LABORATORY OF PARASITOLOGY

DEPARTMENT OF VIROLOGY,
PARASITOLOGY, AND IMMUNOLOGY

FACULTY OF VETERINARY MEDICINE

INTO THE MIND OF A DAIRY FARMER:

A MULTIMETHOD STUDY TO INDUCE SUSTAINABLE WORM CONTROL BEHAVIOUR BY COMMUNICATION STRATEGIES

Fiona Vande Velde

Promotors:

Prof. Dr. Edwin Claerebout
Prof. Dr. Liselot Hudders
Prof. Dr. Verolien Cauberghe
Dr. Johannes Charlier

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List of abbreviations

α	Chronbachs' alpha
ab	Conditional indirect effect
AIS	Agricultural innovation systems
AR	Anthelmintic resistance
BVD	Bovine viral diarrhoea
c	Direct effect
CI	Confidence interval
CFI	Comparative fit index
COREQ	Consolidated criteria for reporting qualitative research
COWS	Control Of Worms Sustainably
DGZ	Diergezondheidszorg Vlaanderen
ELISA	Enzyme-linked immunosorbent assay
EPG	Empowered participatory governance
F	F-statistic
FEC	Faecal egg counts
GIN	Gastro-intestinal nematodes
HAPA	Health action process approach model
HBM	Health belief model
κ	Cohens' kappa
L_{1-5}	Larvae stages 1-5
M	Mean
η^2	Eta-squared
NCI	Non-centrality index
p	p-value

PSA	Public service announcement
RMSEA	Root mean square of approximation
SCOPS	Sustainable Control of Parasites in Sheep
SD	Standard deviation
SE	Standard error
SEM	Structural equation modelling
SPSS	Statistical package for the social sciences
SRMR	Standard root mean square residual
TLI	Tucker Lewis index
TPB	Theory of planned behaviour
TST	Targeted selective treatment
TT	Targeted treatment
TTM	Trans theoretical model

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CHAPTER 1 - Introduction

DAIRY FARMERS' SUTAINABLE GASTROINTESTINAL NEMATODE CONTROL - FAILED UPTAKE AND FUTURE POSSIBILITIES

1.1. GENERAL INTRODUCTION

Gastrointestinal nematode (GIN) infections are a common constraint in pasture-based dairy herds and can cause a decrease in animal health, productivity and farm profitability. Current control practices to prevent production losses of GIN infections in livestock depend largely on the use of anthelmintic drugs. However, due to the intensive use of these drugs, the industry is increasingly confronted with anthelmintic drug-resistant nematode populations. This emphasises the need for sustainable control approaches that minimise the selection pressure and dissemination of anthelmintic resistance (AR). The uptake of diagnostic methods for sustainable worm control could enable more informed treatments and reduce excessive anthelmintic use. However, farmers have been slow in adopting guidelines for sustainable control. Accordingly, in order to successfully implement such control strategies and change the behaviour of farmers, their current perceptions and behaviours need to be comprehended and translated into effective communication strategies.

This review presents a brief history of GIN control practices and how the field should shift towards more sustainable control approaches. It gives a critical overview of the behavioural literature in the field, which contributed to understand the failed uptake of these sustainable practices, followed by the possibilities for improving this currently ill-equipped domain of behavioural research. Finally, additional research on communication practices is suggested, such as knowledge exchange, since this may bridge the gap between scientific knowledge and applicable advices.

1.2. CURRENT STATUS OF GASTROINTESTINAL PARASITISM

1.2.1. The effects of gastrointestinal parasitism in cattle

All grazing livestock are exposed to GIN infections. For cattle in particular, the nematodes *Ostertagia ostertagi* and *Cooperia oncophora* are the most prevalent species in temperate climate areas. *O. ostertagi* is highly prevalent and highly pathogenic, while *C. oncophora* is less pathogenic. However, in most cases co-infection with both parasites occurs during grazing on contaminated pastures. During the free-living phase of the parasites' life cycle on pasture, first stage larvae (L_1) hatch from the eggs excreted by their host, moult into L_2 and consequently develop into the infective third stage larvae (L_3). Cattle ingest L_3 with herbage during grazing, which initiates the parasitic phase of the nematode life cycle. In the parasitic phase, L_3 migrate from the rumen to the abomasum (*O. ostertagi*) or the small intestine (*C. oncophora*) and develop into adult

worms after 2 more stages (L_4, L_5). After mating, fertilised eggs are released by the female worms in the host's gastrointestinal tract and are shed in the faeces.

In the parasitic phase, GIN can be a cause of parasitic gastroenteritis. This disease typically affects young animals during their first grazing season and provokes clinical signs such as diarrhoea, reduced growth, and weight loss. In severe cases it can cause mortality. Due to their immunity, adult cows generally present no clinical signs, but diminished milk and meat production can be attributed to sub-clinical infections of parasitic gastroenteritis. Consequently, substantial economic losses are due to GIN infections in dairy farms in developed countries (Bennema et al., 2010; Charlier et al., 2009a; Sanchez et al., 2004). In Flanders (northern Belgium), the estimated annual losses due to GIN infections per year have been estimated at 11 million euro, or 40 euro per adult cow (Charlier et al., 2009b). Today, some authors estimate GIN infections to be second to mastitis in terms of health costs to dairy farms (Coppieters et al., 2009).

To estimate farm-specific economic effects of GIN infections, novel tools and frameworks were developed (Charlier et al., 2012; van der Voort et al., 2013). These tools (e.g. ParaCalc®) were set up to facilitate farmers' decision making of parasite control on their farms (Charlier et al., 2012). However, in order to enable the implementation of such decision support tools as part of routine farm-management, these should be assembled in one single application together with support for other diseases and production-limiting conditions (Charlier et al., 2017).

1.2.2. Anthelmintic use and farm intensification: co-evolution

The development of highly efficacious anthelmintic drugs has significantly contributed to reducing the economic burden of nematodes (van der Voort et al., 2013; Woods and Knauer, 2010). There are three major anthelmintic families licenced in northern Europe for the control of parasitic nematodes in cattle: benzimidazoles (e.g. fenbendazole), imidazothizoles (e.g. levamisole,), and macrocyclic lactones (e.g. ivermectin). This practice can be put in the '*zeitgeist*' of the late 1980s, where animal health management shifted from treatment of clinical illness of a single animal to disease prevention on a herd level (LeBlanc et al., 2006). To understand this change of practice we have to take a better look at the industry. Animal farming was, and is still, evolving worldwide: industrialization and competition have led to a whole new farming approach (Derks et al., 2013). The traditional farm as we once knew, doesn't exist anymore, it became an agricultural production business included in the global economy. Livestock enterprises were faced with challenges in maintaining a global competitive position and therefore farmers needed to restructure their production to meet market demands (Hansson and

Ferguson, 2011). This new farming approach led to drastic changes regarding animal disease control as we stated above. In the case of nematode control, anthelmintics have been used extensively to prevent emerging infections and thus economic losses. Anthelmintic drug development and the strategic use, positively balanced the economic equation (Corwin, 1997; Hawkins, 1993). This arsenal of relatively inexpensive and highly effective drugs aimed to maximise livestock health, productivity and profitability but led to parasite control that was almost merely based on the frequent use of anthelmintics (Kaplan, 2004). Their ease-of-use was an excellent substitute for other, more labour-intensive control approaches based on extensive grazing (less animals per hectare) or rotation management for example. Hence, the changing industry and the effectiveness of anthelmintic drugs resulted in an approach that was highly successful, but now new drivers urge for new adaptations to the current practices. Moreover, the farm intensification model is also facing a paradigm shift. Due to growing needs for sustainable intensification (i.e. intensification of new technologies and knowledge to cope with the growing world population), and changing market demands (e.g. organic, local produce), disease control approaches based on intensive drug use are being pressured towards new practices that include environmental and animal welfare objectives (Scholten et al., 2013), and result in decreased frequency of anthelmintic treatment with a focus on curative practices.

1.2.3. Anthelmintic resistance in cattle

Due to control practices where the acceptable performance of grazing cattle depends on the availability of effective broad-spectrum anthelmintics to prevent or remove infection with GIN, the industry is increasingly threatened by populations of nematodes resistant to the most commonly used anthelmintic drugs (Sutherland and Leathwick, 2011). Resistance to almost every marketed anthelmintic against nematodes in ruminants has developed worldwide (Table 1.1; De Graef et al., 2013).

The rapid acceptance and widespread use of anthelmintics led to an increased series of reports on anthelmintic resistance (AR) in the 1990s. This had elevated the issue of AR from being a potential problem of the future to being a major threat to small ruminant production in many countries (Kaplan, 2004; Waller, 1999). The cattle industry remained mainly unstudied and AR appeared to have developed more slowly than in small ruminants (Coles, 2002). The number of reports in literature over the past years suggest a rapidly escalating problem (Sutherland and Leathwick, 2011), with growing numbers of failures of anthelmintic drugs to control cattle nematode parasites all over the world (Cristel et al., 2017; Gasbarre, 2014; Geurden et al., 2015; Rose et al., 2015;

Waghorn et al., 2016). The prevalence of anthelmintic resistance was found to be up to 92% for ivermectin in New Zealand (Waghorn et al., 2006) and Brazil (Soutello et al., 2007), and 74% in northern European countries (Demeler et al., 2009). Moreover, multidrug-resistance was reported in New Zealand, with reduced anthelmintic efficacy against albendozole/ivermectin in 74% of farms (Waghorn et al., 2006), and 28% against fenbendazole/ivermectin in Argentina (Suarez and Cristel, 2007). Furthermore, concern rises when we consider the fact that levels of resistance can increase rapidly (El-Abdellati et al., 2010). We cannot rely on the development of new drugs because few anthelmintics are currently being established and it is unlikely that sufficient numbers of new drugs will be developed to maintain a control paradigm based solely on frequent anthelmintic treatment (Kaplan, 2004). Therefore, the need for alternative and innovative nematode control approaches in livestock farming is rising rapidly (Charlier et al., 2014a; Kenyon and Jackson, 2012; Verschave et al., 2014).

