvious that the first image (cages) shows hygiene; but thinking of the animals the second image* (group housing) is the best (R90 (cage-free gestating sows)).

Naturalness of the Production Systems

Naturalness was an important and desired issue for participants that preferred free-range or cage-free systems. Respondents associated naturalness with freedom from suffering: *Because it is more natural and doesn't harm the animal* (R161 (cage-free farrowing sows)); natural behaviours and natural living: *Animals should be raised in the open sky, free to be able to socialize and exercise their natural behaviours* (R427 (cage-free laying hens)); *Animals roaming free and able to express their natural behaviour* (R473 (free-range poultry)); *Because it seems more "natural", less harmful. Animals are free to roam, similar to their*

natural habitat (R93 (cage-free gestating sows)); absence of chemical inputs in the diets: *A natural production system that does not rely on drugs to accelerate production in order to achieve a fast production and commercialization cycle* (R372 (free-range poultry)); animals' natural growth and natural development: *In this case, the animal is raised naturally and has its normal life cycle* (R53 (cage-free laying hens); *Natural cattle, without intensive fattening* (R142 (free-range cattle)); and healthier production: *In the image showing cage-free farrowing sows the system is more consistent with natural, healthier methods* (R357 (cage-free farrowing sows)).

Some participants simply expressed a preference for naturalness, e.g., *Because it is natural, and the natural process is always better* (R186 (free-range poultry)).

Intensive Production for more Abundant and Cheaper Food

Some participants believed confined and caged systems can lead to higher productivity, lower costs of production, and meet consumer demand for low-cost food: *Reduces the space required to raise animals* (R423 (confined cattle)); *It allows for lower costs of production, reducing the selling price and enabling low-income people to consume this product* (R460 (confined poultry)); *Because the system on the image can meet the huge demand of the population* (R201 (caged farrowing sows)).

Concerns Regarding the Environmental Impacts of Livestock Production

Some participants considered free-range and cage-free systems less aggressive to nature: *it is better for the ecosystem to have animals free in nature* (R211 (cage-free farrowing sows)); while others related intensive systems with less use of natural resources: *Confinement requires less use of natural resources, correct control of cattle health and more production in less time* (R205 (confined cattle)); *Besides using less pasture (therefore causing less deforestation), cattle are ready (for slaughter) in less time (in my lay opinion)* (R148 (confined cattle)).

3.4 DISCUSSION

In general, our participants expressed a preference for free-range, cage-free and more "natural" production systems. Similar to reports from around the world (e.g., Europe: (BOOGAARD et al., 2006; EUROBAROMETER, 2007; BOOGAARD et al., 2011b; MIELE et al.,

2011); Canada: (SPOONER et al., 2012; RYAN et al., 2015); US: (PRICKETT et al., 2010; CARDOSO et al., 2016b; SATO et al., 2017), participants expressed concerns with livestock production systems that they perceived to cause animal suffering or distress, limit the movement or the expression of some natural behaviours, and reduce animal health. Many participants also emphasised ethical issues related to the quality of animals' lives, recognizing farm animals as deserving respect and dignity beyond the provision of basic needs. For some, having a good life was a requirement if the animals are destined for human consumption (BOOGAARD et al., 2006). The similarity of our findings to studies done in other parts of world indicates that these values are common to contemporary society.

A preference for systems perceived as being more "natural" and a concern with the quality of the food produced by these systems were salient in participants' justifications of their choices. Naturalness and better product quality were often related to production systems that do not use growth promoters and antibiotics, that feed natural food to the animals, or that allow animals to express their natural behaviours and engage in social interactions. Concerns expressed by our participants regarding the quality of food offered to the animals are in line with previous surveys with European (EUROBAROMETER, 2007; ELLIS et al., 2009; VANHONACKER et al., 2010; BOOGAARD et al., 2011a; MIELE et al., 2011) and North American citizens (CARDOSO et al., 2016b; VENTURA et al., 2016). Positive values associated with naturalness in animal production and rejection of use of growth promoters and additives for animal production have both been identified in several surveys of public attitudes (HOLM et al., 1996; BOOGAARD et al., 2011a; YOU et al., 2014; CARDOSO et al., 2016b; HÖTZEL et al., 2017).

A perceived association between naturalness, animal welfare, and product quality also echoes several previous surveys done in other countries (BULLER et al., 2003; HANSEN et al., 2003; EUROBAROMETER, 2007; YOU et al., 2014; CARDOSO et al., 2016b). In many parts of the developed world this may be explained by abundant media coverage of cases of infectious pathogens in food, antibiotic resistance, and other "food scares", possibly causing the public to associate food quality with good animal welfare (e.g., see (VERBEKE; WARD, 2001; BULLER; MORRIS, 2003). Additionally, marketing instruments used to promote and sell animal products often rely on the use of discourses and images of naturalness that reinforce these ideals (BORKFELT et al., 2015). In Brazil, there are additional

factors that may explain this perception. For example, antibiotics are used as growth promoters in pig and poultry produced for domestic consumption (BOKMA-BAKKER et al., 2014), a practice that has recently received much attention by the Brazilian media (e.g., (OLIVEIRA et al., 2014). Additionally, there has been much debate about GMO (genetically modified organisms) food products in Brazil (IDEC, 2016), and the data reported by the annual publication of pesticide levels (including the presence of unauthorised products) in vegetables available in the domestic market by the National Health Surveillance Agency, ANVISA (JARDIM et al., 2012). There are also numerous other media reports of presence of pesticides' residues in food (ALVIM, 2016). Recent advertisements within the media stating that no hormones are used in domestic poultry production (ABPA, 2014) have likely added additional confusion to this discussion, given that many individuals now question this illegal practice (BRASIL, 2011).

Previous studies have reported low levels of awareness among lay Brazilian citizens regarding animal production systems and practices (DE BARCELLOS et al., 2011b; BONAMIGO et al., 2012; LUGNANI DE SOUZA et al., 2013). Our survey results suggest that, though true in some cases, this degree of awareness cannot be generalised. Although most participants assessed their knowledge of livestock production systems as low and some declared total ignorance about how food animals are reared, or were brief and vague in their responses, others referred to specific practices of intensive livestock systems that were not shown in the images, such as the use of feed additives and veterinary drugs, production methods used to achieve high growth rates, as well as emphasising the importance (in their opinion) of animals expressing their natural behaviours. These statements are also supported by a recent survey of Brazilian citizens where some participants showed some awareness of specific dairy farming management practices but also views that did not resonate with some common management practices (HÖTZEL et al., 2017). In the present survey, when asked which image they believed depicted the most common situation in Brazil, most participants seemed to be aware that the majority of pigs and poultry are reared in confined and caged systems and beef cattle on pasture (ABPA, 2015; ABPS, 2015). Therefore, despite their limited knowledge of the production systems and practices, participants were able to express general expectations and criticisms regarding the quality of life of farm animals, which many associated with the quality of the food produced and thus affected human health.

Historically, increased awareness of livestock production systems has been associated with society becoming more involved in demanding and promoting changes in livestock production systems (e.g., (CENTNER, 2010; VELARDE et al., 2015). In this context, the impact of knowledge of public acceptance of animal livestock production systems has been debated in recent years. Some researchers (YOU et al., 2014; PIEPER et al., 2016) and farmers (HUBBARD et al., 2007; BENARD e DE COCK BUNING, 2013) assume that a more educated public will become more accepting of technologies or systems considered ideal or acceptable by animal and veterinary scientists and the associated farm animal industries. This has been discussed as a "deficit model"—in short, ignorance is the basis for a lack of societal support for issues in science and technology, and can therefore be changed with education (BAUER, 2016). However, it has also been discussed (HANSEN et al., 2003; HÖTZEL, 2016) that non-experts assess technologies based on risk and moral values. Indeed, numerous reports show that increasing information tends to result in increased opposition to contentious livestock production practices (RICHARDS et al., 2013; RYAN et al., 2015; HOWELL et al., 2016; VAN ASSELT et al., 2016; VENTURA et al., 2016; HÖTZEL et al., 2017).

Although most of our participants preferred free-range and cage-free systems, some, albeit a minor proportion, indicated a preference for confined and caged systems. These participants were concerned with the impacts of the production systems on productivity and the cost of food produced, as well as the need to produce sufficient and affordable food for a growing world population (GODFRAY et al., 2010; TILMAN et al., 2011). For some participants, the latter can only be achieved with caged and confined systems, which may be based on the belief that modernization and intensification are required for dramatic increases in meat production to be achieved (STEINFELD et al., 2006). Some of our participants also perceived advantages for the intensive systems in terms of easier animal handling and better hygiene (particularly when discussing swine production). This might be explained by the fact that Brazilian consumers perceive pork meat as a greater risk to health than beef (ZAMBERLAN et al., 2003). Others have shown that, although some sensorial aspects, practicality and convenience and production following animal welfare standards are highly valued by Brazilian pork consumers, animal sanitary aspects are considered the most important (DHEIN DILL et al., 2014). Possibly due to historical and cultural images of early pork production systems that existed in the country (ZAMBERLAN; SPAREMBERGER, 2003; DE BARCELLOS et al.,

2011a), many Brazilians associate pork meat with a source of zoonotic diseases–especially worm infestations–and high cholesterol (DA FONSECA et al., 2008; DOS SANTOS et al., 2011). Accordingly, a Dutch survey (BOOGAARD et al., 2008) found that citizens appreciate some aspects of modern animal farming, such as good hygiene practices and technological innovations that help animal management. Indeed, several studies have reported that food safety is the highest-ranking attribute mentioned by survey participants (VANHONACKER et al., 2010; INGENBLEEK et al., 2011; CICIA et al., 2016; CUMMINS et al., 2016; MIRANDA-DE LA LAMA et al., 2017). Other reasons for Brazilians to be concerned with food safety and hygiene are the recurrent cases of milk frauds (UOL, 2007; RAMOS, 2015), or illegal slaughter of animals (MAPA, 2016) that are usually conveyed with images of poor infrastructure by the media (e.g., (G1, 2016).

Finally, this qualitative, exploratory study was based on a convenience sample of participants, and as such cannot be interpreted as representing the views of the Brazilian society. In comparison to the Brazilian population (IBGE, 2011) our sample contains a greater proportion of well-educated citizens, likely linked with citizens' wealth. There were respondents from all five regions of the country, but with a disproportionate over representation of the south and southeast regions and under representation of the northeast region. Although we acknowledge that the sample is unbalanced in terms of socioeconomic and educational stratification, we argue that the highly educated participants represent a segment of opinion holders that have substantial purchasing power, traits that may influence changes in production practices. This survey contributes original information on an issue underexplored in developing countries (CLARK et al., 2016), which are the fastest growing producers and consumers of animal food products (VON KEYSERLINGK; HÖTZEL, 2015).

3.5 CONCLUSIONS

Many practices used in intensive animal production systems seem far removed from the moral values and expectations of our sample of the Brazilian public. Participants' showed limited awareness of animal food production systems and practices used in Brazil but were critical of perceived outcomes of practices and systems on the quality of the products and in regards to the lives led by the animals (e.g., suffering, freedom, health), and subsequent risks to human health. Legislation (MAPA, 2008) or retail and industry-led changes in husbandry practices

that are starting to happen in developing countries like Brazil (e.g., (GLOBORURAL, 2014a; GLOBORURAL, 2014b; INDUSTRIAL, 2014; INDUSTRIAL, 2015; BRASIL, 2016), may be costly to producers if they are required to comply with mandated requirements (CENTNER, 2010). However, these initiatives may not be sustainable if they are implemented in the absence of dialogue with society per se (VON KEYSERLINGK; HÖTZEL, 2015), for example, if these changes do not meet the expectations of those demanding them (LU, 2013; WEARY et al., 2016).

4 RESTRICTING THE ABILITY OF SOWS TO MOVE: A SOURCE OF CONCERN FOR SOME BRAZILIANS

ABSTRACT

Gestation stall housing for pregnant sows has been, or is being, phased out in many parts of the world in response to public criticism. However, in Brazil, one of the largest global producers and exporters of pork, gestation stall housing is still common. The objective of this study was to investigate the views of Brazilians, including participants associated (ALP) or not with livestock production (NotALP). Participants were provided the option of accessing a short text describing the housing system and a video of pregnant sows housed in either individual or group housing. Participants (ALP n=176; NotALP n=173) were asked to state their position on housing pregnant sows in individual stalls and to provide the reason(s) justifying their position. More NotALP (87%) participants than ALP (69%) participants rejected individual stalls. More participants that (85%) accessed the information rejected the stalls than those (71%) that did not. Qualitative analyses revealed that animal welfare, most often in reference to animal sentience, freedom of movement and ethics, was the main justification presented by the majority of participants that rejected gestation stalls. Those in favour of individual stalls justified their position with statements such as improved production, handling and animal health, and reduced aggression. Our results highlight the shared values between participants associated with livestock production and those that are not and highlight that opposition to gestation stalls for sows reflects an ethical position regarding the treatment of livestock and should not be interpreted as support for group housing in confined systems.

Keywords: Animal welfare. Gestation stalls. Housing. Pig production. Public views. Survey

4.1 INTRODUCTION

Throughout the world there has been growing public opposition to livestock production systems that citizens perceive as negative for the welfare of farm animals (EUROBAROMETER, 2007; CENTNER, 2010). One example is the case of the gestation stalls, in which sows are housed individually, unable to walk or turn around during pregnancy. Views and attitudes surveys suggest that the general public holds strong negative attitudes towards intensive farm production systems that

currently dominate contemporary pork production (NGAPO et al., 2004; MEUWISSEN et al., 2007; KRYSTALLIS et al., 2009). Not surprisingly, gestation stalls for sows have already been banned or are being phased out in much of the developed world, including the European Union, ten U.S. States, Canada, New Zealand, Australia and South Africa; simultaneously, the largest food companies in the world are adopting cage-free purchasing policies (VON KEYSERLINGK; HÖTZEL, 2015).

In Brazil, one of the largest pig producers and exporters in the world (FAO, 2014), nearly without exception gestating sows are reared in intensive commercial systems (approximately 2.1 million – ABPA (2015) and housed in individual stalls. Although there are no specific legislative initiatives to restrict such systems within Brazil (VON KEYSERLINGK; HÖTZEL, 2015), there is some evidence that Brazilian food companies are following international trends. For example, starting in 2014 the three largest pork producers BRF, JBS and Aurora announced their decision to transition to gestating sows' group housing in coming years. Interestingly, these announcements have been publicized in farm animal industry meetings and associated websites (INDUSTRIAL, 2015; BRF, 2018) and on the websites of animal rights non-governmental organizations (HSIBRASIL, 2015b), but with limited public outreach. These changes spearheaded by these producers appear to suggest an interest by the Brazilian pork industry to follow international standards and marketing strategies, possibly to secure potential import markets (VON KEYSERLINGK; HÖTZEL, 2015). Significant changes happened in Brazil since the OIE launched its animal welfare initiative in 2004 (BAYVEL, 2004), which included initial development of animal welfare legislation and industry involvement in the issue (DIAS et al., 2015; VON KEYSERLINGK; HÖTZEL, 2015). However, these changes appear to be driven primarily by factors external to Brazil, indicating either little interest or perceived need to address any concerns raised by Brazilian citizens, who are in fact the largest consumer of Brazilian produced pork (ABPA, 2015). Moreover, as the socioeconomic status of Brazilians increases there is also great potential for expansion of the domestic consumption of pork (DE BARCELLOS et al., 2011a).

