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der Vetsuisse-Fakultät Universität Zürich

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**Stakeholders' perceptions of the challenges to improving calf health and reducing
antimicrobial use in Swiss veal production**

Inaugural-Dissertation

zur Erlangung der Doktorwürde der
Vetsuisse-Fakultät Universität Zürich

vorgelegt von

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Tierärztin
aus Deutschland

genehmigt auf Antrag von
Prof. Dr. med. vet. Heiner Bollwein

2020

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Stakeholders' perceptions of the challenges to improving calf health and reducing antimicrobial use in Swiss veal production

To find effective intervention strategies to reduce antimicrobial use (AMU) in animal production an insight into the individual contexts of supply chain actors is essential. The aim of this study was to investigate key issues and challenges related to calf health management and AMU perceived by stakeholders of the Swiss veal production chain. By means of qualitative interviews, subjective viewpoints of 27 industry stakeholders were explored. Key issues were extracted from transcribed audio files using qualitative text analysis according to Mayring. The results indicate a high level of awareness of the need to reduce AMU and resistance-related risks among respondents. The following characteristic properties of the specialized large-scale veal production system were perceived as main reasons for poor calf health and high AMU: A disunited social framework, financial pressure and mutual dependencies among industry stakeholders, challenging practical conditions for a beneficial calf health management and farmers' attitudes in regard to AMU. However, a radical change away from the existing farming system was mostly perceived as not feasible. The findings of this study provide a social scientific basis for further research to investigate strategies to reduce AMU in Swiss veal production.

Keywords: qualitative interviews; veal production; calf health; antimicrobial use; industry stakeholders;

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Von Akteuren der Kalbfleischbranche wahrgenommene Herausforderungen bei der Verbesserung der Kälbergesundheit und der Reduktion des Antibiotikaverbrauches in der Schweizer Kälbermast

Um effektive Interventionsstrategien zur Reduzierung des Antibiotikaeinsatzes (AE) in der Tierproduktion zu finden, ist ein Einblick in den individuellen Kontext der an der Produktionskette beteiligten Akteure entscheidend. Ziel der Studie war es, von Beteiligten der Schweizer Kalbfleischbranche wahrgenommene Kernthemen und Herausforderungen in Bezug auf Kälbergesundheitsmanagement und AE zu identifizieren. Mittels qualitativer Interviews wurden subjektive Sichtweisen von 27 Akteuren untersucht. Kernthemen wurden aus den transkribierten Audioaufnahmen mithilfe der qualitativen Textanalyse nach Mayring extrahiert. Die Ergebnisse zeigen, dass die Akteure sich der Dringlichkeit einer Reduzierung des Antibiotikaverbrauches zur Minimierung der Resistenzentwicklung und den damit zusammenhängenden Risiken für die öffentliche Gesundheit bewusst sind. Weiterhin wurden folgende Charakteristika des spezialisierten Kälbermast-Systems als Hauptgründe für die mangelhafte Kälbergesundheit und den hohen AE wahrgenommen: Uneinigkeit im sozialen Gefüge der Branchenakteure, finanzieller Druck und gegenseitige Abhängigkeit, schwierige praktische Voraussetzungen für ein vorteilhaftes Gesundheitsmanagement und die Einstellung der Landwirte in Bezug auf AE. Ein radikaler Systemwechsel wurde jedoch meist als nicht umsetzbar angesehen. Die Ergebnisse der Studie bieten eine sozialwissenschaftliche Basis für die weitere Forschung an Strategien zur Reduzierung des AE in der Schweizer Kälbermast.

Stickworte: Qualitative Interviews; Kälbermast; Kälbergesundheit; Antibiotikaverbrauch; Branchenakteure;

Stakeholders' perceptions of the challenges to improving calf health and reducing antimicrobial use in Swiss veal production

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ARTICLE INFO

Keywords:

Qualitative interviews
Veal production
Calf health
Antimicrobial use
Industry stakeholders
Perceptions

ABSTRACT

Large quantities of antimicrobials are used in Swiss veal production. To develop strategies to reduce antimicrobial use, it is important to understand how stakeholders along the veal production chain perceive the current situation and to find the key issues that challenge them about calf health management and antimicrobial use. However, there has been insufficient research into the individual contexts of the supply chain actors, and the central themes that they perceive to enable or limit their actions remain largely unknown. The aim of this study is to investigate the perceptions of the current situation of the Swiss veal production system, in terms of calf health management and antimicrobial use held by industry stakeholders, i.e. dairy farmers, veal producers, traders, slaughterhouse managers, advisors and veterinarians. Qualitative interviews were conducted with 27 respondents and analyzed using content analysis. The results show that stakeholders are aware of the current need to minimize resistance development and the related risks for public health by reducing antimicrobial use. The main reason for high antimicrobial use was nominated as the practice of purchasing calves from many different dairy farms and bringing them together in large groups at a young age, which exposes them to a variety of pathogens that their still developing immune systems are not able to cope with. To prevent and combat infectious diseases which are a frequent consequence of this practice, antimicrobial group treatments are commonly administered, which significantly raises the total amount of antimicrobials used. Group level treatments with antimicrobials were associated directly with the large-scale veal farming system, which uses excess calves from specialized dairy farms, and which the respondents perceive to cause financial pressure and mutual dependencies among participants.

In addition, disunity between actors was perceived as a further challenge to find strategies for the reduction of antimicrobial use. The respondents suggested downscaling the production system so that calves can be treated individually but conceded that the current system may be very difficult to change, so also suggested various improvement measures within the existing system. The results of this study provide a basis for further research to investigate possible interventions that could considerably reduce antimicrobial use in veal production.