Table 1.1.
Introduction of anthelmintic drugs and development of resistance

Anthelmintic class	Generic name	Market release	Reported resistance	Reference
Heterocyclic compounds	Phenothiazine	1940	1957	Leland et al., 1975
	Piperazine	1954	1966	Drudge et al., 1988
Benzimidazoles	Thiabendazole	1961	1964	Drudge et al., 1964
	Cambendazole	1970	1975	Berger, 1975
	Oxibendazole	1970	1985	Drudge et al., 1985
	Mebendazole	1972	1975	Berger, 1975
	Albendazole	1972	1983	Cawthorne and Whitehead, 1983
	Fenbendazole	1975	1982	Barsema and Lewing-van der Wiel, 1982
	Oxfendazole	1976	1981	Le Jambre et al., 1981
	Triclabendazole	1983	1998	Mitchell et al., 1998
Imidazothiazoles and Tetrahydropyrimides	Levamisole	1970	1979	Sangster et al., 1979
	Pyrantel	1974	1996	Chapman et al., 1996
	Oxantel	1976	/	
	Morantel	1970	1979	Sangster et al., 1979
Macrocyclic lactones	Abamectin	Late '70	2001	Wooster et al., 2001
	Ivermectin	1981	1988	van Wyk and Malan, 1988
	Moxidectin	1991	1995	Leathwick, 1995
	Doramectin	1993	2007	Borgsteede et al., 2007
	Eprinomectin	1996	2003	Loveridge et al., 2003
Amino-acetonitrile derivate	Monepantel	2009	2013	Scott et al., 2013

Table adapted from De Graef et al. (2013)

1.3. BEST PRACTICE MANAGEMENT

1.3.1. Novel approaches for GIN control in cattle

The main driving force for the development of new control practices in livestock farming is the emergence of AR in such production systems. To preserve the efficacy of current and any possible future drugs, novel approaches should be developed. These would maximise the efficacy of the current/reduce the reliance on the prophylactic use of anthelmintics. Another crucial incentive is the economic demand of the consumer for

organic, local, and smallholders products, together with the paradigm shift of the farming-model (Knox et al., 2012; Torres-Acosta et al., 2012). Disease control approaches based on preventive and intensive drug use on herd-level are being pressured towards new practices that include environmental and animal welfare objectives with focus on the individual animal-needs (Scholten et al., 2013).

Regarding these purposes, new studies arise proposing novel approaches for the control of parasites on livestock farms. Most of the studies regard small ruminants, because AR is a very common and severe problem here, but insights from small ruminant research can support research in cattle as well. Two important contributions have been made for the sustainable control of parasites in ruminants. A first approach is the use of combinations of different anthelmintic classes with nematocidal activity (Dobson et al., 2012; Leathwick and Hosking, 2009). This novel approach demands a thorough knowledge on pharmacology-based information (Lanusse et al., 2014). Although this strategy tries to decrease the level of AR, again it largely depends on the frequent use of anthelmintics. This approach could be used as a temporary solution but will be unsustainable in the long run (Kaplan and Vidyashankar, 2012). Moreover, the use of combination products is still an issue of debate (Charlier et al., 2017). The use of such combination products can slow down the selection for resistance (Leathwick and Besier, 2014), however if used incorrectly resistance could develop to multiple actives at the same time (Besier, 2007). Although guidelines for implementation of combination products are available (Geary et al., 2012), these have not yet been truly investigated. Therefore, a more sustainable approach should reduce the use of anthelmintics to its minimum instead of moving the problem.

The second approach is based on '*refugia*' strategies, which suggest that the rate of AR development could be slowed by maintaining a proportion of parasite production unexposed to anthelmintic drugs (van Wyk, 2001). *Refugia* is the proportion of the worm population that is not selected by drug treatment and the bigger this proportion, the slower the resistance will develop (Knox et al., 2012). The challenge that exists is in finding the best proportion of *refugia* to minimise the AR development, whilst maintaining acceptable animal performance. Two methods are considered to optimise treatment; targeted treatments (TT; e.g. a group of animals treated after estimation of worm-burden) and targeted selective treatment (TST; e.g. treatments directed only to those animals in need, based on indications of parasite effects; Kenyon and Jackson, 2012). This relatively novel approach depends primarily on the use of different parasitological, pathophysiological and/or immunological markers (see Table 1.2. for an

overview), and only secondly on the implementation of anthelmintics to the targeted (group of) animals.

Table 1.2.
Evidence-based indicators to support targeted (TT) and targeted selective (TST) anthelmintic treatments against gastrointestinal nematodes in ruminants

	Young cattle	Dairy cattle
TT indicators	Grazing management Mean FEC after 4 to 8 weeks during first grazing season Mean serum pepsinogen level at end of grazing season and/or housing	Grazing management Bulk tank milk anti *Ostertagia ostertagi* antibody level Time of effective contact with gastrointestinal nematode larvae based on qualitative analysis of grazing history until first parturition
TST indicators	Live weight gain Body condition score in combination with FEC	

Table adapted from Charlier et al. (2014b)

Recommended and appropriate indicators are age dependent due to separate grazing of adult (dairy) cows and younger stock, and the contrasting effects of GIN on production within these groups (Charlier et al., 2014a). In first-season grazing cattle, the serum pepsinogen concentration at the end of the grazing season is a direct indicator of the pathology induced by *O. ostertagi* (Berghen et al., 1993). Though, due to the relatively high cost and lack of standardization, together with its loss of informative value after housing of the animals (no new exposure to incoming infective larvae), the uptake is rather poor (Charlier et al., 2011). Some of these drawbacks could be overcome by immediately assessing production losses through serum pepsinogen levels (Merlin et al., 2016). This shift in focus from merely detecting the level of infection towards detection of production losses could lead the industry towards a behaviour change in nematode control, as the impact on production would be more meaningful to farmers. This new implementation of diagnosis is still in its infancy, however the current focus of research in diagnostic methods (Charlier et al., 2016). Faecal egg counts (FEC) correlate well with initial infection rates up to 8 weeks after turnout for first-season grazing cattle. Later on, host immunity reduces this correlation, which makes it impossible to indicate the weight gains at the end of the grazing season (Shaw et al., 1997). Therefore, FEC are rather useful for understanding epidemiology and the likelihood that gastroenteritis will occur later in the same year, than gauging for current infection levels or the impact on production (Charlier et al., 2014b). For adult cows, FEC is regarded as a poor indicator of GIN infection levels (Charlier et al., 2009a). However, antibody levels of *O. ostertagi* in milk, measured by ELISA, are thought to be a good indicator of GIN infection within the herd (Charlier et al., 2010b; Guitián et al., 2000). Therefore a bulk-tank milk ELISA is a useful method for assessing GIN infection in an adult dairy herd. Although milk

production losses were connected to the infection with *O. ostertagi* (e.g. average milk production loss per cow per day is estimated at 0.9 – 1.2kg; (Charlier et al., 2009b)), the relationship is not fully established to indicate GIN production losses with ELISA test-result. Therefore, milk production is considered a poor treatment indicator for cows (Ravinet et al., 2014). Nevertheless, it provides some useful indications to inform farmers of losses due to GIN infection and monitor potential losses in the future (Charlier et al., 2014a). Such evidence-based approaches to parasite control can ensure the efficacy and sustainability of anthelmintic drugs in the future (Kaplan and Vidyashankar, 2012). It is therefore that the use of diagnostic tools remains an important strategy for cattle farmers to mitigate the risk of developing and disseminating AR.

Other alternative methods to control GIN infections that do not require the use of anthelmintic drugs include vaccination, genetic selection, biological methods and pasture management (Vercruysse and Dorny, 1999). Pasture management, since long advocated as alternative approach to interrupt the life cycle of the nematode and reduce exposure to infection, is the most feasible non-chemotherapeutic control measure at this moment (Bennema et al., 2010; Charlier et al., 2010a; Morgan and Wall, 2009; Van Dijk et al., 2010). However, grazing management strategies such as pasture resting, mowing, late turn-out, stock rotation, etc. demand much effort and are sometimes limited due to availability of grassland or other resources. Moreover, these practices require good epidemiological knowledge, which is not always available to the farmer. Therefore, an integrative approach of grazing management and implementation of anthelmintics by targeted decision-making is to date recommended as the most feasible and sustainable GIN control method (Charlier et al., 2017).

1.3.2. Limited uptake of new strategies

Due to increasing reports of AR, guidelines and extension programs were created to promote sustainable worm control such as Sustainable Control of Parasites in Sheep (SCOPS) for small ruminants and Control of Worms Sustainably (COWS) for cattle (Taylor, 2012), and Wormkill, WormBoss (Woodgate and Love, 2012) for small ruminants in Australia, to name a few. These initiatives are a collaboration between interested parties from across all sectors of the industry with a view to developing guidelines intended to develop and promote practical recommendations for producers and advisors (Abbott et al., 2012). The recommendations are based on a range of different approaches, and promote 'best practice' control for the preservation of current

and future anthelmintics. For cattle, recommendations are summarised into eight guidelines presented in Table 1.3.

Table 1.3.
COWS guidelines (more details see: www.cattleparasites.org.uk)

Guideline	Comment by Taylor (2012)
Work out a control strategy with your veterinarian or advisor.	Specialist consultation as part of herd health planning is an increasing requirement on farms. Worm control programmes for cattle will require on-going consultations.
Use effective quarantine strategies to prevent the importation of resistant worms in introduced cattle.	Bought in cattle can be a potential route of introducing resistance alleles into a non-closed herd
Test for anthelmintic efficacy on your farm	Whilst resistance is still rare in cattle nematodes, treatment failures do occur. It is important to monitor continued efficacy as under dosing can select for AR
Administer anthelmintic drugs effectively	Administer the right dose in the correct way by following manufacturer's instructions
Use anthelmintic drugs only when necessary	Understand the trade-off between tolerating some level of parasitism and minimising selection for AR. FEC monitoring has an important role
Select the appropriate anthelmintic for the task	Target treatment according to parasites (and their stages) present, based on time of year
Adopt strategies to preserve susceptible worms on the farm	Aim to reduce selection for AR when treating adult cattle, immune older animals or when dosing on low contamination pastures
Reduce dependence on anthelmintic drugs	Alternative control measures include grazing management using sheep or older immune animals

Table published in Taylor (2012) p.67

The implementation of sustainable practices such as TT and TST has been proven effective throughout empirical scientific studies and in commercial settings (Kenyon et al., 2017). Learmount et al., (2015, 2016) evaluated a three-year implementation of the SCOPS guidelines on commercial sheep farms in the UK. They found a significant reduction in anthelmintic treatments without loss of animal performance, confirming the effectiveness of such advices in the field (Learmount et al., 2016). Similar results for a study set up in Brazil, where the assessment of the FAMACHA© system (method for assessing ocular membrane colouration as an indicator of haemonchosis in small ruminants) resulted in a decrease of anthelmintic administration (Maia et al., 2014; 2015; van Wyk and Bath, 2002). Nevertheless, the uptake of these guidelines and of sustainable worm control programmes in general has been slow and is patchy (McArthur and Reinemeyer, 2014; McMahon et al., 2013; Moore et al., 2016; Morgan et al., 2012; Morgan and Coles, 2010; Woodgate and Love, 2012). Accordingly, the need for understanding farmer's behaviour in parasite control, and more specifically the uptake of these applicable advices, is growing. The understanding of farmers' intention to adopt such sustainable control practices is necessary to create effective communication strategies to promote sustainable worm control. A number of factors for adoption must

be considered if recommendations are to be developed and wide acceptance is to be achieved (Besier, 2012; Charlier et al., 2016; Jack et al., 2017).