Little is known about the interest, knowledge, views and attitudes of the Brazilian public about farm animal welfare. The few surveys conducted in the country (DE BARCELLOS et al., 2011b; BONAMIGO et al., 2012; LUGNANI DE SOUZA et al., 2013) have reported low levels of knowledge among Brazilian citizens about specific animal

production systems and practices; however, these surveys also provide some evidence suggesting that more informed Brazilian individuals tend to assign value to animal welfare and to relate high animal welfare standards with better product quality. Thus, it is possible that awareness of the type of housing systems used by the industry may influence public views. Indeed, a recent Canadian study showed a drop-in acceptance of gestation stalls when individuals viewed information on sow housing (RYAN et al., 2015).

Different stakeholders have different interests regarding the use of animals and often contradictory political and ethical postures, which may have implications for the governance of animal welfare (DEGELING et al., 2015). For example, a qualitative behavioural assessment task survey found that Dutch pig producers tend to evaluate pig behaviour more positively than urban citizens and animal scientists (DUIJVESTEIJN et al., 2014). Other work has reported that, when asked, producers tend to relate pig welfare with animal health, biological functioning and production performance (BOCK; VAN HUIK, 2007; BENARD; DE COCK BUNING, 2013); the general public, instead, tends to focus on aspects such as natural living and feelings (LASSEN et al., 2006b; BENARD; DE COCK BUNING, 2013). This disconnect can increase risks regarding the sustainability of an industry (VON KEYSERLINGK; HÖTZEL, 2015) and may generate distrust (ROBBINS et al., 2016).

Societal acceptability and trust in the pork industry in other jurisdictions seem to be influenced by actions that the public perceives as related to animal welfare, such as provision of farm animals with more space (VANHONACKER et al., 2008), different types of housing and flooring (MILLET et al., 2005; VANHONACKER et al., 2008; KRYSTALLIS et al., 2009), or environments that allow pigs to express natural behaviour and social interaction (LASSEN et al., 2006b; RYAN et al., 2015). Thus, the objective of this study was to explore and contrast the views of Brazilian citizens who are associated (e.g., student, teacher, veterinarian, livestock production professional, consultants or outreach professional, producer) or not with livestock production, about the use of individual gestation stall housing for sows.

4.2 MATERIAL AND METHODS

An online survey created using the FluidSurveys platform (http://fluidsurveys.com/) was conducted from December 2014 to March 2015. The survey was initially tested using 20 randomly recruited

participants; their responses were used to refine the questionnaire prior to release. We also tested the video used in the survey to ensure that the images used represented the issue addressed and avoided any examples that participants may have considered to be ‘extreme’ of a given situation.

4.2.1 Participants’ recruitment

The target participants were people of any Brazilian public, a minimum of 18 years, with and without prior knowledge of livestock production. Recruitment of all participants for this online survey was done using a number of different vehicles including direct contact by approaching individuals working at governmental animal health surveillance and protection agencies or universities, and indirect contact through social media outlets (e.g. Twitter, Facebook) and websites and blogs that had either a food or lifestyle focus, science focus (i.e. science communication, higher education) or current event focus (i.e. local news) that operated across different parts of Brazil. All individuals approached were asked to redirect the invitation to others they thought might be interested in participating on the survey. In all cases participation was voluntary and without exception all identities were kept anonymous. This study was approved by the Ethics Committee of Research with Human Beings of Federal University of Santa Catarina, Brazil (Protocol 904.849)

4.2.2 Survey Methodology

The first question addressed socio-demographic information relating to sex (male, female), age (18-25, 26-35, 36-45, 46-55, 56-65, over 66 years), education (elementary school, high school, higher education, technical or higher education), the region of the country of residence (south, east, north, northeast, central-west), size of the city where the participant spent most of his or her life (rural, small town, medium town, large city, metropolis), if the participant had ever lived outside of Brazil (yes, no), and level of association with livestock production ("not associated" or "associated", as: student, teacher, veterinarian, livestock production professional, consultants or outreach professional, or producer). Participants were also asked how informed they considered themselves to be regarding animal production (very informed, somewhat informed, intermediate, somewhat uninformed, totally uninformed) and regarding pig production (very informed,

somewhat informed, intermediate, somewhat uninformed, totally uninformed), and if they consumed animal products (yes, no).

Participants were then provided a short text stating that the objective of the questionnaire was to know their opinion in relation to gestating sows housing in commercial production systems in Brazil. The participant could choose to access some information on the topic before answering or go straight to the next page and answer the questions. If the participant selected to access information they were then directed to a page containing a link to a video and the following explanation: "This video shows some examples of gestating sows in individual stalls or group housing systems and does not contain violent images". The 90-second video contained the same number, time and quality of pictures of sows housed in individual stalls and of sows housed in groups. We produced the video with images and video clips available through public commons directly from the Internet depicting sows housed in both systems. We showed similar situations across both systems, e.g. of sows housed in facilities with different levels of cleanliness, and while feeding and resting. We also showed potential behaviour problems commonly associated with each of the systems (e.g., stereotyped behaviours in sows housed in stalls and scenes of social tension in grouped housed sows); also, we used images of group housing of different sizes, with and without access to substrate (bedding). The video was posted on YouTube with no text, words or any mention of animals, to avoid redirecting viewers to other videos posted by other parties (https://www.youtube.com/watch?v=bLcsofD3BNk).

On the next page the participant could read the following text with 219 words:

> Brazil is one of the world's largest pork producers. About 2 million gestating sows are reared in industrial production systems in the country. During the 114 days' gestation period, sows can be housed in different systems. One system consists of individual stalls, where the floor is usually made of concrete and the space is slightly larger than the animal body. In these stalls, the sows can get up and lie down, but cannot turn around or walk. Another system uses group housing; this promotes social interaction and provides enough room to walk. Usually the floors are concrete, although there is the possibility of using some form of organic bedding such as straw or wood shavings.
>
> Those who support the individual housing system present the following arguments:

•The accommodation in individual stalls facilitates individual balanced nutrition, improving production rates.
•It eliminates problems related to aggression among the sows.
•It facilitates cleaning of the facilities.
•As an overall result, the system allows for a reduction in production costs.

Those opposed to the individual housing system present the following arguments:
•Sows in individual stalls exhibit behaviours that indicate anxiety or frustration.
•Cages prevent sows from moving around, causing inflammation in the joints and pain in the limbs.
•As an overall result, the system reduces the animals' quality of life.

On the following page of the questionnaire the second question asked: "Regarding the housing of gestating sows in individual stalls, I am…: "favourable", "indifferent" or "opposed". Below this the participant was asked to justify the response that began with: "I am favourable/ indifferent/ opposed to housing of gestating sows in individual stalls, because... (space provided for an answer)" followed by a text box with unlimited space where the participant could write freely his or her opinion.

On the next page, the third question asked which system the participant considered to be the most common in Brazil, and offered as an answer the choices, "Indoors in individual stalls", "Indoors in group housing", "Indoors, in both individual stalls and group housing", "In another system", and "I do not know".

On the same page, before proceeding with the next question, the participant was offered again the opportunity to access the video and the information text, with the options: "I have already watched it, I want to move forward", "I do not want to watch, I want to move forward" or "Yes, I would like to go to the video page". The fourth question appeared on the next page: "In your opinion, how should gestating sows be housed in commercial production systems in Brazil?" with the possible answers: "Inside a barn, in individual stalls", "Inside a barn, in group housing", "In another system", and "I do not know". On the same page the fifth question asked whether the participant had read the text (yes, no) and had seen the video (yes, no). The sixth question asked if the video had influenced the participants' response, with the possible answers: "The video influenced my answer because…", "The video did

not influence my answer because...", "The video did not influence my answer because I already knew about it", and "I chose not to watch the video". The seventh and final question asked whether the participant was aware of any initiative of the Brazilian industry to change the system for group housing (with options "no" and "yes, and which", with space for an answer). On the last page, the participant had the opportunity to leave any comments on the subject in an open text box.

The questionnaire did not allow the participant to go back to any of the previous pages/questions. Response options in questions 2 to 7 appeared in randomized order for each participant.

4.2.3 Data Analyses

The questionnaire was considered as part of the final data set subjected to the analyses if the participant completed the questionnaire up to and including question 2. Closed answers were analysed by descriptive statistics and the open-ended responses by qualitative analysis. To assess the participants' views, frequency distribution, access to information and its influence and the probability of independence of the distribution was tested by Pearson chi-test using R (R_CORE_TEAM, 2017).

The qualitative analysis was based on the method described by Huberman and Miles (1994), which follows three stages: the reduction of the data, the encoding on themes of the information contained in the answers, allowing them to achieve a representation of the content and serving if necessary as an index; the data presentation, information organization in order to allow analysis and interpretation; and the conclusion or data interpretation, which identifies the meaning of the data, its regularities, patterns and explanations.

To ensure that the coding themes were appropriate to the proposed objectives, and therefore valid, i.e. that it represented all content displayed on the information collected, four readers initially analysed 20 random responses, irrespective of demographics, turning them into codes used to identify themes. The four readers then compared their results and discussed any discrepancies and ambiguities until agreement was reached. The readers then jointly coded the first 100 answers to ensure agreement. From that point forward the lead author undertook the remaining encodings. The codes were organized, counted and grouped in major themes.

Three major themes were identified in the reasons presented by participants when they conveyed their support, opposition or

indifference towards the use of housing gestating sows in individual stalls: 1) animal welfare (mentioned 287 times; 73%), 2) production (mentioned 83 times; 21%), and 3) product quality (mentioned 18 times; 5%) (see Table 3). Please note that a given participant could cover more than one theme in their response.

Table 3 - Emerging themes in response to the question: "What is your position regarding housing gestating sows in individual stalls?"

Theme	**Position regarding housing gestating sows in individual stalls**			
	Participants not associated with livestock production			
	Rejected (n=151)	Supported (n=14)	Indifferent (n=8)	Total (n=173)
Animal welfare	143 (87%)	9 (53%)	2 (29%)	154 (80%)
Production	12 (7%)	6 (35%)	5 (71%)	23 (13%)
Product quality	10 (6%)	2 (12%)	-	12 (5%)
Total	165	17	7	189
	Participants associated with livestock production*			
	Rejected (n=124)	Supported (n=40)	Indifferent (n=12)	Total (n=176)
Animal welfare	120 (83%)	8 (18%)	5 (45%)	133 (67%)
Production	18 (13%)	36 (82%)	6 (55%)	60 (30%)
Product quality	6 (4%)	-	-	6 (3%)
Total	144	44	11	199

* veterinarian, livestock production professional, consultant/manager, producer, student or faculty in any field of animal agriculture.

The theme animal welfare was identified every time a participant identified issues related to the quality of life of animals. Six sub-themes were identified: freedom to move (including issues related to animal space or movement), natural life (related to expression of natural behaviours and the natural habitat of the animal), sentience (the ability of animals to express positive and negative feelings), animal health (physical and biological; minimizing animal suffering or pain or equivalent), animal stress (physiological or psychological), and ethics (related to the participant's values regarding the use of animals by humans, references to the system as "cruel" or "inhuman", or beliefs about the existence of better alternatives for animal production).

The theme production was identified when the reason provided by the participant was based on production issues. Four sub-themes identified: productivity (cost and efficiency of the system, the cost of the resulting product to consumers, the area needed for pig production), control (referring to management, hygiene, animal health and diseases - controlling diseases, easier to vaccinate and provide medical attention and other practices that enhance animal health as well as being more

productive), ethics (when participants expressed values regarding food production and food supply to the human population), and natural living (allusions to the influence of sows' social behaviour on productivity).

The theme product quality included two sub-themes that were defined as inputs (those used in animal feeding, including pesticides, hormones and antibiotics), and human health (references to the influence of the product for human health).

4.3 RESULTS

From the 472 responses received, 360 were complete and used in the subsequent analyses. In total, there were 112 incomplete responses: 17 were from individuals who were in favour of gestation stalls, 6 who were indifferent, and 39 that were opposed plus an additional 50 that only filled in a few demographic questions. Additionally, during the analyses, an additional 11 questionnaires were discarded for reasons including failure to present a coherent rationale statement, the participant had selected a specific option but provided a reason that justified the other, or it was clear that the participant had confused the production system (e.g. referring to the maternity phase of pig production). Thus, 349 responses were included in the final analyses.

The demographics of participants are reported in Table 4. Compared to the Brazilian population, our sample had more females, young and educated people. Twenty-two participants (6%) did not consume animal products. Of the participants that had some involvement with livestock production, 49% were university students, 13% consultants or outreach professionals, 14% producers, 8% were university faculty, and 16% cited "other type of association" (defined by participants as formerly students, producers or teachers in the area).

Table 4 - Participant demographics of participated in an online survey and of Brazilians according to (IBGE, 2011)

Demographics	Participants; n	IBGE census data;
Sex		
Female	221 (63)	51
Male	128 (37)	49
Age		
18-25	128 (37)	19
26-35	96 (27)	24
36-45	47 (14)	20
46-55	50 (14)	16
56-65	21 (6)	11
66 or more	7 (2)	10
Education		
Primary school	3 (1)	49
High school	39 (11)	15
University education	307 (88)	36
Region of residence within Brazil		
South	221 (63)	15
Southeast	71 (21)	42
North and Northeast	36 (10)	35
Centre West	18 (5)	7
Area of residence		
Rural area	45 (13)	16
Urban	304 (87)	84
Small city – up to 20,000 inhabitants	50 (14)	
Medium City – 20,000-100,000	75 (22)	
Big city – > than 100,000 inhabitants	108 (31)	
Metropolis – > than 1 million inhabitants	71 (20)	
Association with livestock production		
Associated*	176 (50)	
Not associated	173 (50)	

* veterinarian, livestock production professional, consultant/manager, producer, student or faculty in any field of animal agriculture

Most participants associated with livestock production identified themselves as informed on animal production systems including pig production systems; most participants not associated with livestock production considered themselves informed about animal production systems but less informed about pig production systems (Table 5).

