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Changes in perceptions and motivators that influence the implementation of on-farm *Salmonella* control measures by pig farmers in England

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ABSTRACT

This study presents British farmers' perception of, and barriers to, implementing *Salmonella* control on pig farms. Four farms that had implemented interventions and their 33 close contacts (known to the intervention farmers) took part in interviews before (phase 1) and after (phase 2) intervention trials to assess the difference in perception over time. Their results were compared against those from nine randomly selected control farms. The hypothesis was that farms implementing interventions whether or not successful, would influence their close contacts' opinion over time.

Based on a 'pathway to disease control' model, three intrinsic factors known to influence motivation – attitudes, social norms and self-efficacy – were evaluated.

Farmers mentioned that successful interventions on a farm would attract their attention. The use of an appropriate communication strategy is therefore recommended to stimulate farmers' intent to implement control measures. Both before and after the intervention trials, all farmers had a positive attitude towards *Salmonella* control and felt that their peers and authorities were supportive of controlling *Salmonella* on farms. In phase 2, however, farmers were more likely to want to share the burden of control with other stakeholders along the food chain and their belief in self-efficacy had weakened. Whilst social norms were not associated with an intention to take action on control, a positive attitude towards *Salmonella* control and a belief in self-efficacy were more likely to result in an intent to control. In phase 2, farmers with an intent to implement an intervention appeared to have a greater, but not significant positive belief in self-efficacy ($p = 0.108$).

This study confirmed that farmers recognised their responsibility for controlling *Salmonella* in pork – even though their confidence in their ability to control *Salmonella* decreased over time – and believed that responsibility should be shared with the rest of the production chain. It showed that farmers trusted their veterinarian as a source of advice to guide them during the process of implementing change, though an increase in farms' *Salmonella* seroprevalence score (Zoonosis National Control Programme (ZNCP) score) especially for those with a low ZNCP score was also likely to influence their behaviour. Getting concrete feedback from customers or a tangible benefit from their action was a strong incentive especially for farms with a ZNCP score higher than 50%. The study also revealed a need to validate which measures are effective as farmers did not perceive that the current advised interventions were worth the additional effort.

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1. Introduction

In 2006–2007, a European Union (EU) baseline study estimated the prevalence of *Salmonella* in slaughter pigs sampled in abattoirs (Anon, 2008). In the United Kingdom (UK), lymph nodes of 21.2% of slaughtered pigs were infected with *Salmonella* (Anon, 2008; Marier et al., 2014). Another EU survey assessed the presence of *Salmonella* in breeding herds in 2008. The prevalence of *Salmonella* in the UK breeding pig holdings was the fourth highest of all participating countries (Anon, 2009a). In 2013, a third survey in UK abattoirs confirmed the presence of *Salmonella* in 30.5% of the caecal content of slaughtered pigs (Powell et al., 2015). Since pig meat products are a potential source of human salmonellosis (Hald et al., 2003), these results highlighted the need to reduce *Salmonella* prevalence in the UK pig herd.

In 2007, the British Pig Executive (BPEX, now AHDB Pork) commissioned a set of intervention trials, in which individual farmers could propose and apply for funds to support interventions against *Salmonella* (intervention trial). Farms with successful interventions would be used as demonstration farms to others. Separately, to monitor the seroprevalence of *Salmonella*, meat juice samples were tested (ELISA) periodically from each batch of pigs sent to the abattoir, as part of the Zoonoses National Control Programme (ZNCP score, 2008–2012, (BPEX, 2012)).

Implementation of *Salmonella* control on pig farms faces several challenges. Firstly, *Salmonella* is seldom associated with clinical disease (Alban and Stark, 2005; Wales et al., 2011; Wales and Davies, 2016) or apparent (perceived) production loss in pigs (Andres and Davies, 2015; Loughmiller et al., 2007), therefore control is believed to benefit public health rather than the farmer who has to implement interventions. Secondly, farmers may be unable to assess the effect of additional control efforts that they undertake (Evangelopoulou et al., 2015). Therefore, whilst farmers may accept a moral responsibility (Van Dam et al., 2010), the outcome appears remote from the primary producers' perspective. Thirdly, the potential exists to mitigate or aggravate contamination risk at other stages along the food chain (Dickson et al., 2013), from abattoir through processing to consumption. Finally, whilst there is convincing evidence that some human cases of salmonellosis are caused by *Salmonella* strains that are found in pigs (Kirchner et al., 2011), the overall proportion of human salmonellosis that can be attributed to pigs remains uncertain. However, based on a "contribution of food sources to human salmonellosis" study using 2007–2009 data, it was estimated that, 26.9% and 11.7% of cases of human salmonellosis were attributable to pigs in the EU and in the UK respectively (Pires et al., 2011), while a more recent study estimated that 57% of the human salmonellosis cases were attributed to pigs in the EU (Hald et al., 2012).