1.4. FARMERS' ADOPTION OF SUSTAINABLE CONTROL

1.4.1. Factors influencing the adoption of sustainable worm practices

The adoption of sustainable strategies is affected by many personal factors, which can accordingly be divided into benefits (i.e. beliefs positively affecting behaviour) or barriers (i.e. beliefs negatively affecting behaviour). The first studies conducted in veterinary parasitology focused mainly on reporting current helminth control strategies on sheep farms and the technical barriers to the uptake of alternative and sustainable methods. This was a response to limited adoption of the new, sustainable control strategies. Morgan et al. (2012) presented a survey of 600 sheep farmers to characterise current practices, and to identify factors correlated with perceived anthelmintic failure. Although most farmers considered helminths to be a problem on their farms, only half of them were concerned about AR and even fewer believed this compromised their current nematode control (Morgan et al., 2012). Furthermore, anthelmintic use was influenced by past experience and perceived reliability of the drugs, along with convenience of use and price (Morgan et al., 2012). Besides, only a minority of the respondents were aware of the SCOPS programme (Morgan et al., 2012). Low awareness of both the risk of AR and concomitant information campaigns, and positive attitude towards their current use of anthelmintics were accordingly identified as barriers for the adoption of sustainable practices. However, later studies indicate a disconnection between the awareness of AR and on farm problems to nematode control (Moore et al., 2016). Treatment failure was not seen as a consequence of farmers' own behaviours. Consequently, they fail to see that AR is challenging their current control and urging for more sustainable approaches. Similar experiences were reported for other countries such as Australia and New Zealand, where AR prevailed much earlier and is now present on most sheep farms (Besier and Love, 2012; Woodgate and Love, 2012). Here, reports concluded on additional barriers, such as complexity and compatibility, time requirements, difficulty, and the ability to trial the proposed management practices (Kahn and Woodgate, 2012; Woodgate and Love, 2012). Also, the awareness of sustainable practices such as TST was associated with concerns on AR, previous experience with diagnostics and the consultation of professional advisers regarding worm control (Cornelius et al., 2015).

Although most literature focuses on small ruminants, some reports have been made for cattle and horses. These indicate a failure in learning the lessons from resistance development in small ruminants (Leathwick and Besier, 2014). Both the cattle and

equine industries remained until recently oblivious to the issue of AR, which could explain the reluctant position for changing current practices (McArthur and Reinemeyer, 2014). A study on UK horse owners did establish some concerns on AR, however only a small amount were willing to reduce the use of anthelmintics in their horses (Allison et al., 2011). McArthur and Reinemeyer (2014) allocate some responsibility to cattle practitioners in the US in particular, as they may not have the knowledge to implement evidence-based recommendations towards producers. Though, recent studies investigating UK anthelmintic prescribers indicated a good knowledge of basic helminthology and best practice guidelines for livestock veterinarians (Easton et al., 2016). Kenyon et al. (2017) on the other hand consider the advice given to livestock owners in particular more problematic. These advices can be contradictory, and tend to change depending on scientific knowledge.

These reports provide a description on the failed uptake of sustainable advices and strategies throughout the different livestock industries. However, the outcome is a tangle of different factors and explanations for farmers' GIN control approach. Indeed, many of these reports are based on opinions and personal experiences with livestock owners, or are simply based on 'yes-or-no' questions with immediate relation to farmers' current or future control. This limited behavioural research results in unsubstantiated hypotheses. Nevertheless, these insights provided important contributions for herding the scientific world towards a paradigm shift regarding farmers' decision making in GIN control. However, the need for more structured and scientific behavioural research was growing. Therefore, shift changed towards social veterinary epidemiology, a fairly young discipline with contributions from different fields, such as behavioural psychology and sociology (Wauters and Rojo Gimeno, 2014).

1.4.2. Lessons learned from social veterinary epidemiology

From a historical perspective, policy makers, researchers, and veterinarians assumed that farmers' decisions were solely based on rational, technical and economic considerations (Burton, 2004). Livestock farming is a business, thus external factors such as market price and customer demands, as well as costs and returns, influence the decision-making process (Ellis-Iversen et al., 2010; Valeeva et al., 2007). These rational choices play an important role, but are certainly not the only decisive factors. Correspondingly, livestock farming is intertwined with lifestyle and is often associated with family, hence much of the decisions can be explained through more personal traits of the farmer and his/her social environment (Derks et al., 2013; Garforth, 2015; Jansen et al., 2009). Personal traits often explain more variation in farm performance than

farmers' measurable management practices (Ritter et al., 2017; van den Borne et al., 2014). Therefore, the main goal of social veterinary epidemiology is identifying these traits in order to explain and predict farmer specific behaviours. These traits consist of socio-psychological factors (e.g. attitude, subjective norms, risk perception) derived from human behavioural and health psychology. Moreover, poor on-farm adoption of recommendations to decrease disease transmission or enhance biosecurity practices, and low participation in voluntary disease prevention, urged for a better understanding of farmers behaviour (Bell et al., 2006; Brennan and Christley, 2013; Hoe and Ruegg, 2006; Hop et al., 2011; Ritter et al., 2017).

The incorporation of socio-psychological theories and methodologies with traditional epidemiologic approaches has been proven useful for exploring cattle famers' intentions and behaviours. The two most commonly used theories are the *Theory of Planned Behaviour* (TPB, Figure 1.1., Ajzen, 1991), and the *Health Belief Model* (HBM, Figure 1.2., Rosenstock, 1974).
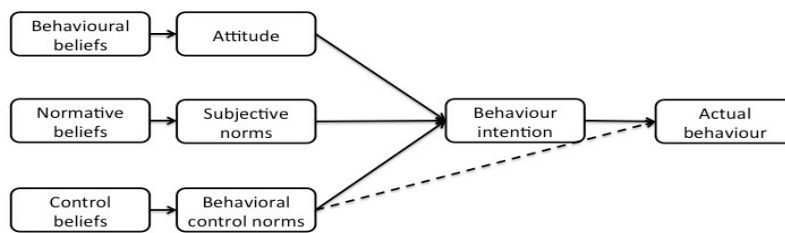
Figure 1.1.
The Theory of Planned Behaviour (Ajzen, 1991)

These theories suggest a bridge between socio-psychological factors, which are formed by a person's beliefs, and behaviour. Within the TPB, behaviour is determined by behavioural intention, which is subsequently determined by attitude (i.e. positive or negative evaluation of the particular behaviour based on the expected outcomes), subjective norms (i.e. perception of the expectation of significant others in performing that behaviour), and perceived behavioural control (perceived ability to perform a specific behaviour).
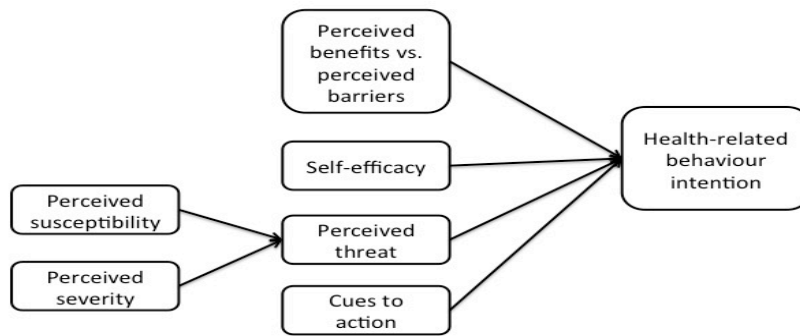
Figure 1.2.
The Health Belief Model (Rosenstock, 1974)

The HBM suggests that people's beliefs about health problems and related treatment programs describe the engagement in health-promoting behaviour (Janz and Becker, 1984). The mechanisms behind the HBM are similar to those of the TPB, with the addition of health-specific factors such as perceived susceptibility (i.e. perception of the vulnerability to danger or harm), perceived severity (i.e. perception of the impact of the risk and its harm), and cue-to-action (trigger for prompting engagement in health-promoting behaviours). The implementation of such models gives a more structured view and justified prediction of farmers' behaviours.

These, or similar, approaches have been used to examine a wide range of animal health-related behaviours, such as the control of mastitis (Jansen et al., 2010, 2009; van den Borne et al., 2014), Johnes' disease (Benjamin et al., 2010; Ritter et al., 2016, 2015), foot-and-mouth disease (Delgado et al., 2014, 2012), lameness (Leach et al., 2010a, 2010b); the implementation of on-farm biosecurity (Gunn et al., 2008; Heffernan et al., 2008; Laanen et al., 2014; Toma et al., 2013); vaccination strategies (Cresswell et al., 2014; Richens et al., 2015; Sok et al., 2016) and antimicrobial usage (Green et al., 2010; Jones et al., 2015; Swinkels et al., 2015). However, due to the specificity of behaviours and the context of the farmers, it is impossible to provide a 'one-size-fits-all' model and explanation. It is therefore necessary to study GIN control in particular, and more specifically the adoption of sustainable worm control.

Besides these socio-psychological determinants, there are often other factors influencing farmers' decisions that are not (or less) internally driven (Poizat et al., 2017). Therefore, farmers' behaviour should not be considered guided only by the ego, but also by other, extrinsic circumstances, which (s)he has less control over (Ellis-

Iversen et al., 2010; Feola and Binder, 2010). In Brofenbrenners' *Ecological systems theory* (Fig. 1.3.;Brofenbrenner, 1977) the individual is placed at the smallest level of a greater system. Five environmental levels interact with one and other, and eventually lead towards integrated decisions of the individual. Correspondingly, and for agricultural purposes in particular, the *Agricultural innovation systems* (AIS) thinking has become an increasingly applied method to analyse and comprehend technological, economic and institutional change (Klerkx et al., 2010; Spielman, 2006). Farmers' decisions are considered the result of a process of networking and interactive learning among different environmental levels and actors (e.g. other farmers, veterinarian, traders, government, animal health organisations; Hall et al., 2006; Leeuwis, 2004).
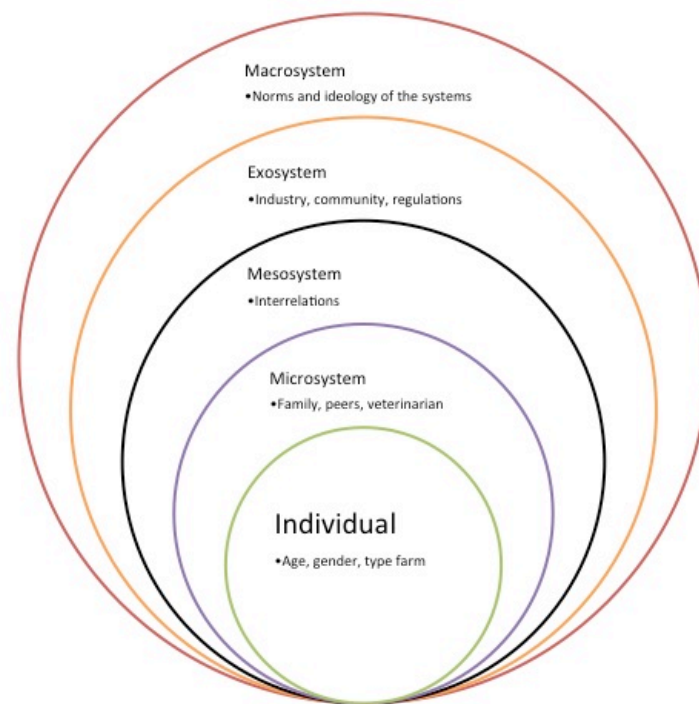
Figure 1.3.
The Ecological systems theory (Brofenbrenner, 1977)

Although these ecological and system theories are most useful for exploring and comprehending farmers' behaviour in a higher perspective, these are less applicable for creating communication messages to induce motivational change, and therefore not studied in this thesis.