Table 5 - Number and percentage of participants who rejected, supported or were indifferent to the practice of housing gestating sows in stalls[1]

	Not associated with livestock production				*Associated with livestock production**			
	Reject	Support	Indifferent	Total (%)	Reject	Support	Indifferent	Total (%)
	151	14	8	173	124	40	12	176
Sex								
Female	108	7	3	118 (68)	83	15	6	104 (59)
Male	43	7	5	55 (32)	41	25	6	72 (41)
Information about livestock production								
Very informed	25	1	0	26 (15)	68	24	5	97 (56)
Somewhat informed	46	5	2	53 (30)	38	14	6	58 (33)
Intermediate	38	2	1	41 (24)	16	2	1	19 (11)
Somewhat uninformed	26	5	2	33 (19)	1	0	0	1 (0)
Totally uninformed	16	1	3	20 (12)	0	0	0	0 (0)
Information about swine production								
Very informed	21	1	0	22 (13)	46	24	13	83 (47)
Somewhat informed	28	3	2	33 (19)	53	9	3	65 (37)
Intermediate	25	3	0	28 (16)	17	7	2	26 (15)
Somewhat uninformed	36	4	1	41 (24)	0	0	0	0 (0)
Totally uninformed	41	3	5	49 (28)	2	0	0	1(1)

[1] Responses are sorted by sex of the participant and their self-assessment of information they had about livestock production and about swine production.

* veterinarian, livestock production professional, consultant/manager, producer, student or faculty in any field of animal agriculture.

4.3.1 Participants' position regarding the use of gestation stalls

Considering all 349 participants, 79% rejected, 15% supported and 6% were indifferent to housing gestating sows in individual stalls. The level of support was different between participants not associated and associated with livestock production ($X2 = 16.9$, d.f. = 2, $p = 0.001$; Table 5).

4.3.2 Accessing the text and video information

The number of participants that chose to access the available information and whether or not they were influenced by the content is shown on Table 6. More participants not associated with livestock production accessed the text and video ($X2 = 13.1$, d.f. = 1, $p < 0.001$) compared to those associated with livestock production. Among the 196 participants that accessed the video, more participants not associated with livestock production said that were influenced by the information ($X2 = 25.2$, d.f. = 1, $p < 0.001$) than participants associated with livestock production. More participants that accessed the information (n = 167; 85%) rejected the stalls than those that did not (n = 99; 71%; $X2 = 17.3$, d.f. = 2, $p = 0.001$).

Table 6 - Number of participants associated and not associated with livestock production and access of information and influence of information

	Not associated with livestock production n =173	**Associated with livestock production*** n =176	**Total**
Accessed the information?[1]			
No	52	88	140
Yes (total)	112**	84	196
Accessed on the 1st opportunity	83	63	146
Accessed on the 2nd opportunity	29	21	50
Was influenced by information?[2]			
Yes[3]	50**	9	59
No (total)	57	68	125
Because they already knew	36	58	94
Gave a reason[4]	21	10	31

* veterinarian, livestock production professional, consultant/manager, producer, student or faculty in any field of animal agriculture.

[1] 13 participants did not answer this question

[2] 25 participants did not answer this question

**$p < 0.01$ = statistically different mean scores between participants not associated and associated with livestock production.

[3] Some explanations: Yes, because… "One can clearly see the reality of animals", (P107); "It shows a reality that we are not used to seeing and experiencing" (P154); "The visual observation makes you reflect on the issue" (P76); "I could see that in either way the animals suffer" (P281); "Watching the animals in those cages made me feel compassion..." (P58).

[4] Some explanations: No, because… "If the animals are already trapped, why see the rest…" (P231); "I already intuited that I would see abuses…" (P345); "(The video) showed what I already assumed or expected" (P277); I already have a formed opinion against animal cruelty. Still, watching the video helps revealing this sad reality" (P257); "…because I had read about the issue and visited a farm" (P321); "I knew about the two rearing methods, but I had not thought that the group housing system does not seem to be ideal either" (P276).

4.3.3 Perception of popularity in Brazil and preference for gestating sows housing system

When asked which system participants considered the most common in Brazil, the most frequently chosen option was “gestation stalls” (Figure 2). Preference for the systems differed between participants associated and not associated with livestock production ($X2 = 13.1$, d.f. = 3, $p = 0.005$; Figure 2), with both predominantly choosing ‘another system’. Some justified their option for “another system”; for instance, stating “I don’t know exactly what the (other) system is, but it should be something that allowed for greater mobility” (P40) or “I think group housing is not ideal, because the animals cannot access the outdoors, I think that would be best for the animals” (P276). Finally, when asked if they were aware of any campaigns or proposals in Brazil to phase out gestation stalls, 21% responded “yes”; of those, the majority (~80%) were associated with livestock production.

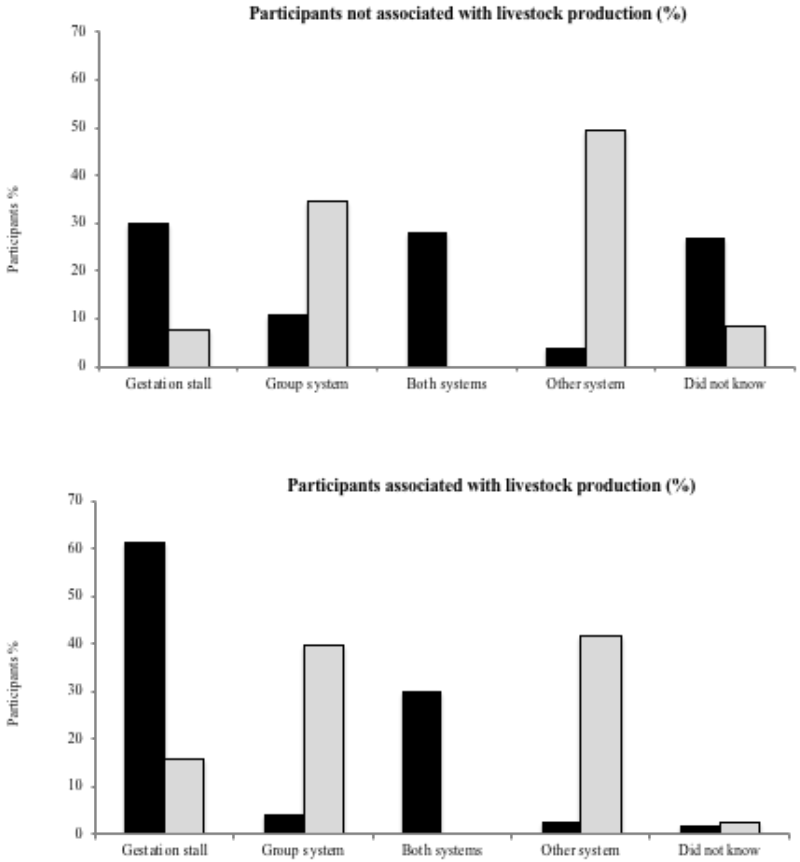


Figure 2. Participants' perception of the most common (black bars) and preferred system (grey bars) for gestating sows' housing in Brazil. The option "Both systems" was only offered for question "perception of the most common system"

The following section is organized by position of the participants (i.e., opposed, favourable and indifferent) and the justifications of participants not associated with livestock production, followed by those of participants associated with livestock production.

4.3.4 Participants opposed to gestation stalls

Participants of both groups that rejected the gestation stall housing for sows justified their position mainly with statements related to the theme animal welfare.

Participants not associated with livestock production

Most participants not associated with livestock production justified their position addressing one or more reasons related to the theme animal welfare. They referred to animal sentience, "...it has been more than proven that animals have feelings" (P219); freedom, "...no animal should be stuck in a cage! Pregnant sows even less ... the lack of movement, the discomfort..." (P24); "…because the right way to raise these animals is free range" (P90); natural living, "...to be able to interact with other sows, get into the mud, and have some of their natural behaviour" (P270); animal stress, "…sows practically can't move, they just lie down, get up and eat. Probably there is a high level of stress in these animals" (P105); animal health, "individual housing harms the health of the pregnant sows because they are unable to walk and lie comfortably..." (P1543), and ethics, "Treating sows like that is extremely inhumane. It is an unnecessary and unjustifiable cruelty" (P291). Some offered more elaborate justifications that covered several of the sub-themes, for example:

"[sows] are living beings and deserve respect and the right to come and go; they deserve to be in contact with other animals and have a quiet life, without factors that make them sick" (P22);

"…sows cannot express their natural behaviour…. They should live free, in a natural environment, free from all stressors (P19).

"...it is in an inappropriate system; I feel sorry for the animals that can't walk, can't be in contact with nature and have access to sunlight" (P196).

Reasons given by this group related to the theme production were of an ethical nature, i.e. "I do not agree with 'optimization of space' with regards to rearing animals; I believe it leads to the (unnecessary) over-production we have today, which in turn encourages over-consumption" (P340); "...what underlies this type of housing system is quite simple:

increased production + cost reduction = profit growth ... in my opinion, the quality of life of animals (which I eat or not) is as important as the quality of life of human beings" (P315)", or related to productivity, "I have heard and read of producers who, with information and help, especially from research centres, had excellent results with group housing for pregnant sows" (P33); “There should be some other way to reduce costs, not that [referring to the stalls]" (P304)

Some participants covered more than one theme to justify their position. For instance, some covered the themes product quality and animal welfare together, associating a good quality of life for the animal with better product quality: “…better quality of life to the animal and healthy meat” (P76). Others referred negatively to the inputs used by the animal industry: “I am opposed [to the stalls] because of the suffering that this system causes to the animals, and also because I believe that drugs and hormones that are used can harm human health” (P89). Participants also frequently combined animal welfare and production, associating the quality of life of animals with productivity, “…we must always seek the best win-win situation for society: quality of life for animals and the humans who get their food from these animals” (P350); “Even if they are reared and intended for slaughter, there must be respect for life..." (P78); "In my understanding the quality of life of these animals must be put above issues related to productivity" (P277) "Animal welfare should be more important than economic gains" (P276).

Participants associated with livestock production

Most participants associated with livestock production also justified their opposition to gestation stalls based on concerns with animal welfare. These participants often covered more than one sub-theme in their responses, including sentience, freedom, animal stress and ethics:

“I do not consider the animal just a product to be consumed… To me cages for pregnant sows are inhumane, knowing the behavioural needs that they have to make nests; besides, they cannot move inside the cage, and this is extremely stressful for any living creature” (P63);

“Clearly, factors such as high motivation to express their behaviour (which is associated with frustrations) and lack of social contact are important for these animals. We have a moral obligation to the animals, so we must seek production systems that provide better conditions for the welfare of individuals” (P144);

"…these animals are stressed and suffer from the lack of space to move around; I find it a cruel way to rear farm animals" (P250).

They also justified their negative opinion of gestation stalls based on ethics, "I support meat consumption. However, I am totally against this form of production. The way we treat animals for consumption extremely cruel and unnecessary" (P25); "animals have their natural habitat and men have no right to interfere" (P39); animal sentience, "Animals are deprived from minimal welfare conditions, that is, they suffer and demonstrate it in a variety of ways" (P61); natural living and freedom, "...the housing system [individual stalls] does not allow animals to express their behaviours normally, and the space is greatly reduced, which can reduce their welfare. Besides, it affects the five freedoms" (P207); "…they [sows] must be well, healthy and in a suitable environment close to their natural habitat" (P91); animal stress, "Drastically restricts movement, normal behaviour and causes a lot of stress to the animal" (P203), and animal health, "... it promotes hoof problems, joint problems, stress, stereotypes..." (P288).

Some participants referred to production aspects such as productivity, "It generates high release of catecholamines and reduces feed conversion..." (P186); and ethics, "In a country the size of Brazil nothing justifies such management" (P330). Some associated a better quality of life for animals with better production: "The stress on pigs is huge, in addition to diseases caused by the weight of the sows associated with lack of movement that ultimately results in high cost of medicaments, veterinary care and early culling of sows... Studies have already confirmed that during the gestating period group housed sows perform better than sows in cages" (P73). Others mentioned product quality together with animal welfare, in a reference to a relationship between the quality of life of the animal and of the resulting product, "…for ethical reasons first, and for the interest in the quality of food, which is superior if the animals are not stressed" (P41).

4.3.5 Participants favourable to gestation stalls

To justify their support for gestation stalls, participants not associated with livestock production frequently referred to the theme animal welfare in their statements; whereas, participants associated with livestock production referred more to the theme production to support gestation stalls.

Participants not associated with livestock production

Participants not associated with livestock production who were supportive of gestation stalls justified their support for individual stalls using reasons that encompassed the theme animal welfare, frequently referring to animal sentience, “Because farm animals suffer, but not as much as vegans would say...” (P37), animal stress, “I am in favour, because the pregnant sow should not suffer stress or irritations” (P246), animal health or comfort, “It must be safer and more comfortable for the sow to be alone” (P310). Others justified their responses based on the theme production, referring to hygiene and ease of handling, “...in individual cages it is more hygienic, and management is more efficient” (P182), and to productivity, “Ease of management, cost, area…” (P241).

Participants associated with livestock production

Those participants associated with livestock production that were in favour of gestation stalls justified their support primarily citing reasons related to the theme production, which encompassed issues related to animal health and management: “This prevents the sows from becoming contaminated or contaminate others with some kind of infection” (P60); “It facilitates individualized care, as supply of food or medication...” (P109); “Because of the ease of handling, better use of space, and besides the benefits of the group housing system are not that great” (P165); or associating ease of handling with greater economic gains: “…lower cost with facilities, less use of labour... lower reproductive losses” (P151). Some commented on issues related to the behaviour of the animals, specifically how it may affect productivity: “Pregnant sows are usually violent and may fight, abort and even kill other sows” (P235); “…we cannot risk housing gestating sows in a group where they may fight and risk having an abortion, premature birth and production losses” (P228). Others challenged the economic sustainability of group housing: “I do not see another economically sustainable production system, because this way [with stall housing] the producer has the lowest cost of production” (P104); “Being favourable [to gestation stalls] does not mean defending the use of individual housing, but I understand that in some production systems it is still unsustainable to use group housing, which occupies larger areas and generates more waste (especially when bedding is used). As both systems have advantages and disadvantages I do not believe that the Brazilian pig production system is fully prepared for the move to group accommodation, while I respect those who choose to adopt it” (P158).

A few participants in this group justified their support based solely on the theme animal welfare, reporting on issues such as animal

stress, “I am in favour of individual cages because pregnant females need a different treatment compared to other animals, based in a relationship between animal welfare and the least amount of stress possible” (P171), and animal sentience, “...this makes the animal feel more relaxed, even at the time of feeding...” (P294). One participant supported his response on his disapproval of group housing: “I am in favour because papers published on group housing did not support improvements in animal welfare (fights, etc.). Even American associations, such as pig farmers and pig veterinarians were against this method" (P44).

4.3.6 Participants indifferent to gestation stalls

Participants not associated with livestock production

Some participants justified their position using references related to production, especially productivity: “In the world we live in, the greatest interest is the economic / practical / functional” (P317), while some related it with animal welfare, “I believe housing sows in cages for a certain period of time (pregnancy) does not interfere in issues related to production or animal welfare” (P326). Two participants said that they did not have enough knowledge to answer the question or to have a position.