1. Introduction

Morbidity and mortality rates in veal production remain on a high level. For example, reported mortality rates are 4.9 % in the Netherlands (Santman-Berends et al., 2018), 5.3 % in Belgium (Pardon et al., 2012b) and 7.6 % in Canada (Winder et al., 2016). Infectious diseases of the respiratory system and gastrointestinal disorders are the main reasons for mortality (Webster, 1991; Pardon et al., 2012b;

Fertner et al., 2016). To combat calf mortality, oral group medication with antimicrobials [AM] is used as a standard metaphylactic treatment within the highly integrated veal production system that is predominant in most European countries (Pardon et al., 2012a, 2014). In 2017, treatment incidence was 20 daily doses per calf and year in the Netherlands (MARAN, 2018). In Switzerland, Lava et al. (2016b) found rates of AM use of 21 daily doses per calf and year. About 65 % of AM sold for veterinary use in Switzerland are drugs intended to be

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<https://doi.org/10.1016/j.prevetmed.2020.104970>

Received 13 November 2019; Received in revised form 14 March 2020; Accepted 16 March 2020

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administered as oral group treatments (BLV, B.f.L.u.V, 2017) and about half of this amount is used in veal production (Lava et al., 2016a).

There is an urgent demand for prudent use of antimicrobial agents in veterinary medicine in the context of public health and the progressing development of AM resistances (World Organization For Animal Health, 2018), but AM reduction must be achieved by alternative strategies to preserve calf health. A wide range of risk factors for calf mortality in Switzerland has been identified including susceptible dairy breeds, large herd size, large group size, insufficient shelter during cold seasons, high ammonia concentration, large weight differences, insufficient quarantine, and absence of clinical examination upon arrival (Bähler et al., 2012; Lava et al., 2016a, b; Schnyder et al., 2019). The large range of contributing factors suggests that there should be many options for amelioration strategies but AM application is still the most widely applied mean of enhancing calf health. This demonstrates that it is not only necessary to find strategies which have the potential to significantly reduce AM use but also to find ways to increase the likelihood that possible improvement strategies will be implemented in practice. Therefore, it is important to gain an understanding of perceived enablers and barriers that influence the different actors along the veal production chain so that AM usage can be reduced while safeguarding calf health.

Looking at the topic of veal calf health and AM use in the veal sector from a socio-economic perspective is a new approach. It therefore requires a method that provides an opportunity to enter into the participants' world so that the environment can be explored from their perspective to give deep insight in their context and find the meaning of central themes in their environment. These properties are provided by the qualitative interview method (Corbin et al., 2014) which is, therefore, appropriate to investigate key issues within the field of veal calf health and AM use by getting an understanding of the particular situations and complex relationships of involved stakeholders. The aim of qualitative research interviews is to present variability rather than quantification (Brinkmann and Kvale, 2015).

Despite the clear need for AM reduction (World Organization For Animal Health, 2018), there has been insufficient study in Switzerland and internationally to address what would motivate stakeholders in the veal production sector to adopt alternative management practices. The objective of this article is to create an overall picture of how actors along the Swiss veal production chain perceive the current situation of the industry and calf health management. Particular attention is given to AM use within this system and to the enabling factors and barriers to preserve or improve veal calf health along with lower AM use. The objectives have been formulated into the following research questions: 1) How do stakeholders perceive the current situation of the Swiss veal production system and calf health management within this system? 2) Which possibilities do stakeholders see to reduce AM use and improve calf health along the Swiss veal production chain?

2. Materials and methods

2.1. Context: the veal sector in Switzerland

Livestock production is the biggest part of the agricultural sector in Switzerland because mountain regions are predominant in which livestock production is possible but crop production is not. The cow population was at about 693 000 in 2017 (BFS, 2019), of which around 562 000 were dairy cows (Agrisat, 2017). About 215 000 calves were slaughtered for veal production in 2017 (Proviande, 2017). Given a set point calving interval of 385 days, meaning on average 0.95 calvings per cow per year, this indicates that calves born on dairy farms play an important role for the Swiss veal production sector (Fig. 1). Calves for fattening are usually sold from the dairy farm with a weight of about 75 kg (SKMV, 2017) which corresponds to an age of around 20–40 days. The average slaughter age is 157 days (Bähler et al., 2016) and the average carcass weight is 126.6 kg (Proviande, 2018b).

Fig. 1. Graphic of the Swiss veal production chain. Arrows stand for calf movements [via markets/collection points or directly from the dairy to the veal farm or within the dairy farm to a fattening unit and from the veal farm to the slaughterhouse]. Illustrated persons stand for an exemplary share of actors in the field of veal production. Actors directly involved in veal production [e.g. dairy farmer, veal fattener, slaughterhouse manager] are placed within the blue rectangles which show the different stages along the production chain. Actors who have an indirect influence on veal production [e.g. veterinarian, politician, feed advisor] are placed on the frame of the orange rectangle which represents the boundaries of the system. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article).

Put into the European context, in 2008, 781 000 tons of carcass weight (Sans and De Fontguyon, 2009) were produced in the EU, which accounted for more than 80 % of the global production (Pardon et al., 2014), with France, the Netherlands and Italy acting as the leading producers (Brown and Claxton, 2011), while Switzerland produced 30 251 tons (Proviande, 2013). Production numbers are, however, steadily declining. In 2018, 21 374 tons of veal were produced in Switzerland of which 10 tons were exported, while 631 tons were imported, resulting in 21 996 tons of veal consumed, which accounts for 5.9 % of total Swiss meat production [selling weight]. As 97.2 % of veal consumed in Switzerland is from domestic production (Proviande, 2018a), veal production is directly determined by the cow population which has been decreasing over the last years (Proviande, 2017). The amount of veal consumption through the gastronomy sector is estimated to be higher than through private households (Python and Gresset, 2018). Swiss veal consumption is at 2.57 kg per capita per year (Proviande, 2018a) while the average annual veal consumption per capita in the EU is at 1.6 kg with the largest consumers being France [4.1 kg per capita per year] and Italy [3.5 kg per capita per year] (Sans and De Fontguyon, 2009). Veal is generally appreciated as a high quality product (Pardon et al., 2014) which is sold at premium prices. In 2014, prices for veal escalope were at of 68.12 CHF/kg in Switzerland (Proviande, 2017) and 24 EUR/kg in France (AND International, 2014).