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1.5.   COMMUNICATION AS A FIRST STEP TOWARDS VOLUNTARY BEHAVIOUR

The R.E.S.E.T. Mindset model (Fig 1.4.; Jansen et al., 2012; Lam et al., 2017) is a figure presenting the five possible routes for changing farmers' mindset and eventually improving udder health. It is originally based on a model by van Woerkum et al. (1999), representing behaviour change in general (Bos et al., 1999; Leeuwis, 2004). The framework summarises different models such as socio-psychological models (e.g. TPB, HBM) and dual processing models (Elaboration likelihood model; Petty and Cacioppo; 1986) in five different cues to action: Rules and regulations, Education and information, Social pressure, Economics, and Tools (Lam et al., 2017). These cues can be used individually, or simultaneously, to induce voluntary or compulsory behaviour of the farmers. According to Mills et al. (2017) the approach to encourage farmers' environmentally positive behaviour in the UK has been three-pronged, through voluntarism, incentives, and regulation. However, regulatory and financial incentives can be viewed as transient drivers, without long-term sustainability in behaviour change if they do not create cultural change (Mills et al., 2017). Therefore, this thesis will focus in changing the internal motivations of farmers, which eventually lead towards a change of voluntary behaviour (Jansen et al., 2012; Lam et al., 2017). Moreover, in case of anthelmintic usage, there are no expectations towards regulatory enforcements (in contrary to antimicrobial use). Accordingly, changing farmers' motivations and voluntary behaviour for sustainable GIN control appears to be a more feasible option to date.
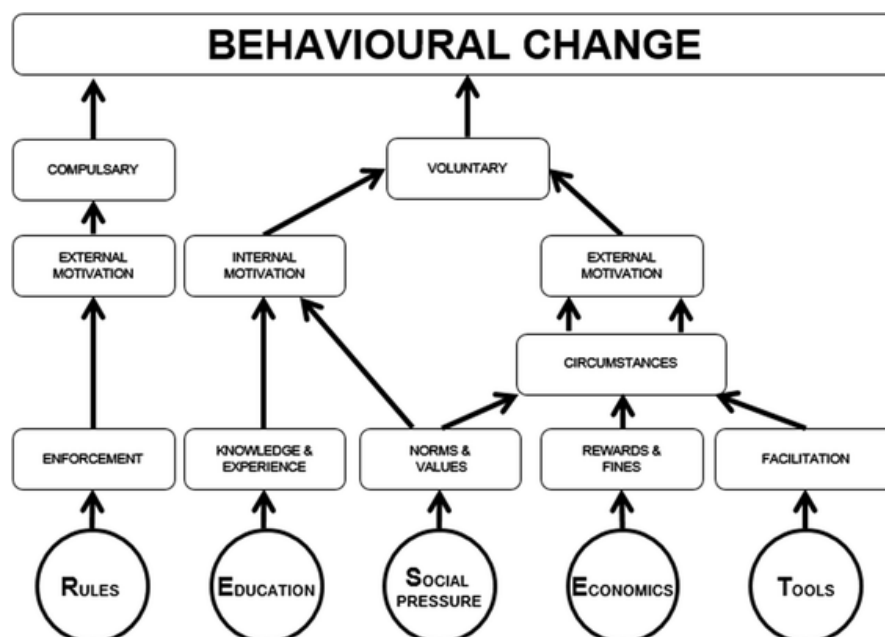
Figure 1.4.
The RESET mindset model published in Lam et al., 2017 p.3)

The end-goal of most of the above-mentioned literature in social veterinary epidemiology is to exploit knowledge on farmer's current (and future) behaviour in targeted communication campaigns and seed for a motivational change in behaviour. However, the usability for translating results from sociology-type studies into communication strategies is barely explored for GIN control in specific, and for animal health in general. Some of the previous work makes grounded suggestions for communication strategies, but their effectiveness remains unconfirmed. Woodgate and Love (2012) propose to enhance the visibility of the problem and concomitant positive outcome when implementing best practice management on sheep farms in Australia (Wormboss). Moreover, evidence of potential economic loss should provide a powerful message regarding the need for effective control programmes (Besier and Love, 2012). McArthur and Reinemeyer (2014) suggest that farmers will only be willing to abandon their historical practices if they can be convinced through economic analyses and scientific evidence. The extension campaigns should also focus on the relative advantage, complexity and compatibility of the sustainable methods, and the ability to trial the proposed change (Woodgate and Love, 2012). This can be provided through targeted education and practical demonstrations (McArthur and Reinemeyer, 2014).

Again, many of the above communication strategies are solely based on thoughts and proposals of the reviewers. Although these are well thought out, they remain limited for evidence-based effectiveness. Not only is the content of these advices sometimes contradictory, also the recommended approach to deliver this message has become confusing. This shifts the question from 'what to communicate to farmers?' to 'how to communicate to farmers?' and urges for applied social and communication research within the field.

1.6. CONCLUSION

There is a substantial gap in literature on cattle farmers' behaviour, and livestock owners in general, when it comes to GIN control. Although the risk of AR is well established in small ruminants and horses, and emerging for cattle, the uptake of advices for sustainable control is fairly low and little actions have been taken from the scientific world to truly understand these mechanisms. Research was primarily focused on finding best management practices to overcome this emerging risk. While further evidence is required on the impact of best management practices on various sustainability criteria, it is time to promote and translate current insights into applicable advices. Up until now, much of the literature dedicated to understand this limited

uptake, was based on descriptive assessments and not grounded in sociologic research methods. Social veterinary epidemiology has its origins in human behavioural and health psychology, and is proven useful for exploring disease control on farm. Therefore, this PhD-project will implement such methods and theories previously described for assessing farmers' behaviour. Afterwards, this newly gained knowledge will be used to create communication messages to raise awareness of sustainable control. Similar to the behavioural literature, not much scientific research has been devoted to communication and advices on GIN control. The second aim of the project will be the exploration of effective and evidence-based messages for the adoption of sustainable GIN on dairy farms.

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Objectives

Gastrointestinal nematode (GIN) infections are a common constraint in pasture-based dairy herds and cause a decrease in animal health, productivity and farm profitability. Current control practices to prevent production losses of GIN infections in livestock depend largely on the use of anthelmintic drugs. However, due to the intensive use of these drugs, the industry is increasingly confronted with nematode populations resistant to commonly used anthelmintics. This emerging anthelmintic resistance (AR) in cattle nematodes emphasises the need for sustainable control approaches. The uptake of diagnostic methods for sustainable control could enable more informed treatments and reduce excessive anthelmintic use. However, farmers have been slow in adopting these guidelines for sustainable control. Accordingly, in order to successfully implement such control strategies, and change the behaviour of farmers, their current perceptions and behaviours need to be well comprehended and translated into effective communication strategies.

A lack of knowledge on farmers' behaviour for sustainable GIN control (Chapter 1), led to two research questions for this PhD project. These were addressed using a mixed-method approach as followed:

> **RQ1: What drives the farmer towards adoption of sustainable GIN control?**
>
> To understand dairy farmers' adoption of sustainable GIN control, and the adoption of diagnostic methods in particular, a behavioural framework was created with identified factors from quantitative (Chapter 2) and qualitative research (Chapter 3).
>
> **RQ2: How can farmers be encouraged to change their current GIN control?**
>
> The most important findings of this framework were implemented in effective messages with a focus on creating awareness of AR (Chapter 4), and a call to

action for sustainable control (Chapter 5), and subsequently tested with communication experiments.

Sustainable GIN control?
Chapter 1

RQ1: Farmers' behaviour?

Quantitative research
Chapter 2

Qualitative research
Chapter 3

RQ2: Communication strategies?

Create awareness risk
Chapter 4

Promote sustainable control
Chapter 5
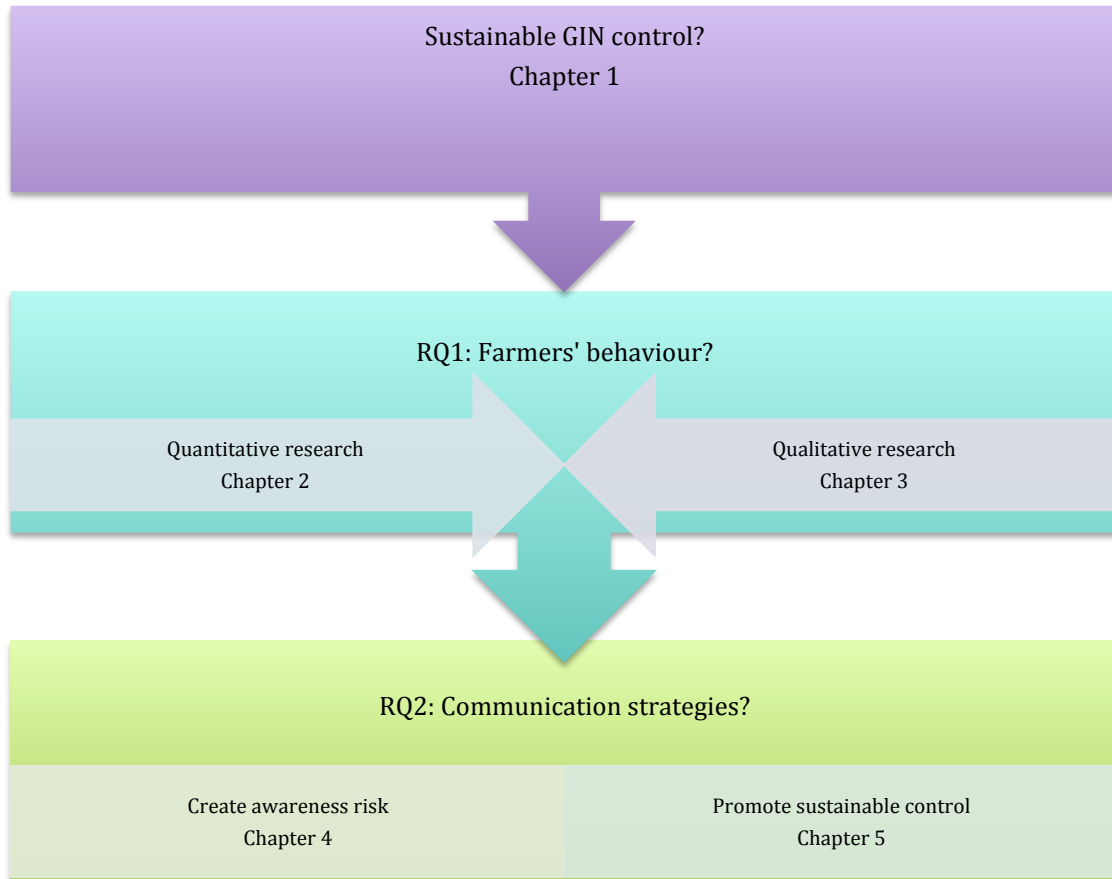
CHAPTER 2

DIAGNOSIS BEFORE TREATMENT - INDENTIFYING DAIRY FARMERS'
DETERMINANTS FOR THE ADOPTION OF SUSTAINABLE PRACTICES IN
GASTROINTESTINAL NEMATODE CONTROL

Abstract

Anthelmintic resistance is emerging in dairy cattle and this can result in a lack of effective control and production losses. Therefore, sustainable control strategies, such as targeted treatments (TT) and targeted selected treatments (TST), should be adopted by the industry. TT and TST approaches require the use of diagnostic methods to take informed treatment decisions. To understand the factors affecting the farmers' intention to adopt diagnostic methods before implementing anthelmintic drugs ('adoption intention'), a cross-sectional survey was carried out in dairy farms in Belgium (Flanders). A framework was constructed to predict adoption intentions based on two fundamental theories in the field of behavioural psychology and health psychology: the Theory of Planned Behaviour and the Health Belief Model. In the tested model, adoption intentions were predicted based on attitudes towards anthelminthics, attitudes towards diagnostic methods, subjective norms, behavioural control and perceived risk. Structural equation modelling was used for analyses. The model fitted the data well and explained 46% of the variance in adoption intention of diagnostics. The factors 'attitude towards diagnostic methods' and 'subjective norm'; i.e. the influence of significant others, had the strongest, positive influence on adoption intention of diagnostic methods. 'Perceived behavioural control' had a weak, positive effect on intention. Further, 'attitude towards the use of anthelmintic drugs' had a negative effect on adoption intention of the diagnostic methods. This implicates an effect of current behaviour on future adoption, which should be considered in future research. Factors measuring risk perception of anthelmintic resistance; perceived severity and perceived susceptibility, had no effect on the adoption intention of diagnostic methods. The threat of anthelmintic resistance is perceived to be low for dairy herds. The study further did not find any differences in the effects of the predictors for young stock and adult dairy cows. The results of this study can be used to develop communication strategies to advertise sustainable nematode control on dairy farms.