Participants associated with livestock production

Some participants justified their position based on production, “We must provide the population with sufficient and affordable food” (P185). Some covered the theme animal welfare, “I am indifferent to housing of pregnant sows in individual cages because both systems have their benefits, and both are acceptable provided there is a commitment to animal welfare” (P143), while others covered both themes, “There are several production systems to suit different situations. Animal welfare is not just associated to the fact that the animal is confined or not, but to the whole process involving these systems and that involve productivity directly” (P239). Three participants said that they did not have an interest on the question because it did not matter to them.

4.4 DISCUSSION

Participants in our study were generally opposed to restrictive housing for sows. This included participants not associated with livestock production, who despite considering themselves uninformed

about swine production, and being unaware of the widespread prevalence of gestation stalls for sows in Brazilian farms, were overwhelming in their rejection of this system. Interestingly, although to a lesser extent, most participants associated with livestock production were also opposed to gestation stalls. Reasons underlying the rejection of gestation stalls were mostly related to animal welfare concerns and a perception that this housing system is not capable of providing an animal the opportunity to live a reasonable good life.

Our findings do not support the contention that Brazilians are not interested in farm animal welfare despite many having a low awareness of animal production systems (DE BARCELLOS et al., 2011a; BONAMIGO et al., 2012; POLETTO et al., 2012). However, it must also be mentioned that our method of online recruiting may have preferentially attracted people that were particularly interested and informed on farm animal welfare issues. Additionally, people that supported the use of gestation stalls may have not accepted the invitation to participate in the survey due to lack of interest, as previously commented on by HELESKI et al. (2005). Also, because it was a self-administered survey, it was not possible to know how many participants may have only viewed the survey and chose not to continue. This qualitative, exploratory study, based on a convenience sample of participants, cannot be interpreted as representing the views of the Brazilian society. In comparison to the Brazilian population (IBGE, 2011) our sample contained a greater proportion of females, which are known to have greater empathy for animals (HELESKI et al., 2006; MARIA, 2006). The sample was also younger and more well educated which may represent a segment of the population that has greater purchasing power, which may ultimately influence changes in production practices (WEIBLE et al., 2016). This type of survey is however important as it provides novel information on an issue less studied in developing countries (CLARK et al., 2016), such as Brazil, a country with an ever-growing proportion of its GDP arising from food animal production systems and a population that is further and further removed from agriculture. Most importantly, this type of information can provide valuable insights into potential issues that have received much discussion in other countries.

Concern regarding animal welfare was the main reason cited by our participants irrespective of their choice of stall housing system and regardless of whether they viewed themselves to be associated or not with livestock production. Public concern with animal welfare is generally related to issues such as animal suffering, ability to express

natural behaviours (LASSEN et al., 2006b), freedom to move (MIELE et al., 2011; YOU et al., 2014) and animal health and stress (MAF, 2011). Accordingly, most statements provided by the participants in this study referred directly to some issue relating to the animals, such as freedom to move, animal sentience, natural living, animal stress and animal health, which collectively accounted for over 65% of all reasons offered by participants that opposed gestation stalls. Ethical considerations were used by both groups of participants when answering the questions. For instance, many participants that rejected the use of gestation stalls used terms like “not right”, “inhuman”, and “greedy”. Since moral values regarding the treatment of farm animals appear to have a greater impact on citizens’ negative attitudes towards farm animal welfare than factual knowledge (BOOGAARD et al., 2011a; HÖTZEL, 2016; VENTURA et al., 2016), this may explain why criticisms regarding certain production practices fail to wane over time.

Participants with and without association with livestock production shared many beliefs and values. Differences between the two groups were focused primarily on the fact that the participants associated with livestock production enriched their justifications with science-based arguments; their references tended to be factual and did not contradict, but mirrored in part comments made by those not associated with animal agriculture. Previous research has shown that industry specialists (CANTRELL et al., 2013) and farmers (TE VELDE et al., 2002; TUYTTENS et al., 2010; SPOONER et al., 2014b) tend to associate farm animal welfare with animal's health and biological functioning; whereas, citizens’ values reflect aspects like space to move, ability to engage in natural behaviours, pain and stress (VANHONACKER et al., 2008; PRICKETT et al., 2010; CARDOSO et al., 2016b; HÖTZEL et al., 2017). However, in our study we identified only small differences between the views of participants associated or not with livestock production.

As expected, more participants associated with livestock production supported the use of gestation stalls than participants not associated with livestock production. A U.S. survey reported that participants associated with swine production rated the use of gestation stalls for sows as less of a concern than participants lacking such background (HELESKI et al., 2004). Other studies have found that stakeholders associated with the livestock industry are more likely to rate the welfare of farm animals as positive compared to citizens (BENARD; DE COCK BUNING, 2013), and support husbandry practices that lay citizens reject (TUYTTENS et al., 2012; HÖTZEL;

SNEDDON, 2013; VENTURA et al., 2013; SPOONER et al., 2014b). Reasons in support of gestation stalls also differed between the groups. Whereas participants not associated with livestock production argued primarily from the perspective of the welfare of the sows, participants associated with livestock production justified their position using arguments that transitioning to group housing would reduce production and cause economic losses. Interestingly, economic and production related arguments were not ignored by participants opposed to gestation stalls; on the contrary, many acknowledged these issues in their statements, but considered them insufficient to justify the harm caused to sows. Similarly, after reflecting on the perspectives of farmers, Dutch urban citizens acknowledged the economic and market pressures pig producers face but this did not change their negative attitudes towards intensive pig production for reasons mostly related to animal welfare (BENARD; DE COCK BUNING, 2013).

When asked about their preferred housing system for gestating sows, over 40% of the participants in our study chose the option "another system", even surpassing the preference for group housing. This result may be criticized by many working in the pig industry as an unrealistic expectation of "ignorant" people that do not understand the pig industry (HOLLOWAY, 2004; BENARD; DE COCK BUNING, 2013). Indeed, in line with a previous survey (DE BARCELLOS et al., 2011a), 72% of the participants showed low awareness about pig production in Brazil, and not surprisingly underestimated the predominance of gestation stall system within Brazil (ABPA, 2015). However, their preference for "another system" is consistent with European citizens' preference for outdoor and free-range systems (MIELE, 2010; PETTERSSON et al., 2016; TEIXEIRA et al., submitted). A few participants mentioned a preference for outdoor and free-range systems explicitly, and many more justified their rejection to the stalls by contrasting them to environments where animals are free to move and that allow them to express natural behaviours. Not surprisingly given the emphasis placed on production and economics in Brazilian agricultural policies (HÖTZEL; SNEDDON, 2013) many of the participants associated with livestock production expressed dissatisfaction with group housing systems, arguing that the disadvantages and risks – mainly regarding reduced reproductive rates related to increased aggression – do not justify the challenges associated with transition from stall to group housing. This may explain why these particular participants, which were likely aware of mandates to ban gestation stall housing thus possibly restricting the future use of this

type of housing, chose “another system” as often as they did group housing. Opposition to housing systems that deprive animals from moving freely and expressing natural behaviours is central to this debate, but we also provide evidence that the rejection of gestation stalls should not be interpreted as support for group housing in confined systems, as to do so may undermine the sustainability of pig industry. Others (VON KEYSERLINGK; HÖTZEL, 2015; WEARY et al., 2016) have discussed the risk involved in developing and implementing changes in animal production practices and housing that do not resonate with public expectations.

The aim of the present study was not to assess the effect of providing information on the participants’ views; rather the objective of providing information was to give elements for participants to form a position regarding sows’ housing. This approach was based on previous studies that suggested that the Brazilian public is not familiar with livestock systems (DE BARCELLOS et al., 2011b; BONAMIGO et al., 2012; LUGNANI DE SOUZA et al., 2013). Information may influence citizens’ position regarding farm animal production; for example, one study (TUYTTENS et al., 2011) showed that providing textual combined with audio-visual information improved attitudes toward immunocastration and raising intact male pigs as alternatives to surgical castration without anaesthesia. In contrast, a recent study showed a decline in support for gestation stalls for sows among Canadian and US American participants that accessed text and video information offered in the survey (RYAN et al., 2015). Interestingly, most participants in our survey said that they were not influenced by the information provided; accordingly, their open responses indicate that their resulting position and justifications were in large part based on previous knowledge of livestock production or a pre-established opinion that cages in general are not appropriate for housing animals. Apparently having factual knowledge of livestock production systems may not be essential for people to have an opinion regarding farm animal welfare (e.g., (MACNAGHTEN, 2004). However, provision of information may contribute to a more critical, engaged public better able to discuss their views on specific issues.

During the time of this survey some pig producers in Brazil publically committed to transition to group housing over the next few years (HSIBRASIL, 2015b), but it appears that few participants, mostly associated with livestock production, were aware of these announcements. Moreover, none of the participants not associated with livestock production that said that had heard about these announcements

remembered the contents of the message. This provides some evidence that these targeted announcements are primarily limited to industry oriented media. Although the NGO's do on occasion convey this information in their communications, the broader public likely has few opportunities to receive this type of information. However, our responses also indicate that this lack of awareness of the phasing out of gestation stalls by some producers would have had little effect on our results. Some industry stakeholders believe that given the complexities associated with livestock production the public should remain ignorant as a means to avoid misunderstandings (BROAD, 2016). We speculate that this may explain why the pork industry limited its announcements regarding its commitment to phase out gestation stalls to their own websites and other similar livestock production specialized sites, which are predominantly visited by commercial partners and other interested parties. However, it has been shown that lack of transparency from the industry may reduce citizens' trust in farmers (ROBBINS et al., 2016).

4.5 ANIMAL WELFARE IMPLICATIONS AND CONCLUSIONS

Brazilian participants opposed to gestation stall housing expressed values and attitudes similar to previous work on citizens from different countries and cultures. These views, which were shared by both participants associated and not associated with livestock production, underlie the international trend to implement group housing systems for gestating sows. However, our work also indicates that our participants showed a generalized preference for some other, non-specified housing system, which differs from both gestation stalls and group housing. We therefore caution that the transition from gestation stalls to group housing may prove unsatisfactory for the public in the long term. Further understanding of the expectations of the public regarding housing systems for sows and the underlying reasons for their preferences may help guide the necessary changes in the livestock industry.

5 IS GENE EDITION OF MALE PIGS AN ACCEPTABLE ALTERNATIVE TO SURGICAL CASTRATION?

ABSTRACT

On the majority of pig farms around the world male piglets are castrated to eliminate the risk of boar taint. Surgical castration, the most commonly used procedure, induces pain and is under scrutiny by society. Gene modification targeted at eliminating boar taint in male pigs has been proposed as a possible alternative to castration. The aims of this study were to explore public acceptability of this biotechnology and underlying reasons using a mixed methods approach. Quantitative data to assess acceptability of 570 participants from southern Brazil were analysed with mixed effects logistic regression and Spearman correlations; qualitative responses of the reasons provided in support of their position were coded into themes. Just over half of the participants (56%) considered gene modification of male pigs acceptable. Acceptability was lower among participants that grew up in an agricultural environment ($\rho = 0.02$), but was not influenced by sex, age, religion, urban or rural living, or level of education. Acceptability of gene modification of male pigs was positively related to the perception of benefits ($r=-0.56$, $\rho<0.0001$) and negatively related to the participant's perception of risks ($r=-0.35$, $\rho<0.0001$). Acceptability was not related to knowledge of basic concepts of genetic biotechnologies ($r=0.062$, $\rho<0.14$), or to awareness of issues related to pig castration or boar taint ($r=0.032$, $\rho<0.44$), both of which were low among participants. Participants that considered gene modification of pigs acceptable justified their position using arguments that it improved animal welfare. In contrast, those that were not in favour were generally opposed to genetic modification. Unforeseen downstream consequences of using genetic modification in this manner were a major concern raised by over 80% of participants. Our findings suggest that perceived animal welfare benefits may increase public support of gene editing of food animals but the risks associated with the technology must also be transparent.

Keywords: Pig castration. Biotechnology. Public survey. Gene edition.

5.1 INTRODUCTION

5.1.1 Gene edition

The direct manipulation of DNA to alter an organism's characteristics using a set of modern biology techniques (biotechnology) is called genetic engineering. In recent years, genome editing (one type of genetic engineering) has allowed to identify specific segments of DNA from the genome of any organism, and make it possible to delete, modify and insert genes with precision (TAN et al., 2012). Techniques known as ZNFs (Zinc finger proteins), TALENs (Transcription activator-like effector nucleases) and CRISPR-Cas9 (Clustered Regulatory Interspaced Short Palindromic Repeats) have turned gene editing more efficient, cheaper and easier than previous methods of genetic engineering (GAJ et al., 2013; WEI et al., 2013; GUPTA et al., 2014; GO et al., 2016). Advances in genome edition of human and non-human living beings have provided unprecedented opportunities in the fields of medicine, agricultural production, and bioenergy (ESTRELA et al., 2016). The development and refinement of gene edition tools promises a number of applications that could be ready to be used in animal agriculture in the next few years (SONSTEGARD et al., 2016).

Gene edition is a novel technology, and often new technologies raise fear, as people may have doubts about their potential health, environmental and ethical implications. In general, people are positive about biotechnology but they tend to have negative attitudes regarding certain applications like the use of modern biotechnology for food production (GASKELL et al., 2006). However, a national survey conducted by the Brazilian Ministry of Science and Technology identified optimistic attitudes about science and technology among Brazilians, and that this optimism did not depend on people's information on the subject (CASTELFRANCHI et al., 2013). Other studies also pointed to relatively positive attitudes of Brazilians in relation to biotechnology, including in agriculture (MACNAGHTEN et al., 2011; RIBEIRO et al., 2016).

5.1.2 Gene edition and farm animal production

Genome edition has been presented as a way to help solve problems faced by the livestock industry, for example promising improvements in farm animal health and welfare (TAN et al., 2012). These improvements include hornless cows (TAN et al., 2013), heat

resistance (AGGENETICS, 2016; SONSTEGARD et al., 2017) and mastitis resistance (DONOVAN et al., 2005) for dairy cattle; boar taint prevention on male pigs (SONSTEGARD et al., 2016), and resistance to African swine fever (LILLICO et al., 2013). Other potential applications target improvements in animal production, as double muscled cattle, sheep (PROUDFOOT et al., 2015) and pigs (CYRANOSKI, 2015).

One example of gene editing application to farm animals is the production of hornless dairy cattle, though the introduction of a polled gene (hornless trait) that occurs naturally in beef cattle, in the dairy genome. The presence of horns is a very frequent but undesirable trait in dairy cattle as it may make routine handling more difficult and be dangerous to humans and to other animals in the herd (RUSHEN et al., 2008). Because of this, cattle often are dehorned (have their horns removed); the procedure is painful, stressful and adds cost to production (STAFFORD et al., 2011). The introduction of the Polled gene in dairy herds by conventional methods of genetic selection is possible, but is largely hampered by the potential implications on dairy productivity (SPURLOCK et al., 2014; THOMPSON et al., 2017). In this context, it is proposed that gene editing of dairy cattle could make the dehorning process unnecessary, without compromising genetic merit and milk yield (TAN et al., 2012).