This paper presents the outcomes of a two-phased study which aimed to use the intervention trials and the ZNCP scores as anchor points to investigate how pig farmers' intention to control *Salmonella* changed in response to evidence of the effectiveness of interventions. The authors relied on a behavioural model according to which (i) intrinsic motivators (attitudes, perceived social norms and self-efficacy) affect the intent to take action and (ii) extrinsic circumstances (community and industry, culture and society, knowledge and skills) influence the step from intent to implementation (Ajzen, 1991; Ellis-Iversen et al., 2010). This paper focuses on the intrinsic factors that impeded farmers' intention to control *Salmonella* before (phase 1) and after (phase 2) the intervention trials and describes the impact of the ZNCP score on these factors. It draws upon the data collected to identify strategies that may promote an intention amongst pig farmers to control *Salmonella* in the future.

2. Material and methods

2.1. Study population

Four farmers recruited by BPEX into the intervention trials (Table 1) were invited to participate in this study. For each of them, up to nine close-contact farms (referred to as 'contact farms') were enrolled to test whether the intervention farm influenced the uptake of control on the contact farms (Fig. 1). These contact farms were first identified by the intervention farmer as individuals with whom they had regular social or professional contact and at least occasionally discussed pig husbandry and farming. Secondly, each farmer's private veterinarian suggested additional farmers to whom they might recommend interventions. Finally, if more farms were needed, BPEX also suggested a list of pig farmers that were part of the same geographical region and therefore, more likely to attend the same pig discussion meetings and receive the same information material as the applicable intervention farm.

To generate an equally large 'control-cluster', up to nine control farms were randomly selected from geographical regions (counties) in which no intervention farms were present, using lists supplied by BPEX. Another eligibility criterion was that the farmer did not personally know any of the intervention farmers.

The (i) intervention farms, (ii) contact farms and (iii) control farms are referred to herein as the three "types" of farms.

2.2. The interventions

The four intervention farms implemented interventions as agreed with BPEX's study. One farm added Bio-Mos® to the lactating and dry sow ration to reduce *Salmonella* levels in piglets. The second intervention farm switched from pelleted to coarsely ground meal feed in the grower pigs. The third farm used a live-attenuated *Salmonella* Typhimurium vaccine for the sows (Salmoporc STM®) and fed weaned piglets & grower pigs with liquid acidified feed. The fourth farm vaccinated piglets at weaning using a live *Salmonella* vaccine (AviPro® vac T) given orally by mixing the vaccine with their gruel (Table 1).

2.3. Intrinsic factors

A "pathway to disease control" model, recently applied to describe livestock farmers' perception, motivators and barriers in relation to disease control (Ellis-Iversen et al., 2010), was used to measure farmers' motivations, intentions and behaviour. This was based on the model of reasoned behaviour that was later expanded to include the extrinsic factors as influencers for livestock farmers (Ajzen, 1991; Panter-Brick et al., 2006). The model's three intrinsic factors were investigated using a structured questionnaire (Table 2):

2.3.1. Attitude

The farmers were asked to rate how important it was to control *Salmonella* in pigs for them, for public health and for the pig industry and whether control of *Salmonella* in pigs was a necessity. Their answers were rated between strongly agree and strongly disagree.

2.3.2. Social norms

The farmers were asked how they thought various peers would feel if they applied an intervention on their farm and whether they would be supportive. Their answers were rated between very positive (approve) to very negative (disapprove).

2.3.3. Belief in self-efficacy

The farmers were asked about how an intervention would affect the burden of *Salmonella* in pigs if it was implemented. They were