2.1. INTRODUCTION

Gastrointestinal nematode (GIN) infections are a major threat for animal health, productivity, and profitability of pasture-based dairy herds (Charlier et al., 2012; Perri et al., 2011). Highly efficacious and relatively inexpensive drugs were developed to prevent GIN infections and concomitant production losses (Woods & Knauer, 2010). Hence, worm control in livestock now largely depends on the use of anthelmintic drugs (Kaplan, 2004). Unfortunately, the intensive use of anthelmintics in cattle has led to the development of anthelmintic resistance (Edmonds et al., 2010; Gasbarre, 2014; Jackson et al., 2006; Mejía et al., 2003; Sutherland & Leathwick, 2011; Torres-Acosta et al., 2012; Waghorn et al., 2006). The emerging resistance in cattle emphasises the need for sustainable control approaches with less intensive use of anthelmintics (Charlier et al., 2014a).

Examples of sustainable worm control practices are the targeted treatments (TT) strategy, i.e. group treatment based on a marker of infection, and targeted selective treatments (TST), i.e. treatment of identified individual animals (Kenyon and Jackson, 2012). Sustainable worm control practices require the use of diagnostic methods to enable informed treatment decisions (Charlier et al., 2014b). However, adoption of diagnostic methods for sustainable parasite control by the farmers is hampered by the lack of tangible effects of anthelmintic resistance on animal health and production on the one hand and the low price of anthelmintics on the other hand (Kahn and Woodgate, 2012; Knox et al., 2012). In order to successfully translate recommendations in such a way that adoption of diagnostics will be facilitated, socio-psychological research is essential. Attempts were made in the past for the translation of new approaches in applicable control programs, e.g. Wormkill and WormBoss, reviewed by Woodgate & Love (2012), and SCOPS and COWS, reviewed by Taylor (2012). However, recent research showed a limited uptake of the presented advice (McArthur, 2014). This emphasises the need to understand the factors affecting the farmers' behaviour, in order to optimise communication and to improve compliance with specialists' advice. However, to our knowledge, little research has been conducted yet on the understanding of farmers' decision making in GIN control and adoption of diagnostic methods.

In this study two grounded theories from behavioural and health psychology were used to build a theoretical framework identifying farmers' adoption of diagnostic methods for GIN control on their farms: the Theory of Planned Behaviour (Ajzen, 1991) and the Health Belief Model (Rosenstock, 1974). The former is a model to predict and explain behavioural intention as an immediate determinant of actual behaviour, while the latter

was specifically developed for the understanding of health-related behaviour. From a historical perspective, researchers and veterinarians assumed that farmers' management decisions were based primarily on rational, technical and economic considerations (Burton, 2004). Although these rational choices play an important role, farmers' decision making is a complex process which involves many factors like social environment, attitude, risk perception, etc. (Derks et al., 2013). Cattle-farming is an industry intertwined with lifestyle and often associated with family, therefore decisions cannot always be explained by external, economic factors alone (Ellis-Iversen et al., 2010). The incorporation of socio-psychological theories and methodologies with traditional epidemiologic approaches has already proven to be a useful tool for the exploration of cattle farmers' behaviour or decision-making in animal disease interventions. Most studies focused on identifying important motivations or beliefs to comply with a certain behaviour using a qualitative approach such as in-depth interviews (e.g., Delgado et al., 2012; Ellis-Iversen et al., 2010), others used quantitative methods like cross-sectional surveys (e.g., Jansen et al., 2009; Laanen et al., 2014; Leach et al., 2010). Few studies focussed on assessing the effect of specific factors on behaviour using quantitative modelling methods (e.g., Garforth et al., 2006; Toma et al., 2013). This study is one of the first in using modelling techniques to measure a theoretical framework built from socio-psychological models.

The objective of this study is to: (1) provide a better understanding of the underlying factors that influence dairy farmers' adoption intention of parasitic diagnostic methods before implementing anthelmintic drugs, and (2) validate a theoretical framework that provides insight in the interactions of these underlying factors.

2.2. MATERIALS & METHOD

2.2.1. Theoretical framework

Numerous socio-psychological theories have been designed to understand and predict human behaviour. For the purpose of this study, the Theory of Planned Behaviour (TPB) (Ajzen, 1991) was chosen to serve as the foundation for the development of a theoretical framework for understanding dairy farmers' adoption of diagnostic methods in GIN control. The TPB is one of the most widely used theories in research of human behaviour. Among many different types of behaviour it has proven useful in modelling a wide range of public health behaviours (Zemore and Ajzen, 2014) and was also recently used to examine animal health related behaviours (Delgado et al., 2012; Ellis-Iversen et al., 2010). Despite its wide-spread use, the TPB could be improved through the incorporation of additional variables (Armitage and Conner, 2001). Therefore, we added

certain factors of the Health Belief Model (HBM) (Rosenstock, 1974) as additional predictors of intention to behave, since the HBM is specifically developed for the explanation and prediction of health-related behaviour. The HBM has proven to be useful in explaining motivations and barriers for mastitis management (Jansen & Lam, 2012). We propose the same for GIN control; hence the incorporation of certain factors of the HBM in the TPB.

The TPB, shown in Figure 2.1. is a general model of human behaviour suggesting a bridge between beliefs and behaviour. Behaviour is determined by 'behavioural intention', which is determined by 'attitude towards the behaviour', 'subjective norm' and 'perceived behavioural control' of a person. 'Behavioural intention' is regarded as the proximal determinant of behaviour and captures the motivation to perform this behaviour (Ajzen, 1991). 'Attitude towards the behaviour' is an individual's positive or negative evaluation of the particular behaviour based on the expected outcomes. Within the context of this study it represents the positive or negative evaluation of using diagnostic methods before implementing anthelmintic drugs. 'Subjective norm' refers to a person's perception of the expectation of significant others in performing that behaviour, the perceived social pressure founded in normative expectations of important referents such as family or friends. 'Perceived behavioural control' represents one's perceived ability to perform a specific behaviour, i.e. the farmer's perception of his/her ability to implement a diagnostic test on the farm, and is based on beliefs whether factors are present that may facilitate or impede its performance (e.g. cost, expertise).
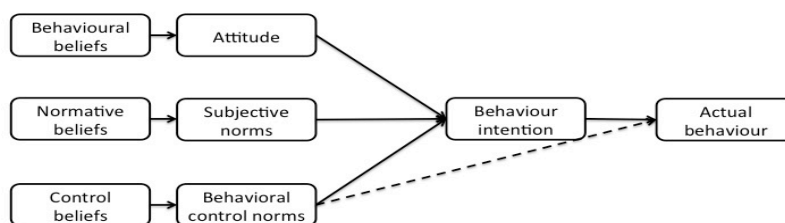
Figure 2.1.
The Theory of Planned Behaviour (Ajzen, 1991)

The HBM, shown in Figure 2.2. was specifically developed for the prediction of behavioural change in health-related topics. The HBM suggests that people's beliefs

about health problems and related treatment programs explain the engagement in health-promoting behaviour (Janz and Becker, 1984). The mechanisms behind the HBM are similar to the behavioural determinants of the TPB such as 'attitude' and 'perceived behavioural control'. In the TPB, 'attitude towards the behaviour' measures the beliefs about the expected outcomes, which are measured by the items 'perceived benefits and barriers' in the HBM. In addition to 'attitude towards the adoption of diagnostic methods', we added 'attitude towards the use of anthelmintic drugs' to our model as a perceived barrier. Farmers appear to have a positive attitude towards these highly effective and relatively inexpensive drugs (Kaplan, 2004), hence a barrier for the adoption of diagnostic methods before implementing anthelmintic drugs. Similar barriers were suggested by Jansen & Lam (2012) in mastitis management. The variable 'self-efficacy' was incorporated at a later stage in the HBM (Rosenstock et al., 1988) and is similar to 'perceived behavioural control' of the TPB. It is a person's self-confidence to perform a particular behaviour. The 'cues-to-action' factor was not included in our framework because of the absence of such cues in a chronic disease like GIN infections (Benjamin et al., 2010). To conclude, 'perceived susceptibility' and 'perceived severity', also grounded in the HBM, were added to the framework. The first refers to the farmer's perception of his vulnerability to danger or harm, the latter refers to the farmer's beliefs about the impact of the risk and its harm (Sheeran et al., 2014; Witte, 1992). In this case anthelmintic resistance is a potential severe risk that may have an effect on the farmer's intention to adopt preventive, healthy behaviour according to the HBM.
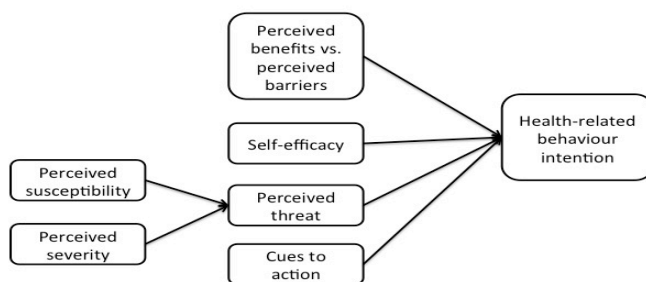
Figure 2.2.
The Health Belief Model (Rosenstock, 1974)