Other application under development would reduce thermal stress in dairy cattle (AGGENETICS, 2016; SONSTEGARD et al., 2017). Thermal stress occurs when animals are unable to effectively dissipate heat produced either by high ambient temperatures or its metabolism (KADZERE et al., 2002). Dairy cows in particular have a high metabolic load associated with high metabolic requirements of lactation and are therefore more sensitive to heat stress (KADZERE et al., 2002). The use of zebu (*Bos indicus*) breeds, which are more resistant to heat, implies in reduced milk production due to the lower productivity of these breeds (DAVIS et al., 2017). Genetic selection for heat resistance also implies in reductions in production (CARABAÑO et al., 2017). The SLICK gene from Senepol cattle was found to be responsible for short and sleek hair coat in animals that confer superior ability for thermoregulation. Thus, the introduction of SLICK gene through gene edition to improve heat resistance in dairy breeds, without modifying other traits of the breed, is also presented as an alternative to dairy production and animal welfare (AGGENETICS, 2016; SONSTEGARD et al., 2017).

In addition, resistance to mastitis through gene edition is also being developed. High milk production cows are particularly susceptible

to mastitis (OLTENACU et al., 2010) and, consequently, to the excessive use of antibiotics. Thus, besides benefiting animal health and welfare, genetic resistance to mastitis would benefit human health through the reduction of antibiotic use (DONOVAN et al., 2005). However, differently from the applications described above, mastitis resistance is given by the precise insertion of the exogenous human lysozyme (hLYZ) gene into dairy cattle genome, using a gene edition tool. Transgenic cows expressing human lysozyme in their milk are resistant to certain, though not all bacterial infections responsible for the mastitis (LIU et al., 2014).

Additionally, other applications of gene editing are being proposed that do not deal with health and welfare issues. One emerging area is the production of increased muscle mass (PROUDFOOT et al., 2015) in cows and pigs. Proponents of the technology claim that this may be used to improve productivity, besides offering environmental advantages by reducing the use of environmental resources to produce meat. However, increased muscle mass may have negative consequences for the animal, as it could cause adverse health and welfare effects, including increased dystocia, and neonatal mortality (KING et al., 2012).

5.1.3 Gene edition, science and society

Gene edition is a novelty in farm animal production; applications to the farm industry are still emerging and still need to receive legal approval before it reaches the market (CARROLL et al., 2015). Genome editing is presented as a tool that can be more easily and precisely used to alter the animals' genetics than previously available technologies, and differently from transgenic technology, may use the species' own DNA (BRUCE, 2016a). In addition, unlike conventional genetic improvement, it may not compromise other animal characteristics (CARLSON et al., 2016). Gene edition can be used for purposes that improve animal welfare and sustainability (MAGA et al., 2010). However, some critics argue that anthropogenic benefits are the main drivers behind the applications of genetic innovations - for example increased production, which some argue inherently causes harm to animals (DENNIS, 2002) and undesirable social consequences (HOSSAIN et al., 2004).

Additionally, there are many unanswered questions about the safety of the technique, especially about possible unexpected effects of gene editing in the organism (BALTIMORE et al., 2015; BRUCE,

2016a). One concern is that off-target and unintended changes may potentially occur in the genome of the gene-edited organism (BUTLER et al., 2015). However, some studies have found low or no incidence of off-target mutations, suggesting that gene editing is more precise than previously thought (NI et al., 2014; VERES et al., 2014; YANG et al., 2014). Other concern is the uncertainty regarding the possible effects on the edited organism when a gene is knocked out or knocked in to an animal (LOTTI et al., 2017). The risk that these mutations will affect the animals' health, though unlikely, are potential obstacles on the future promotion of gene editing (RUAN et al., 2017). Others worry that genome editing technology could be used to make changes not only using naturally occurring alleles, but could also permit the generation of virtually all mutation types, resulting in the creation of animals with traits that do not exist naturally (RUAN et al., 2017). Furthermore, the DNA of gene edited animals does not have a traceable sequence as transgenic animal have, which will require technology and resources to warrant that the creation, reproduction and consumption of these edited animals and products be adequately registered and tracked (RUAN et al., 2017).

Ethical concerns about the use of GM technology in animal production are also related to environmental sustainability, human health and animal welfare (MORA et al., 2012), as well as the social and economic implications of GM technology, including how it would be distributed and which impact it would have on producers (MACNAGHTEN; GUIVANT, 2011). Brazilian citizens complained that GM technology was benefitting the large producers at the expense of the small producers and that so far, the technology had done little to guarantee the future of the world's food supply in the face of a growing population (GUIVANT; MACNAGHTEN, 2015). Respondents of a survey related to animal biotechnologies also reported concerns with social justice, questioning about the real beneficiaries of this technologies and about legislation and regulation (LASSEN et al., 2006a). According to the same authors, people tend to question the real usefulness of animal biotechnology applications and not approve them when they see them as being merely about economic gains.

The aim of the GM technology application also influences public views. Several studies show that people are more positive to genetic modification for medical and environmental applications than for food production (GASKELL et al., 2000; COSTA-FONT et al., 2008). In an online survey with 12,562 respondents across 185 countries to investigate global perceptions of human genome editing applications,

59% of respondents approved the technology to be applied in children and adults or in embryos to cure life-threatening or debilitating diseases; less support, though, was found for the use of gene editing technology for non-health-related purposes, as sporting ability and appearance (ROBILLARD et al., 2014; MCCAUGHEY et al., 2016). However, when applied to food production most people do not agree with the idea that GM food is safe for health (GASKELL et al., 2010). Concerns about health related to GM food consumption have strong influence on risk perception (MARTINEZ-POVEDA et al., 2009). Moreover, people tend to reject the use of genetic modification in animals more than in plants or microorganisms (FREWER et al., 1997a; GUIVANT; MACNAGHTEN, 2015; RIBEIRO et al., 2016). That is probably why there is only one GM animal, a salmon, approved so far for human consumption (HALLMAN et al., 2003; WALTZ, 2016). The claimed benefit of this GM salmon, growing faster than non-GM ones, is perceived by the public as harming nature and the environment (GRUNERT et al., 2001). Also, genetic modification that cross species barriers is susceptible to face greater opposition (SHAW, 2002; MIELBY et al., 2013).

5.1.4 Risk and benefit perception, trust and knowledge of biotechnologies influence acceptance

Risk perception depends on the individual's own judgment, which includes how he gathers and processes information about the hazard, the level of risk perceived and personal experience with the risk (SIEGRIST, 2000; HANSEN et al., 2003). Perception of risk is higher when people believe that the consequences are unknown to scientific experts (SLOVIC, 1987). Risk perception, rather than the technical risk provided by experts, drives people acceptability to new technologies (FREWER et al., 1998). Also, risks and benefits are inversely correlated in people's minds, i.e. higher perceived risk is associated with lower perceived benefit and vice-versa (SLOVIC, 1999).

The perception of potential benefits also drives the acceptance of a technology (RONTELTAP et al., 2011), and the extent to which perceived benefits surpass perceived risks influences acceptability (GRUNERT et al., 2001; KNIGHT, 2007; FREWER et al., 2011). The public questions the need for a new food technology if no benefits are perceived, which may also raise perceived risks and moral concerns (GASKELL et al., 2000). But if they perceive the technology as useful and morally acceptable than they may discount risk (GASKELL et al.,

2006; ROLLIN, 2006). Perceptions that the GM applications are associated with consumer needs and benefits may positively influence people's attitudes. Perception of personal benefits of GM animals to food production is related to lower concerns with safety (GROBE et al., 1999) and greater acceptability of GM animal products (LESCH et al., 2006; QIN et al., 2008). Also, perception of benefits to consumers rather than to the business sector might increase acceptance of GM animals (GUIVANT; MACNAGHTEN, 2015, GUIVANT, 2005, QIN; BROWN, 2006). People seem to base their assessment on judgments about the means and the end of each specific application of genetic modification, instead of rejecting or approving them as such (PARDO et al., 2002).

Perceptions of risks and benefits may also be influenced by social trust (SIEGRIST et al., 2000). Many people lack interest, understanding and knowledge on science and technology. Given that, when there are decisions to take regarding the introduction of technological novelties in the market, personal decisions may be highly influenced by trust in social institutions (scientists, industry, governmental institutions, etc.) (SLOVIC, 1999; SIEGRIST, 2000; SABA et al., 2003). A consumer survey found that people that were sceptical about biotechnology companies and scientists, as well as those that lacked confidence in government regulators, were less willing to buy GM foods (HOSSAIN et al., 2004). GROBE et al. (1999) found a positive relationship between distrust in regulatory agencies and risk perceptions on this type of product.

However, most people have little knowledge on the subject (GASKELL et al., 2003; HALLMAN et al., 2004; CUITE et al., 2005; HUANG et al., 2006; ALEKSEJEVA, 2014). A survey in the US found that 43% of the participants had heard or read very little or anything on genetics or biotechnologies; only half of them were aware that transgenic products were available in the supermarket shelves (HALLMAN et al., 2003). In this same survey, the term genetic modification was largely associated to negative responses, such as danger, wrong, unnatural. Previous studies found that the public perceives the risks of DNA technologies as extremely unknown, not directly observable and that appears only some years after its use (SPARKS et al., 1994; JAMES et al., 2003). A survey found that the correlation between perception of risk and benefits and social trust increased as people's knowledge on genetic manipulation decreased (SIEGRIST; CVETKOVICH, 2000). Therefore, the relation between knowledge and attitude is complex, and surveys related to level of

knowledge and GM acceptance could not draw clear conclusions as to whether a person provided with additional information will be likely to become more positive or more negative to genetic manipulation (GASKELL et al., 1999; SCHOLDERER et al., 2003; GANIERE et al., 2006; MIELBY et al., 2013). Thus, public education on the issue may not necessarily imply in greater acceptability (CHRISTOPH et al., 2008) as there are several factors influencing public attitudes toward gene modification. However, the public must be clearly informed, as by doing so trust is built, and trust is an important factor behind public acceptance (SIEGRIST, 2008).

The importance of informing and dialoguing with the public about the use of new biotechnologies in food production is widely recognised (ROLLIN, 2006). For example, when transgenic products were introduced to the market, it was assumed that the public would understand and accept this new technology; however, a large majority of the public rejected its use (EUROBAROMETER, 2002; MACNAGHTEN et al., 2015). Even if GM food products have gained approval for human consumption in many parts of the world, the labelling required in many countries is a recognition that the public wants to be informed about GMO in the food and to be able to choose to buy or eat it or not (FSA, 2013).

Considering that the grounds for objecting to the use of biotechnologies to modify animals is largely related to risks perception and loss of naturalness (MACNAGHTEN, 2004), it is necessary to study the acceptance by the public of technologies as gene edition. On the other hand, the introduction of foreign DNA is not necessary for an organism be considered a GMO (JAFFE, 2018). The emerging question is how the public will perceive gene edition technology, what will they think of gene edition of farm animals, and how they may weigh the risks in view of potential benefits for animal welfare, production and the environment. Therefore, the current challenge is not only to find better technologies, but at the same time find better ways to dialogue with society, introducing these novelties in a way that allows thoughtful consideration, informed decision-making and trustiness on key actors.

5.1.5 Gene edition as an alternative to eliminate boar taint in pig production

Meat of uncastrated male pigs may present an odour and flavour, called boar taint, that many consumers find repulsive (LUNDSTRÖM et al., 2006). Boar taint is caused by substances that accumulate in the fat,

especially androstenone and skatole, by the time pigs reach sexual maturity (PATTERSON, 1968; CLAUS et al., 1994). To avoid boar taint, most piglets throughout the world are surgically castrated soon after birth. Pain control measures during and after the procedure are available (PRUNIER et al., 2006; RAULT et al., 2011), but not routinely used (DE BRIYNE et al., 2016). Another alternative to surgical castration is immunocastration, which is done through a vaccine that induces the production of antibodies against GnRH, thus inhibiting testicular development and function; this reduces fat androstenone concentrations to levels below the reported threshold for human sensory detection (THOMPSON, 2000; RAULT et al., 2011). Production of entire males with acceptable levels of boar taint is feasible through a combination of early slaughter and specific feeding and environmental measures (BEE et al., 2015), but its use is restricted to some European countries (DE BRIYNE et al., 2016). In Brazil, the slaughter of uncastrated male pigs is prohibited (BRASIL, 2017b). In addition to the increase in economic cost, many producers consider alternative measures to surgical castration or the use of pain control impractical or ineffective (TUYTTENS et al., 2012; ALUWÉ et al., 2015; DE BRIYNE et al., 2016).

The use of gene editing technology to produce pigs that lack testicular development is being presented as potential alternative to prevent boar taint (SONSTEGARD et al., 2016). With a gene edition tool, the gene KISSR, responsible for testicular development in pigs can be knocked-out (SONSTEGARD et al., 2016). No differences are expected on feed efficiency and meat quality compared to surgical castrated animals (RECOMBINETICS, 2018a).

As discussed earlier, the prospect of bringing gene edited animals into animal production systems in the near future has stimulated a hot discussion regarding technical and ethical aspects of the technology (e.g. (PROUDFOOT et al., 2015; BRUCE, 2017; ERIKSSON et al.). To our knowledge this is the first exploration of public attitudes towards gene editing of farm animals. Therefore, our objective was to explore Brazilian citizens' acceptability of gene edition of male pigs for prevention of boar taint, perceptions of risks and benefits, and the underlying reasons. A secondary aim was to identify demographic aspects that may influence acceptability.

5.2 MATERIALS AND METHODS

This study was approved by Ethics Committee on Experimentation of the Santa Catarina State University (P. 2.280.893).

5.2.1 Participants' Recruitment

Participant recruitment took place at the Hercílio Luz International Airport located in Florianópolis, Santa Catarina, Brazil; a place associated with intense movement of people and frequent waiting times. People waiting in the public airport hall located before security were approached and invited to participate in the study. Each participant who volunteered received a consent form and was asked to read and sign before taking the survey. Only participants that were at least 18 years old and who permanently resided in one of the three southern states of Brazil (i.e. Rio Grande do Sul, Santa Catarina and Paraná states) were included in the study. The identity of the participants was not required.

5.2.2 Description of the Survey

Data collection were conducted during the months of September and October 2017. Responses were reviewed, and refinements made to the questionnaire. The final questionnaire was 6 pages long and included a total of 24 open and closed questions.

The first questions addressed participants' socio-demographic information relating to whether they lived in one of the three southern states in Brazil, sex (male, female), age (18-25, 26-35, 36-45, 46-55, 56-65, over 66 years old), education (elementary school, high school, or higher education), whether they were religious or not, whether they lived in a rural or urban area, their level of association with livestock production ("not involved" – no ties with livestock production, "involved" – professional ties with livestock production (rural producer, student, faculty or profession, etc.), or "grew up in a farming environment" – (family owned a farm or participated in some form of agricultural activity), whether they have visited a pig production farm (yes, no), whether they had ever watched any documentary or video on the internet, television, etc., showing how a pig farm works (yes, no), their sources of information on animal production (TV - rural programs, internet, university or school, friends, animal product advertising, NGO campaigns other), and how many times a week they ate meat (none, rarely, 1 to 2 times, 3 to 4 times, 5 to 7 times). Participants that ate meat

(even when only rarely) were also asked how important eating meat was for them as an individual (not important, little important, intermediate, important, very important), and if they considered the welfare of animals when they ate meat (never, almost never, sometimes, often, always).