In Switzerland, it is obligatory to provide calves with roughage and to ensure an adequate iron supply (Tierschutzverordnung, 2008). In contrast, in most European countries, veal calves are fed on a purely liquid diet with the aim of producing veal of a pale meat color (Cozzi et al., 2002; Pardon et al., 2014). Thus, Swiss veal meets the European definition of rosé veal, while in the European Union mainly white veal is produced (EU Regulation EC 566, 2008).

There is a diverse structure of farming concepts in Swiss veal production. Around three quarters of calves slaughtered as veal are kept on the dairy farm where they were born and fattened with excess milk or additional milk powder in a continuous restocking system with or

without additionally purchased calves. About a quarter of calves raised for veal production are, however, sent to specialized veal farms with an all-in/all-out restocking system which exclusively use purchased calves fed with milk powder added to a flexible percentage of whole milk and water. Whey and buttermilk are other residual product of the dairy industry which are frequently used for the production of liquid feed (UFA, 2015; Bähler et al., 2016; Rindergesundheitsdienst, 2019) (Fig. 1).

Private and integrated farms, which base their veal production on the purchase of young calves, all-in/all-out restocking and big fattening groups, can be regarded as large scale [LS] systems. According to Lava et al. (2016a), purchase of calves, group size and herd size are the main risk factors for metaphylactic group treatment and mortality (Lava et al., 2016), which suggests that LS veal farms may account for most of the AM use in veal production.

2.2. Sampling

A purposeful sampling strategy was chosen, which has the principle of maximum variety rather than statistical representation (Patton, 1990; Morse, 1994). Potential respondents were regarded as suitable interview partners if they have an influence on calf health management or on the veal production system. Consumers, who could be argued to be influential actors, were omitted from the study because they were considered to be outside the scope. An initial list provided from an expert: a veterinarian and researcher with a broad network in the sector and who was a founding member of the Swiss Calf Health Service was used as a starting point to approach respondents. This convenience sample was complemented by snowball-sampling by asking interviewed respondents to suggest further persons of relevance. Thirty-two possible respondents were contacted by phone of which 28 agreed to participate. Four stakeholders were not available for an audio recorded interview and one audio record was not usable due to a technical fault, so that 27 interviews could be included in the analysis. The initial list included a diverse range of respondents whose professional backgrounds are shown in Table 1.

2.3. Data collection

Between November 2016 and April 2017, the interviews were conducted and voice recorded by the first author within the framework of a veterinary doctoral thesis, which the respondents were aware of. Five test interviews were conducted beforehand to train the interviewer and test the interview guide. An interview guide [provided in supplement 1], in qualitative interview research, is a list of few broad open-ended questions, which serve as a support for the interviewer to address relevant aspects of the phenomenon under study. However, further questions are developed during the interviews when new themes of interest arise to meet the requirement of exploring the individual situation of each respondent. Interviewees are encouraged to lead the course of the conversation. This strategy offers the opportunity to find out the topics that are truly relevant to the respondents (deMarrais and Lapan, 2003). The interviewer's task was to raise follow up questions and ensure that the main research questions were answered.

Interviews took between 36 min and 140 min. All respondents were visited at home or at their work place and all 15 respondents who were farmers gave the interviewer a farm tour in the course of the interview. In three cases the partner of the respondent was present during the interview and relevant comments were included in the respective transcript. No repeat interviews were conducted and transcripts were not returned to the respondents for correction. According to the professional background of interviewees of this study, adaptations were made in the interview guide: for example questions concerning veal market or milk prices were not specifically addressed during interviews with a veterinary scientist as long as he/she did not introduce the topic by himself/herself. Respondents were asked about their perceptions of

the current situation regarding calf health and AM use in Swiss veal production, what they perceive as main challenges, their power and responsibility to improve the situation and how, in their opinion, the challenges could be solved.

2.4. Data analysis

The recorded interviews were transcribed and analyzed using MAXQDA 12 software (VERBI, 2020). Qualitative content analysis according to Philipp Mayring (2014) (Mayring, 2014) was chosen to perform data analysis. Qualitative content analysis is a systematic and rule-bound procedure which enables a structured analysis of manifest and descriptive content as well as latent and interpretative content. It is based on building a multi-level framework of different categories which identify and define groups of statements or mentioned aspects with common characteristics (Graneheim et al., 2017). As prior knowledge about the phenomenon under investigation was limited in our study, categories were created inductively (Elo and Kyngas, 2008), meaning that they were not chosen in advance but created while going through the transcripts. This approach helps to finally grab the key contents of the whole data set, but, as it is a dynamic process, requires restructuring, merging and splitting of categories in several steps after creating a category system inductively (Graneheim et al., 2017).

Going through the transcripts line by line, the content of the interviews was filtered to extract coherent statements [code-cases] contributing to answer the research questions. A category system [provided in supplement 2] with seven main categories [four assigned to research question one and three assigned to research question two] and four levels of subcategories representing the themes covered was built out of 964 code-cases of relevance. For example, the code-case "Generally I, as a veal producer with years of experience in the business, think, that currently there is a huge outcry. The situation is represented much worse than it really is. In the past it was just like that: Antibiotics were part of the daily life." (I.6), was assigned to: Perception of the current situation/Problem awareness (demand for AM reduction)/Extrinsic motivation for change/Public discussion/Topic is given excessive attention [supplement 2]. Code-cases were assigned to categories until theoretical saturation, which is the point at which categories are well developed in terms of properties, dimensions, and variations so that further analysis contributes little to the conceptualization, even though variations can always be discovered (Corbin, 2014). The initial category system was then restructured in several steps to ensure a consistent internal logic. Merging or dividing categories helped to obtain a coherent abstraction level, meaning that categories of one level should be consistent in their concreteness, while regarding the whole category system, categories of a higher level must be more abstract than those of a lower level. For example, in our final category system, the highest [most abstract] levels are "Perceptions of the current situation" and "Considerations on solutions approaches". Subcategories of the lowest level within a category, such as "Change of feeding system", "Change of housing system" and "Vaccination at arrival" are much more concrete but still have the same level of concreteness or abstraction within their category level. To ensure inter-coder reliability, a second researcher coded five additional interviews in the final category system to confirm its logic. The category system served as a basis for a model of understanding illustrating the key themes.