The resulting theoretical framework (Figure 2.3.) consists of six independent factors, each of them in direct relation to behavioural intention, more specifically the intention of dairy farmers to adopt diagnostic methods before implementing anthelmintic drugs on their farms. The TPB measures the adoption intention through the factors 'attitude

towards diagnostics', 'subjective norm' and 'perceived behavioural control', the HBM uses 'attitude towards anthelmintics', 'perceived susceptibility' and 'perceived severity' in the final framework.
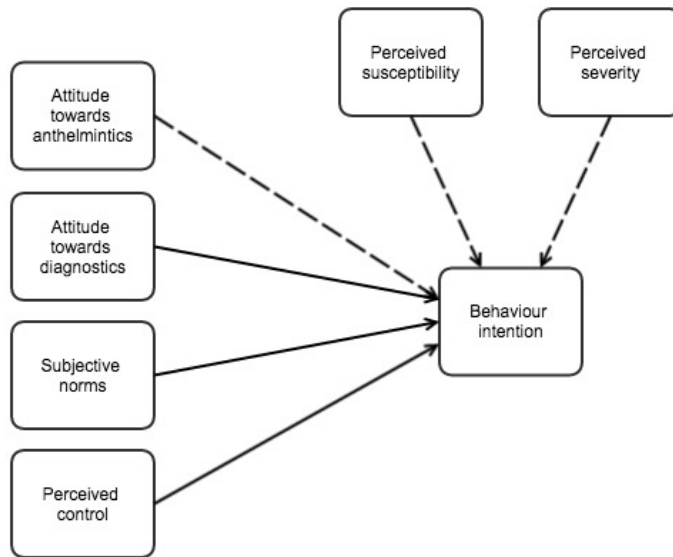
Figure 2.3.
The hypothetical theoretical framework of dairy farmers' adoption intention for diagnostic methods.
Notes, full lines present relations of TPB, dotted lines present relations of HBM

2.2.2. Survey design

The questionnaire was used to measure each factor presented in the framework. Those factors were built up by constructs and each construct exists of a specific set of items: e.g. 'Attitude towards diagnostics' is built out of three items or three bipolar 7-point questions: Good – Bad (item1), Useful – Useless (item2), and Beneficial – Harmful (item3). The questions are called item statements and are labelled into items for the ease of use in the statistical analysis. The items and corresponding constructs of the factors used for the establishment of the model are presented in Table 2.1. Each question presented here was included in the questionnaire and the responses extrapolated to measure the magnitude and the effect of each factor. The items were measured on 7-point bipolar scale as presented above, or on a 7-point Likert response format in which the respondents are asked to fill in their opinion on a scale ranging from strongly disagree till strongly agree. Only known and validated constructs were used to measure each factor in the model. For the development of TPB-based questions we used 'The TPB Questionnaire Construction' guide (Ajzen, 2002) and the TPB-manual established by Francis et al. (2004) developed for the examination of health-related behaviours. The most important part is to clearly define the researched behaviour, in this case: dairy farmers' adoption of diagnostic methods before implementing anthelmintic drugs on their farms. The considered diagnostic methods were focussed

only on GIN control and were specified in the questionnaire: anamnesis, faecal egg counts, serum pepsinogen level and bulk-tank milk ELISA.

Table 2.1.
The original constructs used for the measurement of the latent variables in the theoretical framework fort the adoption of diagnostic methods

Construct label	Construct source	Item label	Item statement	Item measurement
Attitude diagnostics	Francis et al., 2004 Ajzen, 2002	attitude_diagnostics1	Diagnosis before treatment with anthelmintic drugs is:	**Good - Bad** Bipolar 7-point scale
		attitude_diagnostics2	Diagnosis before treatment with anthelmintic drugs is:	**Useful – Worthless** Bipolar 7-point scale
		attitude_diagnostics3	Diagnosis before treatment with anthelmintic drugs is:	**Beneficial – Harmful** Bipolar 7-point scale
Subjective norm	Francis et al., 2004 Ajzen, 2002	subjectivenorm1	People who are important to me think that I should diagnose before using anthelmintics on my farm	7-point Likert response format*
		subjectivenorm2	It is expected of me that I diagnose before treatment	7-point Likert response format
		subjectivenorm3	I feel social pressure to diagnose before using anthelmintics on my farm	7-point Likert response format
Perceived behavioural control	Francis et al., 2004 Ajzen, 2002	controlbehavior1	The decision of performing a diagnosis on my farm is under my control	7-point Likert response format
		controlbehavior2	I can easily command for a diagnosis on my farm	7-point Likert response format
		controlbehavior3	I can have a diagnosis whenever I want	7-point Likert response format
Attitude anthelmintics	Francis et al., 2004 Ajzen, 2002	attitude_anthelmintic1	Preventive use of anthelmintic drugs is:	**Good - Bad** Bipolar 7-point scale
		attitude_anthelmintic2	Preventive use of anthelmintic drugs is:	**Useful – Worthless** Bipolar 7-point scale
		attitude_anthelmintic3	Preventive use of anthelmintic drugs is:	**Beneficial – Harmful** Bipolar 7-point scale
Perceived susceptibility	Witte, 1992	susceptibility1	It is likely that nematodes on my farm will develop anthelmintic resistance	7-point Likert response format
		susceptibility2	The nematodes on my farm are at risk to develop anthelmintic resistance	7-point Likert response format
		susceptibility3	It is probable that the nematodes on my farm will develop anthelmintic resistance	7-point Likert response format
Perceived severity	Witte, 1992	severity1	Anthelmintic resistance is a severe threat for animal health	7-point Likert response format
		severity2	Anthelmintic resistance is a serious threat for animal health	7-point Likert response format
		severity3	Anthelmintic resistance is a significant threat for animal health	7-point Likert response format
Behaviour intention	Francis et al., 2004 Ajzen, 2002	intention1	I expect to diagnose before using anthelmintic drugs in the future	7-point Likert response format
		intention2	I want to diagnose before using anthelmintic drugs on my farm	7-point Likert response format
		intention3	I intend to diagnose before using anthelmintic drugs in the future	7-point Likert response format

* 1 = strongly disagree; 2 = disagree; 3 = slightly disagree; 4 = neutral; 5 = slightly agree; 6 = agree; 7 = strongly agree

The HBM factors that were added to the framework; 'perceived susceptibility' and 'perceived severity', were constructed using well established theoretical constructs from fear-appeal literature (Witte, 1992). For 'attitude towards the use of anthelmintics', which we consider to be grounded in the HBM, we used the same measurement construct as for 'attitude towards adoption of diagnostic methods' from the TPB questionnaire guide.

The questionnaire differentiated between two types of herds: young stock and adult dairy cows. This was stated in the introduction of the questionnaire. An equal number of participants were asked to fill in the questions regarding their young stock or regarding their adult dairy cows. Therefore, the questions remained similar, but the introduction pointed each participant to a specific group. This segregation was made considering the difference in GIN control for both age groups. Young stock are generally treated more intensively to prevent clinical disease, while dairy cows are treated less frequently, mainly to prevent production losses. Diagnostic methods differ in both groups as well. While faecal egg counts and serum pepsinogen levels are used to diagnose GIN infections in young stock, for dairy cows bulk-tank milk ELISAs are preferably used (Charlier et al., 2014b). This difference in treatment and diagnosis makes us assume a different adoption process for both groups. Therefore we consider the questionnaire-topic (young stock vs. adult dairy cows) to be a control variable for the model.

The questionnaire also asked for information on the farm: herd size (number of lactating animals), location (province in Flanders), type of produce (only milk or other farm activities), pasture management (hours of grazing per day), history with worm infections (degree of infection in the past) and use of diagnostics in the past (anamnesis, faecal egg counts, serum pepsinogen level, bulk-tank milk ELISA). The questionnaire included some items on the producer as well: age, gender, member of farmer organisation, level of sustainable attitude (construct for the measurement of one's sustainable principles) and information seeker (which channels are most important, actively seeking for information on the topic).

A pilot questionnaire was tested on four farms, following the guidelines from Francis et al. (2004) and questions were adapted to increase the comprehension. The final version was implemented in an online system (www.qualtrics.com, 2014, Qualtrics LLC).

2.2.3. Data collection

The target population for this research involves all dairy farmers in Flanders, Belgium, with a minimum of 30 adult dairy cows (>24 months) in 2014. The population contained a total of 4032 dairy operations. The farms were selected from Sanitel, the official

Belgian database for identification and registration of animals. Two thousand participants were randomly selected out of the total population of 4032 dairy farms through an arbitrary number generator in Microsoft Excel (2014 Microsoft corporation). Participants were addressed per e-mail (if e-mail address available) or by post. The electronic mailing list contained 1025 farmers. Thirty-six addresses were inadmissible and therefore deleted from the list. Eventually 975 farmers received a questionnaire per post and 989 farmers an invitation per e-mail. As such, a total of 1964 farmers were asked to participate in this study. Farmers included in the mailing list received an invitation mail containing a link to one of the questionnaires and afterwards two reminders, respectively after 14 days and 42 days. The group of farmers addressed by post received an invitation letter and a paper version of the survey by post, but no reminders. To increase the response rate, an incentive (lottery of one I-Pad and 10 duo film-tickets) was provided for both groups.

2.2.4. Statistical analysis

Responses were coded in a database using the Statistical Package for the Social Sciences (SPSS, IBM SPSS Statistics version 22.0). Firstly, we assessed the respondents' demographics using descriptive statistics. The representativeness of the sample for the total dairy farmers population was evaluated with a chi-square goodness-of-fit test using the number of farms located in the five different provinces in Flanders (statistics were provided by Veepeiler Rund, Animal Healthcare Flanders). This demographic variable was chosen upon the presumed differences in farms and farmers for the five provinces. We can conclude for a good representation of the population once equality is established for differences between regions in the sample and the population.

Reliability analyses were performed on the constructs and an exploratory factor analysis on the exogenous factors to gauge consistency of constructs with theoretical concepts. Internal consistency or reliability of the constructs was measured through Chronbach's alpha (good: α >0.70, acceptable: α >0.60). If α <0.60, the theoretical construct was re-evaluated and adjusted. Afterwards an exploratory factor analysis was used to confirm the constructs of the exogenous factors and to scout for possible correlations between different items. The correlation value of an item should remain under the margin of $r = 0.3$ with any other measured item and exceed the margin of $r = 0.7$ for its own factor (Wijnen et al., 2002).

Structural equation modelling (SEM) was performed using the lavaan package (Rosseel, 2012) in the statistical software R (lavaan version 0.5-16, R version 3.1.1, The R Foundation for Statistical Computing, 2014). SEM was used to validate and measure the

theoretical framework. The maximum likelihood estimation was used to assess for missing values. The model was evaluated and model fit acquired using following indices: χ^2-test statistic (p >0.05), the Comparative Fit Index (CFI) and the Tucker Lewis Index (TLI) (CFI/TLI >0.90), the Root Mean Square of Approximation (RMSEA) (<0.08) and the Standard Root Mean Square Residual (SRMR) (<0.10) (Hu and Bentler, 1999). If the χ^2-test statistic was significant (p <0.05) due to large sample size, the χ^2-value was divided by the degrees of freedom and the result should be <2.00 ($\chi^2/df = \chi^2(1)$ <2.00) (Wijnen et al., 2002). Once the model presented a good fit, two multi-group analyses were performed using two control variables: the 'questionnaire format' (paper vs. online) and the 'type of herd' (young stock vs. dairy cows). The first multi-group analysis was conducted to assess equality in the scores for both groups (paper vs. online), therefore allowing the interpretation of the data file as a whole. The second multi-group analysis measures the difference in adoption intention for young stock and dairy cows. To do so, measurement invariance was tested as described by Beaujean (2014) and Varni et al., (2013). For the comparison of measurement invariance we used Chen's cut-off points (2007) for the Comparative Fit Index (CFI) and Mc Donald's Non-Centrality Index (NCI). To test change in fit between nested models, we used the suggested threshold of 0.005 for Δ CFI and 0.010 for Δ NCI (Chen, 2007).