Participants were also asked two questions based in surveys of Brazilian citizens' opinions towards s science and technology (CASTELFRANCHI et al., 2013; CGEE, 2015) inquiring their attitudes towards science and technology: "In your opinion, science and technology brings more harms or benefits to humanity?" (only benefits, more benefits than harm, both benefits and harms, more harm than benefit, only harm) and "If a new technology offers benefits, it should be used even if its consequences are not well known" (totally agree, agree in part, disagree in part, totally disagree, do not know).

Participants were then asked to read a short text on male pig castration techniques:

> "The majority of pigs in Brazil are slaughtered at around 5 months of age as older male pigs begin to sexually mature (e.g. the testicles develop) and there is increased risk that the meat of these animals can express "boar taint." If the pigs are left intact (i.e. with the testicles), approximately 10 to 20% of the meat will express boar taint. Most consumers perceive the taste and odour as very unpleasant. In Brazil, to ensure that meat is not contaminated by boar taint, all male pigs must be castrated prior to slaughter (Decree 9133 of 2017).
>
> The most commonly used technique in Brazil is surgical castration (removal of the testicles). Piglets are castrated between 3 and 10 days of age, usually by the farm staff. The use of medicines to relieve pain is not common in Brazil.
>
> An alternative to surgical castration is called immunocastration. The piglets receive two injections with a substance that restricts the development of the testicles. The injection does not contain hormones, but it causes the pig to produce antibodies against its own reproductive hormones. The risk of boar taint in the pigs that have been immunocastrated is eliminated. The method is approved and adopted in several countries, including Brazil.
>
> Another alternative is to employ gene-editing technology. This technology makes it possible to alter one gene in the swine embryo. Pigs with this edited gene produce acceptable concentrations of sexual odour in the flesh. Pigs generated using gene edition technology will show this trait. This biotechnology may make castration of piglets unnecessary."

Thereafter, participants were asked their opinion regarding the statement, “It is acceptable to produce pork meat using the gene editing technology described above”, with the options ‘totally unacceptable’, ‘unacceptable’, ‘intermediary’, ‘acceptable’, ‘totally acceptable’; thereafter, they were asked to justify their position in an open-ended question. They were then asked to assess the risks (‘no risk’, ‘little risk’, ‘intermediary’, ‘some risk’, ‘high risk’) and benefits (‘no benefits’, ‘little benefit’, ‘intermediary’, ‘some benefit’, ‘high benefit’) associated with the introduction of the gene editing technology described in the text.

Participants were also asked to rate the acceptability of some common biotechnologies used in food production, with response options ranging from 1 (not acceptable) to 5 (very acceptable), and whether they were aware of some pig production practices common in Brazil (“The following statements are true and we want to know if you were aware of this information before filling this questionnaire”, with response options ‘I already knew’ or ‘I did not know’). Finally, the participates were asked to complete a knowledge quiz on biotechnology that had five previously validated questions (EUROBAROMETER, 2002; HALLMAN et al., 2003; CUITE et al., 2005), with response options as ‘true, ‘false and ‘I do not know’.

Statements within the questions regarding acceptability, awareness and knowledge of biotechnologies were randomized. Additionally, for validation purposes we included two check questions where we specifically asked the respondent to mark a given option (e.g., please, for the purpose of validating this questionnaire, mark option 4).

5.2.3 Data Analyses

From the initial 677 participants, it was possible to use 570 questionnaires as 107 of them were excluded because they were either incomplete (n= 78) or participants failed one or both of the check questions (n= 29).

Descriptive statistics for the responses were calculated using Microsoft Excel for Windows and all other statistical analyses were conducted using SAS 9.3. For the question regarding the acceptability to produce pork meat using the gene editing technology, options ‘totally unacceptable and unacceptable’, and ‘acceptable and totally acceptable’ were grouped. Age 56-65 and over 66 years old were grouped due to the low number of participants in these categories.

Spearman's correlation coefficient was calculated to analyse the degree of association between acceptability of gene editing to prevent boar taint in male pigs and the perception of benefits coming from this technology, the perception of risks, the awareness of common pig production practices, and knowledge biotechnology assessed in the quiz. The association between the two questions regarding participants attitudes towards science and technology ("In your opinion, science and technology brings more harms or benefits to humanity?"; "If a new technology offers benefits, it should be used even if its consequences are not well known") were analysed by Chi-square.

Multinomial Logistic Regression Models were used to analyse associations between acceptability of gene editing to prevent boar taint in male pigs and socio-demographic data. Acceptability of gene editing was considered as dependent variable. Univariate models were built to separately assess the influence of each predictor variable on the dependent variables. Predictor variables with $p < 0.20$ were used to build multivariate models. Backward selection was used to eliminate predictor variables until only those with $p < 0.10$ remained in the models. Results are presented as odds ratio (ODDS) and 95% confidence interval (95% CI). Statistics associations were reported when $p \leq 0.05$ and tendency when $0.05 < p \leq 0.1$.

The five-point Likert scale questions about the position of participants regarding acceptability were reclassified into three points (acceptable/ indifferent/ not acceptable).

Open answers were analysed using the method previously described by (HUBERMAN e MILES, 1994) which has three stages: data reduction (information is coded), data display (organization of the information) and conclusion drawing and verification (e.g. triangulation between two or more readers). o ensure that the coding of themes was appropriate given our study objective, two readers initially analysed 50 random responses and independently developed themes. The two coders then compared their results and discussed any discrepancies and ambiguities until agreement was reached. Finally, the same two readers then coded all answers independently and compared their results and again discussed and reconciled any discrepancies and ambiguities.

5.3 RESULTS

Demographic data are shown in Table 7. Participants' distribution of sex, age (except for those 66 years old and over), and place of residency approximately corresponded to the Brazilian population

according to the Brazilian Institute of Geography and Statistics Census (IBGE, 2011) for the three southern states of Brazil. Older people were less willing to accept participating in the study, resulting in a lower proportion of participants within this group. Compared to the general population of the southern region of Brazil, a higher proportion of participants had undergraduate level education and self-identified as not being religious (IBGE, 2011).

More than half of the participants (57%) had watched a documentary or video on how a pig farm works in the Internet or television and 44% had visited a pig production farm. Fifty percent ate meat 5-7 times a week, 33% ate meat 3-4 times a week, 12% 1-2 times a week and 5% rarely ate meat.

Table 7 - Demographics of survey participants (n=570) and of the associated general population living in southern Brazilians according to latest Brazilian Institute of Geography and Statistics census (IBGE, 2011)

Variable	*Participants (%)*	IBGE* *(%)*
Sex		
Female	49	51
Male	51	49
Age		
18 to 24 years old	18	16
25 to 34 years old	23	23
35 to 44 years old	25	20
45 to 54 years old	19	18
55 years old and over	15	23
Education		
Up to high school	33	64
Undergraduate education (completed or ongoing)	66	36
Religious	80	95
Current residence urban	95	85
Involvement with agriculture		
No involvement	61	
Professional involvement	12	
Grew up in an agricultural environment	27	
For you, consuming meat is...		
Important	66	
Intermediate	21	
Not important	10	
When you eat meat, do you consider the welfare of animals?		
Always/often	27	
Sometimes	46	
A few times/never	27	

5.3.1 Acceptability of gene editing to eliminate boar taint

The majority of participants (56%) considered the gene editing option an acceptable method to reduce boar taint in male pigs, 22% were intermediate and 22% were opposed. Acceptability was lower among participants that grew up in an agricultural environment ($P = 0.0223$). No other demographic variable, nor awareness of pig production practices or knowledge of biotechnologies influenced the acceptance of male pig gene editing.

5.3.2 Sources of information on animal production

The sources cited were TV (65%), internet (57%), friends (33%), advertisements of animal food products (24%), university or school (12%), ONG campaigns (10%) and experience with farming (4%).

5.3.3 Attitudes towards science and technology

Participants were mostly positive when asked about the benefits of science and technology (Table 8); however, their position was not related to acceptability of gene editing of pigs as a way to prevent boar taint (Chi-square 12, d.f. = 8, $p < 0.15$). Over half of our participants agreed that a new technology that offers benefits should be used despite the downstream consequences not being fully understood (Table 8), and this was associated with acceptability of preventing boar taint using gene editing (Chi-square 29.3, d.f. = 8, $p < 0.001$).

Table 8 - Participants position on harms and benefits of science and technology and their position on whether the technology should be used despite no available knowledge regarding its long-term consequences (n=570)

	Participants	Southern region (CGEE, 2015)
In your opinion, science and technology brings more harms or benefits to humanity?		
Only benefits	16%	51%
More benefits	41%	30%
Equal benefits & harm	41%	7%
More harm	2%	3%
Don't know/didn't answer	0%	9%
Only harm	0%	0%
If a new technology offers benefits, it should be used even if its consequences are not well known?		
Totally agree	7%	13%
Partly agree	48%	21%
Partly disagree	24%	19%
Totally disagree	19%	40%
Don't know	2%	7%

*The Centre for Management and Strategic Studies (CGEE) is a social organization supervised by the Ministry of Science, Technology, Innovation and Communications (MCTIC). The 2015 survey on public perception of science and technology in Brazil aimed to discover how much Brazilian population knows about issues related to the area.

5.3.4 Perception of risks and benefits of gene editing of pigs to prevent boar taint

Most participants (65%) perceived some or numerous benefits from the use of gene editing of pigs to prevent boar taint, 22% were intermediate and 13% perceived little or no benefits. The acceptability of gene editing to prevent boar taint in male pigs was positively related to the perception of benefits coming from this technology ($r=0.56$, $\rho < 0.0001$).

Participants perceived much or some risk (39%), little or no risk (35%) from the implementation of this technology, and 26% positioned themselves as intermediate. The acceptability of gene editing to prevent boar taint in male pigs was negatively related to the perception of risks ($r=0.35$, $\rho < 0.0001$).

5.3.5 Acceptability of biotechnologies in food production

Acceptability of different application of biotechnology to produce food was in general low (Table 9).

Table 9 - Acceptability of different plant and animal-based biotechnologies used in food production of southern Brazilian residents' participants (n=570)

	Acceptable	Intermediate	Not Acceptable
Vegetables genetically modified to contain higher concentrations of nutrients for food	43%	20%	37%
Microorganisms genetically modified to improve their efficiency for production of fermented food for human consumption	31%	20%	44%
Pigs genetically modify to produce more meat for human consumption	28%	18%	54%
Meat produced by pigs fed with diets containing transgenic components	28%	26%	52%
Meat produced *in vitro* from pig stem cells	25%	20%	55%

5.3.6 Awareness of pig production issues

When asked specifically about pig production practices in Brazil, the majority of participants were mostly unaware (Table 10). Acceptability of gene editing to prevent boar taint in male pigs was not related to awareness of common pig production practices ($r=0.032$, $\rho < 0.4$).

Table 10 - Participants' awareness on six pig production issues. Questionnaire was applied in September/October 2017 (n= 570 southern Brazilian residents)

	Awareness (% participants)
Most pigs and poultry feeds used in Brazil are produced with transgenic soy and corn	71
Genetic modifications can be induced in animals through biotechnologies to improve various characteristics, such as heat resistance, protein production or disease resistance	54
Surgical castration of pigs without pain control is the most common technique in Brazil	30
Meat from non-castrated pigs slaughtered after puberty may present boar taint	29
All male pigs slaughtered in Brazil are castrated	24
Vaccines used to stimulate the body to produce antibodies do not leave residues in animal products	20

5.3.7 Knowledge of genetics and biotechnology

Few participants answered the questions on the biotechnology knowledge quiz correctly (Table 11). Acceptability of gene editing to prevent boar taint in male pigs was not related to knowledge biotechnology assessed in the quiz ($r=0.062$, $\rho<0.14$).

Table 11 - Percentage of correct, incorrect and do not know answers of southern Brazil residents (n=570) on the biotechnology knowledge quiz*

	% correct	% incorrect	% don't know
By eating a genetically modified food, a person's genes could also become modified	57	10	33
Pigs modified with genes from a fish would probably taste fishy	43	5	52
Ordinary tomatoes do not contain genes, while genetically modified tomatoes do	39	13	48
Genetically modified animals are always bigger than ordinary ones	36	28	36
It is possible to transfer animal genes into plants	14	30	56

*Questions were adapted from (EUROBAROMETER, 2002; HALLMAN et al., 2003; CUITE et al., 2005).

5.3.8 Participants' reasons to justify the acceptability of gene editing of pigs to prevent boar taint

Table 12 shows the proportion of participants with different positions regarding the acceptability of gene editing of pigs to prevent boar taint. The main themes used by participants to justify their position were in descending order: 1) positive effects on animal welfare (42%), 2) doubts or perception of potential risks of gene editing (31%), 3) perceived effects on product quality (11%), 4) insufficient information on the issue to form an opinion (9%), 5) dislikes or is opposed to genetic modification (7%), and 6) perceives gene editing as unnatural (4%). Of the total survey participants that mentioned risks, 38% mentioned potential risks to humans, 27% risks to animals, and 35% unknown or unspecified risks. Regarding meat quality, participants perceived both positive and negative effects.

Table 12 - Reasons presented by participants to justify their position regarding the use of gene editing technology to reduce boar taint in pigs. Data are shown as % participants in each group

	Position regarding gene edition to prevent boar taint (n=570)			
Themes associated with justifying position	Total	**Acceptable** (56%)	**Intermediate** (22%)	**Not acceptable** (22%)
Positive effects on animal welfare	42%	61%	17%	13%
Potential risks of gene editing	31%	25%	55%	21%
Perceived effects of product quality	11%	10%	14%	9%
Insufficient information on the issue	9%	5%	24%	7%
Dislike or opposition to genetic modification	7%	1%	2%	32%
Gene editing is unnatural	4%	3%	2%	12%

Acceptance was often related to the belief that castration causes pain and suffering, which was seen as not acceptable: *It is interesting, given that it reduces animal suffering* (R55 Position = Acceptable); *To end animal suffering* (R29 Position = Acceptable); *It is acceptable because this way pig castration won't be necessary, preventing them from experiencing the pain* (R175, Position = Acceptable); *I believe that a technology that does not cause suffering to animals and does not incorporate foreign (unnatural) substances into the metabolism of animals must be used* (R423 Position = Acceptable). It was suggested that consumers would value the positive effects on animal welfare when faced with products from gene edited animals: *Anything that is for animal welfare is very valid and important, and surely the consumer will take this into account when they realise that animals are produced in this way (with gene editing)* (R249, Position = Acceptable).