Table 2 Category system with the two research questions, seven main categories and two to four levels of subcategories, which was inductively created and used as a basis for developing a model of understanding.

3. Results

To illustrate the extracted key themes and interrelations between them a model of understanding has been created (Fig. 2). In section 3.1 and 3.2, contents of the model are further explained according to the

Table 1
Professional backgrounds of the respondents.

Interviewee	only veal production	only beef production	veal/beef and milk production	only milk production	trade	slaughterhouse company	veterinary practice	veterinary science	integration management	feed advisor	politics (veterinary office)	representative of an association	association
L1 ^a			X									X	breeders
L2 ^a		X					X					X	veterinarians
L3												X	organic label
L4												X	farmers
L5 ^a	X											X	veal producers
L6 ^a	X											X	veal producers
L7												X	milk producers
L8 ^a			X									X	beef producers
L9 ^a		X										X	beef producers
L10												X	beef producers
L11							X					X	stable
L12													construction
L13 ^a	X				X	X							ruminant
L14										X			veterinarians
L15									X				traders
L16													
L17					X		X	X		X			
L18													
L19											X		
L20 ^a				X				X					
L21 ^a			X										
L22 ^a			X										
L23 ^a				X									
L24 ^a				X									
L25 ^a			X										
L26 ^a				X									
L27 ^a			X										

^a Respondents who are farmers.

Table 2

XXX.

Research question	Main category	Subcategory level (SL) 1	SL 2	SL 3	SL 4
Perception of the current situation					
	1. Demand for AM reduction				
		Intrinsic motivation for change			
			Awareness of consequences of AM use (intrinsic motivation)		
			For public health		Knowledge about AM resistances
				For the veal sector	Loosing effective drugs
					Possible legal restrictions
			State of health in Swiss veal calves		
			In the past calves were not healthier than now		
			There is a crisis in calf health		
		Extrinsic motivation for change			
			Public discussion/pressure		
			Motivates stakeholders to take action		
			Topic is given excessive attention (media/politics)		
			Veal production in the focus of criticism		
		Desire of recognition of the efforts being taken			
	2. Characteristics of the specialized veal production system (indirect impact on calf health)				
		Social environment			
			Passing responsibility		
			To consumers		
			To retailers/processors		
			To veal producers		
			To dairy farmers		
			To veterinarians		
			To traders		
			To the pharmaceutical industry		
			Differing interests and disunity		
		Structural circumstances/market			
			Linkage of veal and dairy sector (specialization)		
			Veal producers' dependency on dairy production		
					Calves as primary material
					Seasonality in calf supply
			Dairy farmers' pressure to expand/specialize		
					Milk price
					Excess calves
			Calf market characteristics		
			Seasonality		
			Non-transparency		
			Difference between dairy and beef breeds		
			Economic situation for specialized veal producers		
			Labels/requirements for products characteristics		
					As a chance to ensure profitability
					Strict requirements - risk of deductions
			Low profit margins		
			Veal as a product		
			Decrease in demand		
			Seasonality in demand		
			Bad reputation of veal		
	3. Calf health management in specialized veal production				
		Resources for calf care			
			Time		
			Manpower		
		Challenging practices of the LS system			
			Change of housing system		
			Change of feeding system/ feed		
			Vaccination at arrival		
			Transport/regrouping		
	4. Perceptions on farmers' mindset/attitude				
		low priority of future veal calves			
		Getting used to poor calf health			
		Trust in AM			
Considerations on solution approaches					
	5. System change				
		Criticizing the specialized system			
		Doubts about the feasibility of a system change			
	6. Improvement measures within the system				
		Collaboration/information structures			
			Systematic herd health management		
			Calf health service		
		Cooperation circles			
			App		
			Social control		

(continued on next page)

Table 2 (continued)

Research question	Main category	Subcategory level (SL) 1	SL 2	SL 3	SL 4
Perception of the current situation					
		Financial incentives	Limitations		
			Breeding strategy		
		Top-down regulation	Preventive measures on the dairy farm		
	7. Alternatives to the LS system		Restricting AM use		
		Producing veal on dairy farms			
			Balancing out milk price fluctuations		
			Double box system		
		Set transport age higher			

research question they contribute to answer.

3.1. Perception of the current situation

There were four main themes extracted which refer to research question one: demand for AM reduction (1.), structural framework (2.), conditions for calf health management (3.) and perceptions on farmers' attitudes (4.). Identified subthemes within each main theme were summarized to a set of perceptions (1c., 2c., 2g., 3f. and 4d.), which build the basis for the two main sentiments (5. and 6.) respondents emphasized. These two sentiments, in combination, cause the feeling of

being in an impasse if the aim is to significantly reduce AM use without damaging animal health.

3.1.1. Demand for AM reduction (1.)

The interviewed actors expressed a high level of awareness that AM use in veal production must urgently be reduced (1c.). External pressure coming from the public discussion around AM mis- and overuse in animal production (1a.) is one factor that causes the respondents' willingness to change the current situation (5.). They widely evaluated the extent to which the theme of calf health and AM use is included in the public discourse as appropriate. However, fear was expressed that

Fig. 2. Model of understanding showing the interrelations between extracted key issues. Light grey boxes show the four main themes (1.-4.) identified which answer research question one [RQ1]. Curly brackets summarize extracted subthemes [black boxes] of each theme and arrows point to the consequences they cause [boxes on white background] and the direct connection to research question two [RQ2]. Within theme 2. dark grey frames show the type of stakeholder who is affected by the associated aspects. Broken lined frames highlight perceived preconditions and text on arrows distinguishes between financial stress and (inter-)dependency perceived by the stakeholders. The dark grey box contains the extracted key topics referring to research question two [RQ2].

the discourse around AM resistances might result in a general prohibition of AM use in livestock production with negative effects on animal health and possible conflicts with the animal protection law. There was high awareness that the veal industry is in the focus of criticism in Switzerland because it is perceived to be among the largest consumers of AM in Swiss animal production. Particular criticism was perceived from the human medical area, especially regarding critically important AM. Despite the general agreement with the criticism, respondents demanded other AM consuming sectors, such as human medicine and companion animal medicine, to assume their responsibilities, as well, and contribute to the problem-solving process. The current public discussion was, however, considered to motivate industry stakeholders to take action and was also perceived to have an impact on farmers' attitudes towards using AM.