Table 2.2.

Characteristics of the dairy farmers questioned for adoption of diagnostic methods.

Attribute	Levels	% Sample
Producer type	Dairy	49.7
	Dairy/ Beef	30.6
	Dairy / Other	19.6
Province located	West Flanders	38.2
	East Flanders	29.8
	Antwerp	18.9
	Limburg	10.0
	Flemish Brabant	3.2
Gender	Male	81.1
	Female	18.9
Age	<20	0.2
	21-30	6.9
	31-40	17.6
	41-50	38.2
	51-60	31.7
	>61	5.5
Member of a cattle/ farmer society	Yes	86.5
	No	13.5
Years in industry	Mean	27

Notes, 2014 - N= 574

2.3.   RESULTS

2.3.1.   *Description of the population*

Out of the 1964 addressed farmers, 574 completed the survey (29% response rate) in total, 227 out of 989 finished the survey on-line (23%) and 346 returned fully

completed questionnaires by post (35%). Table 2.2. shows descriptive results concerning the farms and farmers in more detail. The chi-square goodness-of-fit test for representativeness of the sample was performed upon the location of the farms. The results showed no significant difference between the study sample and total population for spread in province (p = 0.102), suggesting that the study sample is as equally distributed as the study population (dairy farmers in Flanders)

2.3.2. Description of the factors

The framework consists of one endogenous latent factor (behaviour intention) and six exogenous latent factors. To gauge the reliability of the theoretical constructs Chronbach's alpha was measured for each factor. The results of the reliability analysis are presented in Table 2.3. All but two factors presented good reliability measurements for the used theoretical scales. The factor 'subjective norm' was originally measured by three 7-point Likert scales (α = 0.78) (Appendix A), but the reliability of the construct increased if the item ''I feel social pressure to diagnose before using anthelmintic drugs on my farm" (subjectivenorm3) was deleted (α = 0.85). Three items measured 'perceived behavioural control' (α = 0.63). The value of this construct did not increase by deleting one item, therefore we used this slightly weaker construct for the measurement of perceived behavioural control.

Table 2.3.
Reliability analysis of the constructs measuring the latent factors

Factor	α	Item	α if item deleted
Attitude diagnostics	0.908	attitude_diagnostics1	0.885
		attitude_diagnostics2	0.820
		attitude_diagnostics3	0.897
Subjective norm	0.782	subjectivenorm1	0.645
		subjectivenorm2	0.599
		subjectivenorm3	0.847
Perceived behaviour control	0.625	controlbehavior1	0.539
		controlbehavior2	0.509
		controlbehavior3	0.532
Attitude anthelmintics	0.940	attitude_anthelmintic1	0.915
		attitude_anthelmintic2	0.828
		attitude_anthelmintic3	0.933
Perceived susceptibility	0.863	susceptibility1	0.866
		susceptibility2	0.771
		susceptibility3	0.788
Perceived severity	0.889	severity1	0.867
		severity2	0.833
		severity3	0.826
Behaviour intention	0.927	intention1	0.916
		intention2	0.886
		intention3	0.882

Notes, α stands for Chronbachs' alpha, measurement of construct reliability.

The exploratory factor analysis confirmed the validity of the constructs and no item interacted heavily with other factors, as all margins were respected. The rotated component matrix is presented in Table 2.4.

Table 2.4.
Rotated component matrix of the items used for the framework

Variable	Component					
	1	2	3	4	5	6
attitude_anthelmintic2	**0.947**	-0.012	0.011	0.153	-0.048	-0.042
attitude_anthelmintic1	**0.940**	-0.027	-0.010	0.075	-0.047	0.001
attitude_anthelmintic3	**0.921**	-0.039	-0.009	0.098	-0.062	-0.035
attitude_diagnostics2	-0.038	**0.939**	0.069	-0.028	0.124	0.074
attitude_diagnostics1	-0.056	**0.902**	0.094	-0.032	0.140	0.026
attitude_diagnostics3	0.014	**0.898**	0.028	0.003	0.138	0.098
severity3	-0.035	0.071	**0.913**	0.109	0.035	0.036
severity2	-0.016	0.014	**0.900**	0.113	0.000	0.084
severity1	0.043	0.102	**0.862**	0.146	0.029	0.100
susceptibility3	0.117	-0.015	0.119	**0.895**	0.005	-0.083
susceptibility2	0.140	-0.016	0.117	**0.889**	0.072	-0.121
susceptibility1	0.067	-0.024	0.134	**0.849**	-0.063	0.073
subjectivenorm2	-0.085	0.175	0.013	0.033	**0.906**	0.107
subjectivenorm1	-0.064	0.204	0.044	-0.025	**0.899**	0.125
controlbehavior2	0.071	0.078	0.139	-0.034	0.162	**0.742**
controlbehavior3	-0.112	0.072	0.057	-0.009	0.001	**0.738**
controlbehavior1	-0.012	0.019	0.005	-0.057	0.061	**0.737**

The correlations (loadings) between items measuring the independent variables of the theoretical framework for the adoption of diagnostic methods.

After confirmation of the latent factors' internal validity and reliability, a general idea of the factor scores was attained. Table 2.5. presents the items' intercepts on a 7-point Lickert scale. The intercepts ranging from 1 till 4 can be perceived as negative, and those ranging from 4 till 7 as positive. Results show a positive attitude for anthelmintic use and the use of diagnostic methods, overall a positive attitude for nematode control. Items measuring 'Perceived behavioural control' are presented fairly positive and the two items for 'subjective norm' are considered neutral. The severity of the risk is perceived slightly positive, while the perceived susceptibility is slightly negative. The intention to adopt diagnostic methods is considered fairly neutral.

Table 2.5.
Intercepts of the items used for the measurement of the constructs presented in the framework

Item	Intercept	Std. err	Fact. load.
attitude_diagnostics1	5.96	0.068	0.872
attitude_diagnostics2	6.11	0.060	0.957
attitude_diagnostics3	5.99	0.064	0.849
subjectivenorm1	4.25	0.060	0.856
subjectivenorm2	4.11	0.063	0.876
controlbehavior1	5.26	0.055	0.515
controlbehavior2	5.22	0.050	0.725
controlbehavior3	4.92	0.055	0.526
attitude_anthelmintic1	5.75	0.078	0.904
attitude_anthelmintic2	5.75	0.082	0.970
attitude_anthelmintic3	5.65	0.076	0.874
susceptibility1	3.44	0.062	0.737
susceptibility2	3.16	0.058	0.896
susceptibility3	3.10	0.057	0.885
severity1	4.69	0.062	0.808
severity2	4.78	0.064	0.860
severity3	4.55	0.067	0.897
intention1	4.60	0.060	0.860
intention2	4.61	0.061	0.934
intention3	4.58	0.062	0.914

Notes, Measurements were performed on a 7-point Lickert scale.
Factor loadings represent standardised values.

2.3.3. Model validation of the theoretical framework using SEM

The model was found to fit the observed data: $p < 0.001$ (due to big samples $p < 0.05$), $\chi^2(1) = 1.52$, CFI/TLI = 0.98, RMSEA = 0.033, SRMR = 0.028. The model explained 0.46 of the variance in adoption intention of diagnostic methods.

The results of the model are presented in Figure 2.4. 'Attitude towards the use of diagnostic methods' was significantly associated with 'behaviour intention' ($\beta = 0.34$, $z = 6.84$, $p < 0.001$), as was the variable 'subjective norm' ($\beta = 0.41$, $z = 6.71$, $p < 0.001$). Both variables have the strongest effect on 'behavioural intention'. 'Perceived behavioural control' had a positive, significant effect on 'behavioural intention' as well ($\beta = 0.18$, $z = 2.91$ $p < 0.01$), but to a lesser extent. 'Attitude towards the use of anthelmintics' correlated negatively with 'behavioural intention' ($\beta = -0.11$, $z = -2.68$ $p < 0.01$). 'Perceived susceptibility' and 'perceived severity' (factors representing risk perception of AR) were not significantly associated with 'behaviour intention'.
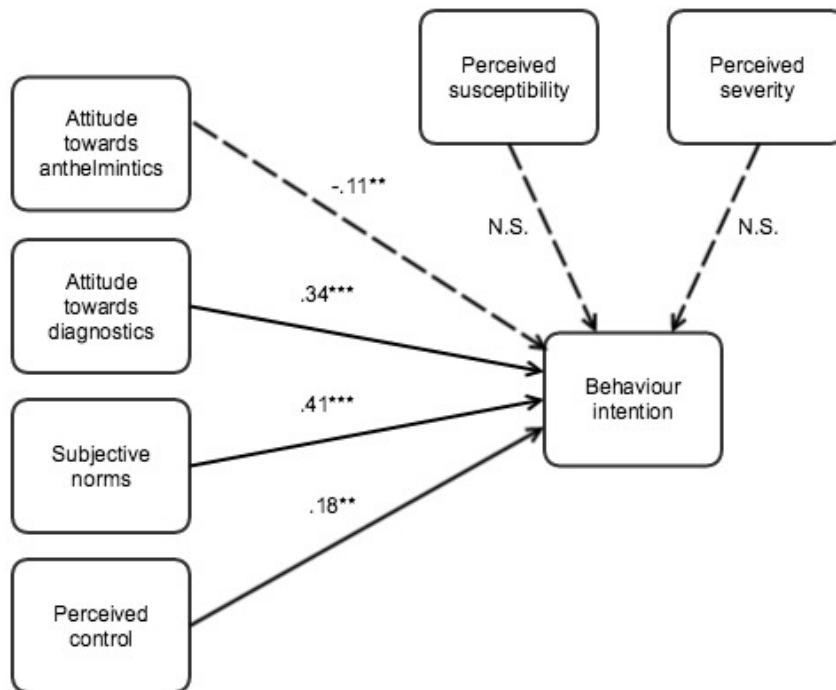
Figure 2.4.
The verified model of dairy farmers' adoption intention of diagnostic methods.
Notes, ***p < 0.001, **p < 0.01, *p < 0.05. Figure presents standardised estimates. Full lines present relations of TPB, dotted lines present relations of HBM.

2.3.4. Multi-group analyses of the model

The first multi-group analysis implemented the control variable 'questionnaire format'. Strict invariance was gained (Table 2.6.), which implicates that scores have equal meaning for both groups and can be interpreted similarly. Subsequently, the data can be interpreted as a whole. The second multi-group analysis was performed using the control variable 'type of herd'. Results show a strong invariance for the comparison

between groups, see Table 2.7. No significant differences were found for the regressions between both herd-types.

Table 2.6.
Test for invariance by questionnaire format on the hypothetical framework for the adoption of diagnostic methods.