A quarter of the participants that found the technology acceptable expressed concerns with the unknown effects of the technology: *The genetic mutation to which pigs would be subjected is as unnatural and inhuman as castration. However, I believe that the gene-editing alternative is less harmful or barbaric* (R228, Position = Acceptable); *Any genetic change is troubling. What kind of side effect may it have? But to avoid animal suffering, then I prefer it* (R247, Position = Acceptable).

Some weighed the acceptability of the technology in terms of the 'lesser of two evils', often referencing animal suffering and meat "contamination", especially by hormones:

If all the tests are done and it does not bring any risks, I agree, since we already eat a lot of contaminated meat. For everything that represents animal suffering, if there is a way for it not to happen, then it is acceptable (R147, Position = Intermediate)

Animals would not be subjected to unnecessary torture and it would reduce concerns about the vaccines used for immunocastration (R411, Position = Acceptable)

The less suffering for the animal the better and it does not need to undergo the transformation of the meat with antibodies produced against its own hormones (R268, Position = Acceptable)

I believe this is the most practical (alternative), without the suffering caused by surgical procedures and without the risk of any effects or modifications caused by hormonal applications (R283, Position = Acceptable)

Other participants concluded that the potential offered by the technology to improve animal welfare does not justify subjecting the animals to genetic modification. Some weighed the potential risks of the technology (*I do not trust genetic manipulation as a mechanism to improve animal welfare. I think this alternative can't be compared to the others because the long-term consequences are unknown*; R203, Position = not acceptable), and others expressed moral considerations (*Although it doesn't cause pain to the animal, it's sad to know that the pig will be genetically modified in order to be consumed*, R145, Position = not acceptable).

Scientific evidence of lack of any harmful effects was mentioned by many as a condition for acceptance of the technology; this was often associated with concerns with potential risks for humans (e.g., *Because we are not sure of the development of a human being that consumes such a modified animal, whether it can generate new diseases, or not. It could be fit for testing, but not for immediate use*, R71, Position = Not acceptable; *How sure are we that this biotechnology will not affect humans? If there were studies proving that this will have no side effects on those who ingest this meat, then I would support it*, R422, Position = Intermediate; *I have doubts regarding consumption and the transmission to humans at the genetic level*, R21, Position = Acceptable), the animals (e.g., *My doubt is whether this gene editing may cause genetic erosion within the pig population*, R274, Position = Intermediate), or both (e.g., *Gene editing is totally acceptable as long as there's no side effects or risks of hormonal or genetic changes, as much in the pig as in the consumer*, R355, Position = Acceptable). However, a third of those expressing concerns with potential risks of harm stated

this in general terms, without specifying the kind of harm (e.g., *I think that with the advancement of biotechnology many problems can be solved, but we must consider the risks that this DNA modification may end up generating new problems*, R503, Position = Acceptable; *Long-term studies are needed to show that this change, or the gene in general, are not harmful,* R457, Position = Intermediate; *I am highly suspicious regarding genetic modification. It needs to be thoroughly studied so that we don't suffer the consequences later*, R203, Position = Intermediate).

Among the implications of the introduction of the technology proposed, some participants discussed indirect effects on the producers: *The text implies that this way of castration is not painful for the animal... But one reservation is related to the cost of this technology for the producer, already submitted to hardship by the economic ups and downs*; R240, Position = Acceptable). Others commented on implications for the industry, with some participants implying that the introduction of the technology could lead to an increase in the power of larger corporations to the detriment of smaller producers: *Another issue is the question of costs, I know that small producers usually make little money from livestock production, wouldn't the cost increase? The big meat packing companies could afford the increased costs, but how about the small guys?* R93, Position = Acceptable).

Another concern expressed was the distrust that parties interested in developing the technology would genuinely be interested in improving animal welfare: *Somewhat acceptable, because I need more clarification regarding the issue. In general, the companies that own this kind of knowledge care more about profits than about the natural environment, the animals and consumers' health* (R495, Position = not acceptable); *I think it is fair if we consider that it may cause the least possible suffering to the animal; however, I do not believe that the use of this technology is aimed at the welfare of the animal, rather at potential greater financial returns* (R372, Position = Acceptable).

Many participants that were unsure in their position, as well as others, claimed that they needed more information to give an opinion (e.g., *It's difficult to understand all this process from a single paragraph explaining the issue. Anything that involves genetic manipulation deserves to be carefully studied, for ethical reasons*, R61, Position = Intermediate; *I don't know the technology, which is for me a limiting factor for giving an opinion*, R40, Position = Intermediate; *Does the gene issue only have good points? I don't have enough information to say that it's totally acceptable*, R93, Position = Acceptable)

Some participants suggested that the sources of information available to them may lack transparency: *...because it makes castration unnecessary; however, there may be some negative aspects yet unknown (and perhaps already expected)* (R181, Position = Acceptable); *I don't know the gene editing method and I don't have conditions to assess it just from the information above, there may be consequences not informed there*, R67, Position = Intermediate; *I didn't know about surgical castration, that is something the ads don't show*, R125 (Position = Acceptable).

Loss of naturalness was discussed primarily by participants that stated that gene editing was not acceptable (*I don't like using science to manipulate nature. I believe that the excessive exploitation of animals is a mistake. We must respect nature and preserve it. This action does not preserve it*, R256, Position = not acceptable; *It goes against the 'natural law' of the animal, of how it should happen...*, R160, Position = not acceptable; *I have insufficient information to give an opinion. But I find this too artificial* (R399, Position = not acceptable). However, naturalness was also mentioned by some participants that indicated acceptance of gene editing, for example: *The pigs would not feel pain, but it would not be something natural* (R45, Position = acceptable).

Opposition to gene editing to eliminate boar taint was in large part associated with an objection, usually of moral nature, to any kind of genetic modification: *I find it outrageous to change the genetic make-up of a living being simply so that it meets a 'need' in the consumer market*, R154, Position = not acceptable; *In my opinion anything that needs to be modified, shouldn't be eaten*, R386, Position = not acceptable; *Even being 'scientific', I do not agree with these changes*, R121, Position = not acceptable; *I don't like to change anything genetically*, R74, Position = not acceptable). Some participants articulated pragmatic arguments regarding the potential of unknown consequences to explain their opposition to genetic modification: *I don't agree with genetic modification of animals for consumption. I don't believe that all the consequences are well known*; R139, Position = not acceptable; *The more we use genetic experiments, the more prone to mutations we are, because they (referring to the "experiments") are not 100% safe*; R434, Position = not acceptable).

5.4 DISCUSSION

The majority of participants found gene editing to prevent boar taint acceptable. In general, acceptance was justified by perceived

improvements in animal welfare; rejection, in contrast, was related to a widespread opposition to genetic modification and perceived loss of naturalness. Importantly, acceptance was in great part conditioned, directly or indirectly, to assurance of absence of unforeseen harm to humans, animals and the environment, and a demand for greater clarification of the process and its consequences.

Improving animal welfare was the main issue discussed by participants that supported the use of gene editing in pigs. Pain caused by human intervention is one of the most important farm animal welfare concerns among lay citizens (VANHONACKER et al., 2008; CARDOSO et al., 2017a). More specifically, European citizens show negative attitudes towards piglets' castration without anaesthesia (FREDRIKSEN et al., 2011; MANCINI et al., 2017), which has led Europe to discuss steps to ban the practice (DE BRIYNE et al., 2016). Thus, the fact that gene editing was presented in the context of surgical castration without anaesthesia and immunocastration may have influenced the acceptability rates found in this survey.

We chose the case of production of pigs that do not express boar taint for a number of reasons to explore the views of Brazilian citizens regarding gene modification of farm production animals for a number of reasons. Firstly, it has been argued that it is desirable to understand consumer's views and acceptability before a new technology is introduced (ROLLIN, 2006). This is an application of gene edition technology to animals that is still in its preliminary stages of development, as its use on farm requires assessing feed efficiency, meat quality, and best practices for recovery of puberty and fertility of the gene edited animals (SONSTEGARD et al., 2016; RECOMBINETICS, 2018b). Secondly, we agree that questions regarding GM and genome editing should be discussed with the public in the context of modern farm animal breeding, and not as a separate phenomenon (ERIKSSON et al., 2018). In this context, we explained to survey participants that castration of male pigs in Brazil is mandatory and presented the gene edition option in the context of surgical castration and immunocastration, the two most used practices on farms in Brazil. Indeed, when justifying their positions regarding gene edition of pigs many participants assessed its benefits compared to the alternatives presented to them in the text, which most were unaware of before participating in this survey. Thirdly, considering the low awareness of Brazilian urban citizens regarding livestock farming practices (e.g., (CARDOSO et al., 2017a; HÖTZEL et al., 2017), we considered that piglet castration would be an appropriate case to test whether survey

participants would consider the animal welfare implications when assessing acceptability of the gene editing alternative. We also found our respondents are interested in the quality of life of pigs despite low awareness regarding farm animal production practices widely used in Brazil.

In the open question, many participants implied that they were rating acceptability of gene edition as an alternative to the currently used methods to eliminate boar taint. Although most participants were not aware of the widespread use of surgical castration in Brazil, many considered it cruel or negative for the welfare of the animals, as it has been shown by European researchers (VANHONACKER et al., 2009; FREDRIKSEN et al., 2011; HEID et al., 2013; VAN BEIRENDONCK et al., 2013). Others have shown that lay citizens' low awareness of livestock production systems and practices does not explain negative attitudes towards contentious practices nor support for alternatives perceived as more positive for the animals (VENTURA et al., 2016; HÖTZEL et al., 2017; TEIXEIRA et al., 2018). This may apply to acceptability of other gene editing applications that may reduce animal suffering, such as dehorning or heat stress (DAVIS et al., 2017; ERIKSSON et al., 2018), which the public has low awareness but tend to reject (e.g., (ROBBINS et al., 2015; CARDOSO et al., 2017a). It has been shown that perception of risk of new food technologies is reduced in the presence of perceived benefits to consumers (GROBE et al., 1999; SIEGRIST, 2008). Our findings suggest that perceived benefits to animals are also likely to reduce the relative importance given to perceived risk, increasing support of new technologies.

However, it is perhaps equally relevant that concerns regarding potential risks associated with the application of gene editing technology to a food animal were raised by supporting, opposing and undecided participants. Participants opposing the technology presented these risks as a reason for not acceptance, whereas many undecided or supporting participants demanded clarification or assurance against their concerns as a condition to full acceptance. Gene editing is considered more efficient (SONSTEGARD et al., 2016) as well as safer compared with previous genetic engineering methods (TAN et al., 2012). Some authors, though, recognise the potential of the technology but warn to the need to consider potential risks to animals, humans, the environment and society (CAPLAN et al., 2015; SHRIVER et al., 2017; WHITALL, 2017; ERIKSSON et al., 2018).

Concerns with unknown or not fully known outcomes conveyed by our participants encompassed issues like future harm to animal and

human health - such as creation of new diseases and undesired mutations – harm to the species' integrity and loss of naturalness, and environmental hazards. Some were opposed to humans changing another species, implying that animals have an intrinsic moral value (ROLLIN, 1995b).

As in the present survey, other surveys (JAMES; BURTON, 2003; CUITE et al., 2005; KNIGHT et al., 2005; RIBEIRO et al., 2016) showed that people are more open to accept plant-based GM than animal-based GM foods. Interestingly, most concerns raised by our participants regarding modifying pigs are the same as those discussed regarding the use of other biotechnologies in animal agriculture (THOMPSON, 1998; ROLLIN, 2006; KNIGHT, 2007). Indeed, the fact that no foreign DNA would be used in the proposed technology, which may be relevant to achieve societal support (MIELBY et al., 2013) and legal approval (ERIKSSON et al., 2018), was not discussed by participants. This supports that risk distinctions between gene editing and other genetic modification methods "may not easily be conveyed to publics" (BRUCE, 2016b). This is unsurprising, given the low knowledge on basic biotechnology concepts among participants, also shown among citizens from other countries (GASKELL et al., 2003; HALLMAN et al., 2004; CUITE et al., 2005; ALEKSEJEVA, 2014). In this survey, this type of knowledge was not associated with acceptability of gene editing of pigs. This was despite some evidence that more knowledgeable individuals are more critical of biotechnologies (ONYANGO et al., 2004; CASTELFRANCHI et al., 2013; CGEE, 2015), that limited knowledge increases risk perception and decreases GM foods acceptability (GASKELL et al., 1999; SCHOLDERER e FREWER, 2003; GANIERE et al., 2006), and that additional information may reduce consumers' acceptance of GM food (SCHOLDERER; FREWER, 2003). MIELBY et al. (2013) warned that conclusions concerning the effect of knowledge on acceptance of GM technologies cannot be generalized to all applications. Whereas risk perception is more influenced by scientific literacy (MIELBY et al., 2013), perception of benefits for animal welfare, related to moral values rather than knowledge or awareness (WEARY et al., 2016; HÖTZEL et al., 2017), may enhance acceptance of risks. Further support for this conclusion is the lower acceptance of other uses of biotechnologies used in livestock production, such as diets containing transgenic components for pigs, pigs genetically modify to produce more meat for human consumption, and meat produced in vitro.

Participants complained about the lack of information available to them regarding the risks of GM technologies, some believing that the risks of the use of genetic engineering in food production are hidden from society. In a survey on perceptions towards transgenic crops (GUIVANT; MACNAGHTEN, 2015) Brazilian lay citizens' expressed discontentment with information sources and complained that they had been misinformed, which caused confusion and distrust. Some of our survey participants questioned the motivation of proponents of food animal gene editing, arguing that large animal industries seek economic gains rather than improving animal welfare, or arguing whether small producers would have access to it. Similarly, negative attitudes towards GM crops among Brazilian lay citizens was related to perception of few benefits for consumers and family farmers, as opposed to large producers (GUIVANT; MACNAGHTEN, 2015). A common concern regarding the application of biotechnologies in agriculture are the social consequences for small producers or breeders that may become unable to compete with larger corporations (ROLLIN, 1992; THOMPSON, 1998; BRUCE, 2017). Concerns with the consequences of the introduction of costly biotechnologies for family farms in Brazil may be relevant, as smallholder family farmers are responsible for over 70% of the food consumed domestically, which brings food security and social wellbeing considerations (BRASIL, 2015; BRASIL, 2017a).

Media reporting of genetic modification is characterized by a large volume of information of varying levels of accuracy and types of content; contradictory messages from different sources and actors in the risk debate, "dramatization" of risk information though "scenarios", and the symbolic connotations of terms or concepts used in messages may contribute to the public concern with risks (FREWER et al., 2002). For example, two biotechnologies used in animal production that achieved lower acceptability than gene editing to eliminate boar taint – the use of diets containing transgenic components and artificial meat – have already received considerable media coverage in Brazil (e.g., (DEMARTINI, 2015; SUL21, 2017). In contrast, it is likely that many participants were introduced to the subject of gene editing of food animals for the first time in life during this study. People use mental short-cuts to facilitate and speed up the decision-making process (CIARELLI et al., 2009), accessing the pool of feelings, either positive or negative, that they associate with the issue in question (JOFFE, 2003). Thus, we may infer that participants that related the information offered in the text to benefits to the animals may have been influenced to choose the option "acceptable", and those who related it to moral

concerns regarding gene manipulation and future harm to human and animal health may have chosen the option “not acceptable”. Another study found that doubts and knowledge gaps concerning the potential risks for human health and the environment arising from the use of transgenic crops for human food were often translated by survey participants into distrust towards the technology (CHLOË FURNIVAL et al., 2008).