Intrinsic motivation of respondents, as the second factor, is based on the prioritization of human health before animal health but also by the awareness that AM resistances can cause major damage to the livestock sector itself (1b.).

3.1.2. Conditions linked to progressing specialization and the LS system (2. – 4.)

Theme (2.) refers to circumstances coming with a high level of specialization, which mainly affect stakeholders who are directly or indirectly involved in the LS system. This includes specialized dairy farmers, specialized veal producers and any stakeholder who is involved in the supply chain of conventionally marketed veal. Themes (3.) and (4.) directly refer to the LS veal production system which reflects the broad consensus that the problem is caused by the conditions coming with this production form, and explain the general perception of a limited scope of action and inflexibility in a system which does not provide a good basis for preserving calf health and reducing AM use (6.).

3.1.2.1. Structural framework (2.). The relationships between stakeholders represent the social environment in which the discussion is held. The tendency of passing responsibility between actors and blaming others (2a.) and the involvement of a wide range of stakeholders with differing interests (2b.) causes the perception that the debate is held in a rather challenging and dis-unified social framework (2c.).

Typically, dairy farmers were held responsible for providing healthy calves to the market because they care for the calves during the delicate period of the first weeks of life and therefore have the power to enable a robust immune system as a precondition for a good performance on the fattening farm. However, some veal producers were convinced that even if dairy farmers did their best, the conditions of the LS system just overstress the immune system of young calves. Several fingers were pointed at the traders, with some respondents claiming that traders do not feel responsible because they solely transport the calves in the sense of a service. Next to the consumer, the gastronomy as a major buyer of veal is criticized for its continuing demand for white veal, which slows down the process of change. Respondents from slaughterhouse companies felt they were left with the task of solving an issue that should actually be solved by the dairy industry, as, according to them, the root cause of the problems is the high number of excess-calves from dairy farms placed on the market, which creates an over-supply of veal.

Structural circumstances, which are preset by the market and the high level of specialization put actors in a position of mutual dependency and financial pressure (2 g.). Identified factors are assigned to the stakeholders that are affected. Arrows show the chains of consequences of the identified preconditions [broken lined frames] which are related to the proceeding specialization and separation of dairy and veal production (2d.), considerable seasonal fluctuations on the calf market and in the demand of veal meat (2e. and 2f.), and the uncertain market situation for veal as a product (2f.). Labeling on the arrows indicates the situation of interdependency between dairy and veal producers, the one-sided dependency of veal producers on

slaughterhouse companies and retailers and situations of financial stress caused by unstable producer prices [for milk and slaughter calves] and the unstable calf market.

The veal production sector was described as inseparably connected with, and highly dependent on the dairy industry, as it is based on incurring and refining its side-products [calves and excess milk] and placing them on the market. As the dairy industry determines the amount and flow of primary "material" [which in fact are live calves] available for veal fattening, it is perceived as clearly dominating over the veal sector. Zooming into the dairy industries' structures, it was emphasized that many dairy farmers are put under considerable pressure by the dairies who dictate the milk price and thereby force them to increase milk production and expand their farms to be able to maintain economic efficiency. Seasonal fluctuations in calf supply are caused by the common concept of "seasonal calving", meaning to aim for a peak of parturitions in winter which disburdens farmers during summer, when field work prevails. In the mountain regions, where cows are often brought to graze on alpine pastures in summer, calving also occurs in winter. According to the interviewees, this causes an oversupply in winter resulting in low sale prices for young calves. Rising prices in summer months, on the other hand, are due to lower supply and veal producers' high demand to purchase calves which are to be slaughtered for the Christmas business. Non-transparent pricing, meaning that actual prices on the market are not in accordance with the target prices determined by members of the veal industry, was strongly criticized.

There was general agreement that self-employed LS veal farming is quite risky if it is the sole source of income, with highly fluctuating purchase prices and small profit margins. Other frequently mentioned reasons for economic uncertainty were unforeseeable veterinary costs, expensive feed and the risk of failing to meet label requirements regarding carcass characteristics which can lead to payment deductions. It was further reported that private veal producers tend to join integration companies to achieve better financial security. Veal distributors have to deal with a decreasing number of veal consumers. Responsibility for the drop in consumption was given to high retail prices of veal and to the fact that the classical well-situated consumer group, which belongs to the elder generation, is declining whereas veal is not popular in the younger generation. The lack of popularity among the young was reported to be due to the bad reputation of veal that is caused by perceived high inputs of AM and animal welfare issues related to pale veal. However, consumers were also accused of having paradoxical expectations concerning the low price they are willing to pay and the higher costs of providing the animal welfare standard they demand. Low consumption rates and low willingness to pay, combined with the need to maintain financial viability, sometimes force slaughterhouse managers to pay producers a price for slaughter calves that is below the production costs, while retailers are rather independent from veal meat, because they have the choice to focus on other meat products to sell.

3.1.2.2. Conditions for calf health management. Current social and production system related structures have an indirect impact on calf health and AM use as they determine the wider frame of the environment calves are kept in. Looking at the direct conditions calves face, being fattened in the LS system, respondents saw major challenges for calf health (3f.).

Nearly all respondents were convinced that the current LS system, which favors transport and regrouping in large units with young calves coming from many different dairy farms, and therefore carrying different stable-related bacteria, causes physical and mental stress which result in poor calf health. Aggravating factors related to transport and regrouping were: transport routes not planned in favor of the animals, frequent loading and unloading of calves at collection points or market places, transport of sick calves, unfavorable transport age of about three to five weeks and the common perception trading with calves is risk-free and profitable, with traders not seeing themselves as responsible

for the health of the animals they carry. Despite this critique, it was also emphasized that traders undertake the important task to compensate the fluctuations in calf supply by distributing them among the fattening farms.

It was described as a common practice to vaccinate calves against bovine respiratory disease at arrival on the veal farm, which was considered to be an extra challenge for the calves' immune systems. On specialized dairy farms, calves are often housed in single calf huts. The change to a housing system of groups of 30–50 calves was seen as a cause for social stress. Additionally, calves are exposed to new feed and feeding system when entering the fattening unit. Mostly calves are bucket fed with whole milk on dairy farms and have to adapt to an automatic feeder providing a milk by-product as feed. This situation was evaluated as stressful and therefore weakening to the immune system of calves.

Sick calves were seen as demanding investment of scarce farmer resources in the form of both manpower and time: regardless of farm type or size. On LS veal farms, the time and manpower aspect was named as a possible reason to administer group treatment, which accounts for the largest part of AM consumption, rather than individual treatment. The typical number of 100–300 calves on LS veal farms was said to exceed management capacities of veal farmers. Specifically, many interviewees explained that animal observation, which is seen as one of the most important preconditions for a good herd health, is not feasible in large fattening groups. Respondents stated that many managers of LS veal farms do their best to reduce AM use but are overstrained by the situation. In conclusion, the LS system was perceived to be lacking the potential to work with less AM as it exposes young calves to a high number of stressors their immune system cannot deal with.

3.1.2.3. Perceptions on farmers' attitudes. Respondents frequently expressed their opinion on farmers' attitudes which influence their behavior regarding calves. These attitudes represent mental burdens for the process of improving calf health and reducing AM use (4d.).

Calf performance, which is strongly associated with a good health status, was claimed to be a main priority for veal producers, while young calves intended to be sold for fattening are rather seen as by-products by dairy farmers, which discourages them investing in calf health. This applies even more to male calves of pure dairy breeds as they are not considered contribute to a farm's profitability.

Respondents reported that many farmers, from both veal and dairy farms, simply accept that a certain percentage of calves will become ill due to their susceptibility in the first days and weeks of life. Farmers were described to be used to having sick calves on the farm instead of perceiving it as a temporary crisis that has to be solved.

Professional veal producers reported great successes with AM for treatment of infectious diseases. AM applied at group level for metaphylactic treatment of infectious diseases was described as an integral part of standard management practice within the current system which veal producers see as inconceivable.

The outlined perceptions on the LS system which was raised as the problem-causing system due to its dependency on AM group treatments stand opposite the current need to reduce AM use. Taking the willingness to reduce AM use (5.) and the feeling of a limited scope of action in an inflexible system which does not provide a good basis for improvement of calf health and reduction of AM use (6.), it can be concluded that stakeholders find themselves and other actors in an impasse regarding the objective to significantly reduce the amount of AM used in veal production.

3.2. Considerations on solution approaches

In regard to research question two: which possibilities do stakeholders see to reduce AM use and improve calf health along the Swiss veal production chain?, the identified perception of the LS system being an impasse provides a logical basis for respondents' ideas on solution

approaches: most respondents drew the consequence that the only way to reduce AM use to a significant extent would be to replace the LS system (7.). Respondents emphasized that fundamental rethinking among all actors and complete change of common practices is needed. They criticized the elaborate and expensive infrastructure required for trading and transporting calves and milk replacer to specialized fattening farms and, that too many actors along this supply chain have to make a profit, which causes low earnings for primary producers and high retail prices for consumers. AM are administered to compensate for deficiencies in management and husbandry within this system: Various actors were convinced that it can never be consistent with the reduction of AM usage if animal health is to be safeguarded.

Nevertheless, the required radical change of the current structures was frequently expressed in a hypothetical sense, as many of the respondents think that, in practice, the current LS system is irreplaceable due to the far progressed specialization. In these cases, it was rather discussed about measures to improve calf health and reduce AM use within the LS system (9.): For example, the development of appropriate structures for education, sensitization, research, networking and communication with all stakeholders including consumers was demanded. A lot of faith was put in the national Swiss Calf Health Service which was recently initiated by the producers who now receive financial support from the government in order to establish a competence center for calf management and to implement preventive measures on farms. On the demand side, efforts must be made by the main retailers, who were said to be in the best position to provide consumers with background information about the challenges faced by the veal sector, to enhance willingness to pay the price premium for sustainable production.

Several respondents proposed cooperation circles between a small number of dairy farms and one veal farm from the same region to reduce calf-shifting, to shorten transport distances and to create sustainable trade relationships, which were said to possibly serve as a certain social control by inhibiting dairy farmers to sell sick calves. This approach was perceived to be only viable in connection with continuous calf buying on the purchasers' side, as professional veal producers, typically working with the all-in/all-out system, need to buy a high number of calves with similar weights at once to achieve homogeneous fattening groups. Furthermore, in times of low supply the veal producer is forced to buy calves from a bigger catchment area, while, in times of high birth rates, specialized dairy farmers usually need to sell their calves urgently to make space for newborns and are reluctant to wait until the veal producer demands calves.

Respondents further suggested giving dairy farmers financial incentives to make more effort to provide veal farmers with robust calves. Frequently named prevention measures that could be implemented by dairy farmers are controlled colostrum supply, vaccination against bovine respiratory disease, ad libitum feeding, selenium and iron supplementation, and other feed supplements. In return, dairy farmers receive supplementary payments from the veal producer. Financial incentives can also come from the market when dairy farmers produce crossbreedings with beef bulls, which achieve higher prices and therefore motivate calf care. Furthermore, optimizing breeding management by using sexed sperm to reduce the production of male milk breed calves was named as a promising solution.