It has been argued that the largest factor influencing acceptability of gene editing in agriculture may be the perceived usefulness of the application to humans (BRUCE, 2016b) and, more specifically, the perceived benefits to consumers as opposed to the industry (FREWER et al., 1997b; FREWER et al., 2002). The potential of using gene edition to reduce animal suffering was clearly a decisive factor in the assessment of acceptability for an expressive proportion of participants; in contrast, participants opposed or unsure about the application considered the risks of the application to assess acceptability. Thus, stakeholders seeking social support for these applications need to prioritize communication on risks perceived by the public (DELIZA et al., 2003; RENN, 2004; BEHRENS et al., 2009). Importantly, the vehicles for such communication need to be carefully chosen, as trust in information sources about new technologies hinges among other things on credibility and shared values with providers of information (COSTA-FONT et al., 2008). Gene edition has a growing presence in the media, and it is often reported as a novel technology able to solve important problems; however, science does not have all answers about the genetic background of traits involved or how it may work once in large-scale use (ERIKSSON et al., 2018), and these issues are not clearly informed to the public.

Our sample of participants matched the demographics of the region except for schooling levels, which were higher than in the southern Brazilian population. Nation-wide surveys undertaken in 2010 and 2015 (CGEE, 2015) have shown that Brazilian citizens have low knowledge and positive attitudes towards science and technology, which was confirmed in our sample. These surveys also showed that education, access to information, income, region of residence within the country, and interest in science and technology do not influence these attitudes (CASTELFRANCHI et al., 2013). This supports our findings that demographic characteristic did not influence the acceptability of gene edition. One exception was growing up in agricultural environment, which reduced acceptability. People that grew up in agricultural environment and then moved to urban cities, differently from those that

just lived in urban cities may have information from both sides, i.e., scientific knowledge and awareness of pig production and rural values related to the animal's lives and to producers' situation, which may influence acceptability.

5.5 CONCLUSIONS

Brazilian citizens are interested and show concern with the quality of life of farm animals, despite having low awareness regarding livestock production practices widely used in Brazil. Our findings suggest that perceived animal welfare benefits may increase public support of gene editing of food animals if the risks associated with the technology are communicated and perceived as acceptable by the public. The industry should consider citizens´ attitudes and expectations regarding farm animal genetic modification to develop appropriate solutions for all stakeholders and for the animals otherwise these initiatives may not be sustainable.

6 GENERAL DISCUSSION

In this thesis, we explored the views and attitudes of the Brazilian public towards some farm animal production housing systems and potential use of gene edition of male pigs to prevent boar taint. We also explored the underlying reasons respondents used to justify their preference or acceptability to the specific practices studied. These surveys provide a better understanding on the ways Brazilian public perceive and value farm animal welfare in livestock production. This information contributes to a sustainable relation between animal production stakeholders and society, an issue underexplored in Brazil (CLARK et al., 2016), which is an important livestock producer and consumer of animal food products (FAO, 2014).

The qualitative, exploratory studies presented in this thesis were based on convenience samples of participants, and as such cannot be interpreted as representing the views of the Brazilian society. In comparison to the Brazilian population (IBGE, 2011), our sample contains a greater proportion of young and well-educated citizens. The first two surveys, exploring the respondents' views on production systems and on gestation stalls, had respondents from all five regions of the country, but with a disproportionate over representation of the south and southeast regions and under representation of the northeast region. The survey of opinions on gene edition of pigs used a more representative sample for respondents from South Brazil; although we acknowledge that the sample was younger and more well educated than the population in the region, we argue that the highly educated participants represent a segment of opinion holders that may influence changes in production practices. Additionally, we have to mention that our method of online recruiting in the gestating sow housing survey may have preferentially attracted people particularly interested on farm animal welfare issues. This type of surveys however, are important as they may provide novel information on issues less studied in developing countries (CLARK et al., 2016), such as Brazil, a country with an ever-growing proportion of its GDP arising from food animal production systems and a population that is further and further removed from agriculture. Most importantly, this type of information can provide valuable insights into potential issues that have received much discussion in other countries.

In general, participants expressed preference for practices that do not cause pain or suffering to the animals and for free-range, cage-free housing systems. Product quality and animal welfare, which many

perceived as having a direct relationship, were cited by respondents as the main reasons justifying this preference. Animal welfare was often related to animals having enough space to move, being free to express their natural behaviours, free from pain and suffering and to have at least some access to their natural environment, which was often related to naturalness of the production systems. Many respondents also considered caged housing as 'cruel' and 'inhumane'. Participants of the gene edition survey showed ambivalent attitudes: on the one hand, they found the technology acceptable as they saw it as a possibility to end surgical castration without anaesthesia and pig suffering; on the other hand, most were concerned with the integrity of the species, loss of their naturalness, undesired mutations or diseases and other unknown effects of genetic modification either rejecting it or conditioning acceptance to clarification of these concerns. Some respondents expressed an objection, usually of moral nature, to any kind of genetic modification. The opposition to humans changing the genome of an animal species, imposing them unnatural conditions of life and painful practices, implies people believe that animals have an intrinsic moral value (ROLLIN, 1995b), where the interests of animals might overcome those of science, consumers and industry.

Participants' showed limited awareness of animal food production systems and practices used in Brazil. Although most participants in the first survey seemed to be aware that the majority of pigs and poultry are reared in confined and caged systems and beef cattle on pasture in Brazil, respondents in the second survey were not aware of the widespread prevalence of gestation stalls for sows in Brazilian farms. Yet, participants of the third survey were not aware that male pigs are routinely castrated, and that immunocastration vaccination does not leave residues in pork meat. In short, even though Brazil is one of the major pork producers in the world, our participants were unfamiliar with the current practices of pig industry.

Confirming findings from our surveys, several surveys showed that although with limited awareness about livestock production practices the public consider animal welfare as a very important issue in livestock production (GASKELL et al., 2003; HALLMAN et al., 2004; EUROBAROMETER, 2007; MIELE et al., 2011; NORWOOD e LUSK, 2011; ALEKSEJEVA, 2014; SPOONER et al., 2014a). Once informed about some farm animals' production practices most of our respondents expressed discontentment and rejection for those perceived as negative to animal welfare, as caged and intensively confined housing and genetically modifying pigs to produce more meat. Our findings

suggest that despite their limited knowledge of the production systems and practices, Brazilians respondents care about the quality of life of the animals raised to produce their food. Respondents were also critical of perceived outcomes of practices and systems on the quality of the products. Despite some individuals showing concerns on food safety and hygiene that justified their preference for confined and caged systems, most respondents were concerned with residues such as medicines, chemicals and hormones in the meat, which they perceived to be less used in free-range and cage-free systems. Product quality and possible residues in the meat were also cited among the concerns regarding the gene edition of male pigs. This perceived association between naturalness, animal welfare, and product quality is also found on the public of other countries (CLARK et al., 2016).

Many surveys have found that stakeholders and lay citizens have contrasting views about the animal welfare in livestock production systems (BOCK e VAN HUIK, 2007; BENARD e DE COCK BUNING, 2013; DUIJVESTEIJN et al., 2014), and often contradictory political and ethical postures, which may have implications for the governance of animal welfare (DEGELING e JOHNSON, 2015). For this reason, we explored the views of Brazilian citizens associated or not with livestock production in the survey regarding the use of individual gestation stall housing for sows. However, in this case the two groups shared many beliefs and values; although to a lesser extent than participants not associated with livestock production, most participants associated with livestock production were also opposed to gestation stalls and expressed preference for a system different than stalls or group housing for gestating sows. Reasons underlying the rejection of gestation stalls were mostly related to the perception that this housing system is not capable of providing an animal the opportunity to live a reasonable good life. Differences between the two groups were mostly that the participants associated with livestock production enriched their justifications with science-based arguments, whereas lay citizens offered reasons based on moral values.

Several surveys tried to assess the influence of knowledge on public attitudes towards farm practices (RYAN et al., 2015; BAUER, 2016) or biotechnologies (SCHOLDERER e FREWER, 2003; MIELBY et al., 2013) reaching no consensus. In our surveys, neither self-assessment about information on livestock production nor the information provided in the questionnaire about housing gestation sows in individual cages influenced respondents' attitudes. Likewise, knowledge and awareness of food production biotechnologies did not

influence respondents' acceptability to the gene edition of male pigs. Moral values and perceived riskiness appeared to have a greater impact on Brazilian citizens' negative attitudes towards farm animal practices than factual knowledge. The fact that our respondents' concerns regarding animal welfare were often based on anthropomorphic values, such as freedom, behaving naturally, freedom from pain, rather than on scientific assessments of welfare such as incidence of feather pecking, bone deformities, mortality in the different housing and production systems, corroborates that moral values drive their attitudes. People's values and beliefs of what is more important to them and to society, what is good or bad, right or wrong probably drives decisions and acceptance on food production systems. And these values and beliefs can be related to several issues including animal welfare, human heath, environment hazards, naturalness, social justice, productivity, feeding the growing population, etc. Depending on the strength of each belief and the valence of the outcome evaluations, an individual may or may develop a positive or negative attitude toward the object. Therefore, because of the complexity of gene edition, some respondents were uncertain about how to weigh their beliefs. Respondents that judged animal welfare as important, despite their fears and concerns on genetic modification and the perceived potential risks considered the gene edition of male pigs as an acceptable alternative. This suggests that the potential benefits of gene edition for animal welfare is probably a powerful argument to be used by biotechnology stakeholders to target undecided individuals. However, it cannot be said that people will accept everything in the name of animal welfare. Most respondents, despite accepting gene edition as a way to improve animal welfare also demanded guaranties that the technology would not harm humans, animals and environment as a condition to accept its use in farm animals. Indeed, the production of artificial meat, another biotechnology that could benefit farm animals by reducing their demand, was rejected by the majority of the respondents, indicating that public attitudes towards genetic modification are influenced by judgments about the means and the ends of each specific application.

It has been argued that the same individual may be inconsistent in his role as citizens from his role as consumers; when acting in his role as consumers, individuals are egoistic and have interests mainly related to health, taste, price and easy access, while in their role as citizens they also present moral and ethical interests, for example, in the way food is produced (BENNETT et al., 2002). Furthermore, when answering survey questionnaires most people do it as citizens, and as citizens with

moral obligations their ethics values influence their answers. That is a probable reason most people that claim to oppose animal industry practices still buy animal derived products.

The majority of respondents rejected animal-based biotechnologies used in food production, such as feeding pigs with diets containing transgenic components and genetically modifying pigs to produce more meat; also, most respondents rated eating meat, which they eat more than five time a week, as important. This consumer-citizen ambivalence may be explained by the fact that people often avoid thinking about the issue or are deliberated blind (GJERRIS, 2015) to situations that may conflict with other pre-existing attitudes and can induce a psychological state of discomfort and to a need of attitude/behaviour change (FISHBEIN e AJZEN, 1975). A survey found that people avoid thinking on sows in cages, which they would not approve, to avoid feeling guilty for eating pork (Bell, 2017). It is easier to avoid thinking about the issue that causes discomfort than changing attitudes or behaviours. However, unlike consumers, whose expression is restricted to the marketplace, citizens mean of expression are wider and include cultural, social, political and economic aspects of the public sphere. Indeed, most changes observed in animal husbandry practices in recent years came through their vote on referendums and ballots (HSI, 2014; BALLOTPEDIA, 2016; ASPCA, 2018) or from citizens concerns being translated into legislation (STEVENSON, 2012; BLANDFORD e HARVEY, 2014). In the US, although initiatives to change farming systems started within the private sector, in the last decade 10 states have passed laws prohibiting the use of conventional cages housing in farming systems, and many others are currently discussing similar laws (ASPCA, 2018). Therefore, special attention should be given to Brazilian citizens' concerns on livestock practices. Although there are no specific legislative changes in Brazil, some Brazilian and multinational food companies are following international trends to restrict caged systems within Brazil (VON KEYSERLINGK e HÖTZEL, 2015; CASSUTO et al., 2016).

There are several examples of biotechnologies released without previous discussion, as for example transgenic crops, that ended up in extremely negative attitudes from the public (ROLLIN, 2006). This indicates a need for information and dialogue about the effects and benefits of GMO before they are marketed. Although gene edited pigs are not transgenic, there are several issues that are of common concern with other biotechnologies, e.g. the genetic manipulation of living beings and patents issues, which may cause strong negative attitude

from society. In the case of livestock production, many production practices to which animals have been submitted to have been hidden from society (SCHNEIDER, 2009), which had also ended up in extremely negative attitudes. Cages and husbandry practices that causes pain are some examples. It is not expected that genetic manipulation will be someday fully accepted by society (Frewer et al., 2000), and the same can be argued regarding intensive farm animal practices. However, provision of information may contribute to engage and form a public better able to discuss their views on specific issues (AVARD et al., 2009; SWANSON et al., 2011).

Indeed, to achieve greater accordance between animal industry practices and society acceptance, collaboration of all stakeholders in the food chain and citizens well-informed will be extremely important to meet compromise and mutual benefits. Before costly changes are demanded to the producer, it is imperative that these changes meet the expectations of those demanding them (LU, 2013; WEARY et al., 2016) otherwise these initiatives may not be sustainable (VON KEYSERLINGK e HÖTZEL, 2015). For example, results from our survey on gestation stalls indicate that participants have a generalized preference for some other, non-specified housing system, which differs from gestation stalls and group housing. Transition to group housing, as has been required by multinational food retailers in Brazil, may prove unsatisfactory for the public in the long term. The difficulties faced by producers in regions where legislative changes have occurred, indicate that the production sector needs to act proactively, interacting with the public to identify legitimate concerns and develop appropriate solutions for all stakeholders and for the animals based on scientific knowledge.

Finally, we suggest further studies using in depth interviews, which may offer more information on the issue to better understand citizens' and animal industry stakeholders' concerns, expectations and assessment of trade-offs involving welfare of animals and other issues in livestock production. There are also several questions to be investigated in further studies regarding the different applications of gene edition in livestock production. For example, the attitudes of the public if the gene edition application uses foreign gene (as mastitis resistance) or not (as polled cattle or thermal tolerance); if the gene edition application uses the addition of a gene from the same species (polled cattle) or does not add any gene but knocks out one (castration of pigs); and if there are differences if the expected result is animal welfare improvement or other human benefit such as increased production and environmental improvement (as double-muscle pigs and cattle). Also, future research

could focus on public trust on different sources of information (media, science, industry, regulatory agencies), exploring the elements to dialogue construction and message acceptance.

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