A top down mechanism could simply be to regulate AM use, but opinions on the contribution of regulations to improving calf health were partly seen critical. For example, it was pointed out that restricting prophylactic AM treatments may simply encourage farmers to record their treatments-at-arrival as "metaphylactic" instead of "prophylactic" which does not decrease net AM use.

Respondents who believed that it might be possible to replace the LS system, proposed alternative systems for veal fattening in Switzerland (8). Fattening all calves on their dairy farms was widely seen as the best way to remove the need for AM group treatments. However, this approach was often evaluated as unfeasible due to the large numbers of

calves that are born on big specialized dairy farms that lack the capacities to take care of them. An alternative argument was that dairy farms should develop such capacity so that keeping calves on the dairy farm for fattening could act as a possible safety valve for dairy farmers to compensate milk price fluctuations: when the milk price decreases, some farmers keep their calves for fattening with whole milk, whereas when milk price increases they would sell calves. A practical solution for big dairy farms could be a housing-system based on a double-box for keeping two calves together [until the age of for months] as the smallest group housing system possible.

According to some respondents, transporting calves at a higher age would significantly contribute to a better calf health and reduction of AM usage because the immune system would be further developed. There was disagreement as to what the optimal age should be, although most respondents felt that 21 days [which is the current directive] was too young because calves at that age are still in the immunological gap. However, later transportation could cause difficulties in accustoming older calves to new feeding systems, as well as in loading and unloading heavier calves. Additionally, keeping calves on the dairy farms for some months, as proposed by some respondents, would mean using them for beef production, where the slaughter age is much higher, instead of veal. This is because heavier calves would be too expensive to buy for a veal producer considering that the fattening period would be reduced to only some weeks, which gives the veal producer little time to feed the animals intensively to achieve high slaughter weights. An approach from the organic sector is castrating young bulls, keeping them on their dairy farms until the age of 12 weeks and subsequently selling them for organic pasture beef production. Outdoor fattening is another proposed alternative to the current LS system, which is currently being tested in a research project. In this system, calves are transported directly from the dairy farms to the fattening farms where they are kept in single hutches for some weeks at the beginning of the fattening period and are housed in groups of ten calves in outdoor hutches with a roofed outside pen afterwards. However, these strategies are not common practice, which indicates that farmers perceive little intrinsic motivation to apply them.

4. Discussion

This study presents the current situation of the Swiss veal production system in the context of AM use and calf health management from the view of respondents along the production chain including farmers, members of the industry and professionals in calf health. To reduce AM use in veal production it is important to understand the perceived initial situation, related challenges and considerations about improvement strategies. Therefore it is essential to integrate a large spectrum of different perspectives of the topic. This study has identified relevant constructs in the framework of a range of variation rather than quantification (Brinkmann and Kvale, 2015) that can inform future research using quantitative methods to obtain representative results.

4.1. Reflection of the method and study limitations

The interviews were based on a voluntary participation so it is likely that respondents had above average awareness of the importance of improving, or at least preserving, calf health along with a reduction in AM use. Many of the respondents were deliberately selected as members of producer associations. It cannot be excluded that their responses might be related to the objectives of their respective associations. However, the benefits of interviewing respondents with a deep knowledge and broad overview of the sector, exceeded this disadvantage.

Finally, all of the interviews were conducted in Switzerland about the Swiss industry in which animal welfare standards are already above the European level (Vogeler, 2017). In most European countries there is a much higher homogeneity of farm types that are represented by integrated large-scale farms which produce veal for domestic

consumption as well as for export (Pardon et al., 2014; Proviande, 2018a). Therefore, the transfer of the results of this qualitative study to other contexts should be done with care, as the results are based on statements of respondents' with a particular background and experiences which must be understood (Malterud, 2001). Despite these limitations, the results allowed the creation of a picture (Fig. 2) of the Swiss veal production sector with regard to current challenges in calf health management and considerations about solution approaches.

4.2. Discussion of the main results

4.2.1. Awareness of the need to reduce AM use and the public discussion

The perceived public pressure to reduce AM use can be a powerful driver to further sensitize all participants of the field and enhance their awareness even more. Bokma et al. (2019) attribute the successful reduction in used AM on Belgian veal farms to societal and political pressure in connection with increased awareness of the risk of the development of resistances. However, many studies found farmers of different livestock sectors to be unaware of the risks of AM use (Friedman et al., 2007; Stevens et al., 2007; Visschers et al., 2014; McDougall et al., 2017). One study revealed the Swiss dairy farmers are not sufficiently informed about the use of critically important antimicrobial drugs (Pipoz and Meylan, 2016). Although respondents mostly agree with the way public organs, industry associations and animal health institutions address the topic, pressure coming from the human medical sector and the media is rather perceived as threatening. In this context, stakeholders fear radical restrictions that could jeopardize animal welfare on one hand and the whole production sector and therefore their own existence on the other. Whether this fear is justified remains unclear as there have been studies that have found that AM use [mainly referring to group treatments] and increased mortality can be positively (Jarrige et al., 2017), negatively (Bähler et al., 2012) or not associated (Bokma et al., 2019). Nevertheless, literature on the effects of losing effective AM treatment due to either resistances or prohibition points out that animal suffering as well as socio-economic stress of the livestock-keeper might increase in case of disease outbreaks – especially in intensive production systems with low profit margins (Vaarten, 2012; Bengtsson and Greko, 2014).

4.2.2. System change?

Most respondents automatically guided the conversation towards the LS system and clearly identified this system as the cause of the problem as it was associated with group treatments. Within the perceived challenges related to this system, two levels could be identified. Firstly, socio-economic circumstances imposed by a high level of specialization cause an environment of financial pressure and interdependencies. In this sense, the situation was described as being entrenched due to the level of specialization in dairy and veal farming. Furthermore, increasing difficulties in distributing veal were nominated as tightening the margins for producers even more. The concerns, which were raised in the context of intensive veal production, are similar to challenges of the veal industry in other European countries (Sans and De Fontguyon, 2009; Pardon et al., 2014). Nevertheless, it must be taken into account that a highly integrated fattening system is predominant in many other veal producing countries, such as France, The Netherlands, Italy and Belgium, while Switzerland has particularly diverse structures. Only about a quarter of calves slaughtered as veal enter a LS veal farm, while most of them are still fattened on dairy farms on a smallholder level (UFA, 2015; Rindergesundheitsdienst, 2019). On a socio-political level, the existing diverse structure can be seen as a good basis to implement a shift towards less AM consuming systems as they already exist. However, regarding the implementation of changes in terms of introducing new standards, highly standardized production systems might offer a more suitable environment. In Belgium for example, regulations could be applied very easily as the whole veal industry is highly integrated (Pardon et al., 2014).

In the current study, change on system level was perceived to be inhibited through differing objectives of veal industry members, with respondents often referring to the economic interests of dairies, veal distributors, and farmers. According to Speksnijder et al. (2015c), non-binding intentions to reduce AM use might not be efficient as the livestock industry might prioritize other interests, such as economic interests, before interests such as public health. In this sense, top down interventions appear more likely than optional measures to have a positive effect: a notion that was also proposed by several respondents. However, any system change that threatens the existence of key stakeholders is likely to face resistance.

The second level identified includes aspects directly challenging calf health management. Stakeholders' ideas of the causes of poor calf health are mostly in accordance with the findings of research that has investigated risk factors for mortality or AM use (Brscic et al., 2012; Pardon et al., 2012b; Santman-Berends et al., 2014; Lava et al., 2016a; Santman-Berends et al., 2018; Schnyder et al., 2019). Furthermore, lack of time and manpower was described as hampering favorable calf health management on veal and dairy farms, which is in accordance with the findings of Vaarst and Sorensen (2009), who found flexible time to be an important factor which empowers calf managers to react straight away to unexpected events regarding calf health. The impact of farmers' mindset towards calf health and AM use also plays an important role according to the literature (Coyne et al., 2014; Ge et al., 2014; Kramer et al., 2017).

Speksnijder et al. (2015b) found that veterinarians perceive financial and time restrictions to be the main reasons why farmers do not comply with veterinary advice to improve animal health. Factors identified in this study that have an impact on whether veterinarians prescribe AM: namely client expectations, financial dependency on clients, and public health interests, are in agreement with the findings of McDougall (McDougall et al., 2017), Speksnijder (Speksnijder et al., 2015a) and Gibbons (Gibbons et al., 2012). No literature was found to support the finding that Swiss veterinarians are perceived to be insufficiently specialized in veal calf herd health management, but the recently founded Swiss Calf Health Service is currently making efforts to establish a network of contractual veterinarians specialized and further educated in calf health (Swiss Calf Health Service, 2018).

5. Conclusions

This study points to the conclusion that actors in the veal sector are highly aware regarding the need to reduce AM use in Swiss veal production. The most effective leverage point seems to be to abandon large-scale veal farming, because they account for high AM consumption rates. What remained less clear was which changes are feasible under Swiss conditions. A radical change away from the existing farming system was mostly perceived as not feasible in the nation-wide context, due to the importance of the industry to incur dairy by-products in the form of calves and milk powder. Those who could not imagine a system replacement were convinced that improvement measures within the current system were the only options to reduce AM usage. Other respondents could imagine a replacement of the existing system and proposed alternatives. This study illustrates that there are challenges associated with both incremental and large scale changes, which go beyond the scope of solving technical issues. This further points to a suggestion that significant change to the production systems will require simultaneous efforts on economic, social and political level that enable changes without threatening the viability of veal farming with the over-all aim to reduce AM usage in a production system that favors high animal health and welfare standards.

Acknowledgements

We gratefully acknowledge the participating interviewees for sharing openly their opinions, experiences and ideas with us. This work

was funded by the Swiss Federal Food Safety and Veterinary Office under project number 1.16.08 and by the Swiss Expert Committee for Biosafety.

Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:<https://doi.org/10.1016/j.prevetmed.2020.104970>.

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Danksagung

An dieser Stelle möchte ich allen beteiligten Personen meinen großen Dank aussprechen, die mich bei der Anfertigung meiner Dissertation unterstützt haben.

Zuerst möchte ich mich bei Prof. Dr. Martin Kaske für die Möglichkeit zur Erstellung einer Dissertation und für die stete fachliche Unterstützung und Begleitung herzlich bedanken.

Bei Dr. Michael Walkenhorst bedanke ich mich für die intensive und Begleitung bei der Erstellung dieser Arbeit sowie für den freundlichen und motivierenden Zuspruch in anstrengenden oder scheinbar komplizierten Momenten.

Dr. Mette Vaarst, Dr. Robert Home und Dr. Bernadette Oehen danke ich sehr für die fachliche Unterstützung und unkomplizierte Zusammenarbeit bei der Erstellung der Publikation, sowie für generellen Rat und Anregungen im Bereich Sozialwissenschaften, der mir sehr geholfen hat, dieses transdisziplinäre Projekt durchzuführen. Ebenso danke ich Dr. Corinne Bähler für ihre Bereitschaft, mir einen Einblick in die Realität der Schweizer Kälbermast zu verschaffen. Nadine Wunsch danke ich für die schönen Erinnerungen an eine sehr intensive und positive Zeit in Wien und Basel und für ihr unglaubliches Engagement bei der Erstellung ihrer im Rahmen meines Dissertationsprojektes erstellten Masterarbeit, die sicherlich zur Qualität der Arbeit beigetragen hat.

Meiner Familie, meinen Freunden und Arbeitskollegen spreche ich einen herzlichen Dank für die immerwährende Unterstützung und den steten Glauben an mich aus. Mischa und unserem/r kleinen Bauchbewohner/in, der/die in den nächsten Tagen geboren wird, bin ich sehr dankbar für die vielen kraftspendenden Momente in der finalen Phase der Dissertation und die stetige Erinnerung an das, was wirklich zählt.

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