Model	Description	χ^2	df	χ^2 (1)	CFI	Δ CFI	TFI	NCI	Δ NCI	RMSEA
Model1	Equal configuration	406.26	298	1.36	0.977	-	0.97	0.883	-	0.039
Model2	Equal factor loadings	412.02	311	1.32	0.979	*	0.97	0.885	*	0.037
Model3	Model2 + equal intercepts	432.53	324	1.33	0.977	0.002	0.97	0.879	0.006	0.037
Model4	Model3 + equal error variances	435.57	331	1.32	0.978	0.001	0.98	0.882	0.003	0.036

Notes. The *p* values for the χ^2 as well as the MLR scaling factors are not shown. All *p* values were < 0.001 and all scaling factors were between 1.03 and 1.04. χ^2 represents the scaled values.
CFI Comparative Fit Index, *TLI* Tucker-Lewis Index, *NCI* McDonald's Non-centrality Index, *RMSEA* Root Mean Square Error of Approximation

Table 2.7.
Test for invariance by type of herd on the hypothetical framework for the adoption of diagnostic methods.

Model	Description	χ^2	df	χ^2 (1)	CFI	Δ CFI	TFI	NCI	Δ NCI	RMSEA
Model1	Equal configuration	400.09	298	1.34	0.978	-	0.97	0.883	-	0.039
Model2	Equal factor loadings	412.23	311	1.33	0.978	0.000	0.97	0.880	0.003	0.037
Model3	Model2 + equal intercepts	419.08	324	1.29	0.979	0.001	0.98	0.886	0.006	0.037
Model4	Model3 + equal error variances	444.40	331	1.34	0.975	0.004	0.97	0.868	0.018	0.036
Model5	Model3 + constrain structural paths	421.08	330	1.28	0.980	0.001	0.98	0.889	0.003	0.034

Notes. The *p* values for the χ^2 as well as the MLR scaling factors are not shown. All *p* values were < 0.001 and all scaling factors were between 1.04 and 1.06. Δ χ^2 represent the scaled values
CFI Comparative Fit Index, *TLI* Tucker-Lewis Index, *NCI* McDonald's Non-Centrality Index, *RMSEA* Root Mean Square Error of Approximation

The comparison of the latent factor means resulted in several significant differences between the types of herd, see Table 2.8. 'Attitude towards anthelmintic use' was lower for dairy cows than for young stock (-0.63, $p < 0.001$), as was 'perceived susceptibility' (-0.22, $p < 0.05$). Attitude towards diagnostic methods was slightly more positive for dairy cows than young stock (0.24, $p \leq 0.05$). The other latent factor means presented no significant difference between groups. Behavioural intention remained equal for both groups.

Table 2.8.
Group differences by type of herd for latent variable means

Latent variable	Mean difference	Std. err	*p*-value
Attitude diagnostics	0.24	0.15	0.05
Subjective norms	0.19	0.07	0.08
Perceived behaviour control	-0.02	0.11	0.78
Attitude anthelmintics	-0.63	0.14	< 0.001
Perceived susceptibility	-0.22	0.10	0.03
Perceived severity	0.06	0.11	0.59
Behaviour intention	0.04	0.09	0.63

Notes, Measurements were performed on a 7-point Lickert scale.
Dairy cows representing the baseline model

2.4. DISCUSSION

New, sustainable worm control practices are intended to prevent or slow down anthelmintic resistance (AR). Unfortunately, there is low compliance of these new practices and the uptake of sustainable advises is limited. This indicates the need for improved communication towards farmers, and therefore a better understanding of factors driving farmers' behaviour. Since farmers' behaviour is not only based on rational and economic considerations, but also on intrinsic, socio-psychological factors, this study investigated dairy farmers' intention to adopt diagnostic methods in order to obtain sustainable GIN control strategies on their farms.

A general model of the theoretical framework was presented to predict farmers' intention to adopt diagnostic methods before implementing anthelmintic drugs preventively on their farm. Results of a large scale survey study among 574 farmers revealed that farmers' adoption intention for diagnostic methods can be predicted by their attitudes towards these methods and by the perceived opinion of important others (subjective norms). Attitude towards anthelmintic drugs on the other hand is a negative predictor for adoption intention, thus the more positive one is towards anthelmintic use, the less likely one is to adopt diagnostic methods.

These results are in line with previous research, which has shown attitudes are good predictors of farmers' behaviour when it comes to disease control management (Garforth et al., 2006; Jansen et al., 2009; Toma et al., 2013). A positive attitude towards diagnostic methods indicates a positive adoption intention for GIN control, i.e. the stronger the positive attitude, the more likely the farmers will adopt diagnostic methods before implementing anthelmintic drugs on their farms. Animal health and welfare aspects have already proven to be important drivers of farmers' attitude for disease control (Delgado et al., 2012; Laanen et al., 2014).

'Subjective norm' was also identified as a strong factor influencing intention to adopt diagnostics, expressing the importance of significant others in farmers' decision-making. Although cattle farming is an industry, it is intertwined with lifestyle and is often associated with family. Therefore decisions cannot always be explained by external, economic factors. Several studies suggest the importance of family and the private veterinarian on producers' decision making (Delgado et al., 2012; Ellis-Iversen et al., 2010; Jansen et al., 2010). Our research confirms these findings as the general model presented a solid relation of 'subjective norm' with 'behavioural intention'. This factor has great potential for persuading farmers into changing GIN control practices, regarding its strong effect on intention and neutral score of the items. It indicates a

fairly big margin to raise the farmers' perception of subjective norms and consequently increase the adoption intention of diagnostics.

'Perceived behavioural control' had a positive effect on intention to adopt diagnostics, but to a lesser extent than the formerly discussed variables. For GIN control our model suggests only a moderate effect towards adoption. The role of the veterinarian could explain the lower effect of this variable. Since the veterinarian is the primary advisor and performer of health and disease control on the farm, the farmer's decision may depend on the knowhow of the veterinarian on that matter. The veterinarian performs the actual diagnosis and therefore farmers' perceived control does not have a strong influence on the behaviour intention. In case of mastitis control, this perceived feeling of control was important in explaining the variation in mastitis incidence (Jansen et al., 2009). The farmers' behaviour was here defined by actions such as 'wearing gloves when milking', which is not performed by the veterinarian. Thus, the effect of control depends on the form of behaviour.

'Attitude towards the use of anthelmintic drugs' was proposed as a barrier for the adoption of diagnostic methods. The results confirmed this hypothesis, since a positive attitude for anthelmintics presents a negative relation with intention to adopt, which was expected given the low complexity of administration and high efficacy of these drugs. This implicates that positive attitudes towards preventive use of anthelmintic drugs, impede the adoption of diagnostics. This strong, positive attitude also indicates that anthelmintics are still perceived to be effective in cattle farms and AR is not considered as a severe problem yet. This may explain why the variables 'perceived susceptibility' and 'perceived severity' had no direct effect on intention to adopt diagnostics. Both factors were added to the model assuming the risk of AR would have an immediate effect on adoption, as proposed by the HBM. However, there was no significant effect found. These results are not compatible with the empirical support of the theory in which the effect of 'threat' on intention regarding health-related behaviours is confirmed. A low risk perception may be due to the fact that the emerging anthelmintic resistance in cattle in Western Europe has not yet reached a level that visibly interferes with animal health and production. Therefore the malfunction of the HBM in predicting farmers' behaviour for nematode control lies in the character of the disease, not the predictive power of the theory.

A multi-group analysis was performed for the use of diagnostic methods in young stock vs. dairy cows. We controlled for differences in the structural model, but effects of the factors on behaviour intention were found equal. This implicates each identified factor has a similar effect on adoption intention for both herd-types. When comparing latent

means we found differences for several factors. The attitude towards anthelmintics was more positive for young stock than for dairy cows. Young stock are more susceptible to GIN infections and therefore more dependent of anthelmintic treatments, while in dairy cows the use of anthelmintics is less intense and directed to prevent production losses. This also explains the lower score for perceived susceptibility of AR for dairy cows. Less intensive treatment lowers the risk for anthelmintic resistance. Finally the factor 'attitude towards diagnostics' had a higher score for dairy cows. This could be due to the fact that diagnostic methods for dairy cows are easier to implement and lower in cost (e.g. bulk-tank milk ELISA), since complexity and usability of anti-parasitic treatment could have an effect on attitude towards diagnostics (Kenyon and Jackson, 2012).

Although several factors were identified with a significant effect on farmers' behaviour intention, we lack knowledge on the beliefs or motivations underlying these factors. Underlying beliefs or motivations could be recognised by in-depth interviews with farmers, which could identify the most important barriers and motivations for the adoption of new GIN control strategies. This study has shown the importance of the barrier 'attitude towards anthelmintic use' in implementing diagnostics, therefore current behaviour should be considered in these interviews as well. Future research should also focus on differentiating between different types of farmers. The adoption of diagnostic methods may depend on farm size, types of farming etc.

Although the response rate is acceptable and the study population is well represented on demographic level, the tendency of more engaged farmers participating in the survey should be considered. Taking this into account, we assume lower involved individuals to be less intended to engage in such behaviour as the adoption of diagnostic methods. Therefore, the model should be reconsidered for less-engaged individuals, as a non-response bias due to self-selection of the participants could be a limitation to the presented model. This should not be a drawback for communication specialists or policy makers, for more engaged farmers are known to show more tendency in changing behaviour and adapting new practices.

The insights presented in this paper may be used in developing communication strategies for the adoption of sustainable parasite control practices in dairy farms. The most important factors driving the adoption of diagnostic methods were 'attitude' and 'subjective norm' and should therefore play a principal role in constructing an effective communication strategy. 'Attitude' can be used in two ways; increase the positive attitude towards diagnostic methods could result in a higher adoption rate, while a more negative attitude towards preventive use of anthelmintic drugs could have a positive impact on adoption of diagnostics as well. 'Subjective norm' has great potential

regarding the strong direct effect and the moderate present value. The thought that significant others like family or the veterinarian feel positive about diagnostic methods could increase the farmer's adoption. Although this is an interesting route, additional research is needed to measure the attitude and thoughts of these significant others before implementing them in a communication strategy. Finally, threat-messages of anthelmintic resistance should raise the risk perception of the farmer, which subsequently could lead to behaviour change. According to this study factors measuring the risk perception of resistance have no direct effect on adoption of diagnostics, therefore this could be a less preferable route. Hence, we suggest positive advice towards the implementation of diagnostic methods, encouraged by the surrounding network of the dairy farmer

2.5.   REFERENCES

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CHAPTER 3

BELIEFS, INTENTIONS, AND BEYOND – A QUALITATIVE STUDY ON THE ADOPTION OF SUSTAINABLE GIN-CONTROL PRACTICES IN FLANDERS' DAIRY INDUSTRY

Abstract

Emerging anthelmintic resistance emphasises the need for sustainable control approaches against gastrointestinal nematode (GIN) infections in cattle. The uptake of diagnostic methods for sustainable control could enable more informed treatments and reduce excessive anthelmintic use. Unfortunately, the adoption of such methods remains relatively poor. A better understanding of farmers' motivations and behaviour would help to develop applicable advises and communication strategies for sustainable worm control strategies. A previous study created a general model for adoption intention of GIN diagnostics on dairy farms and measured the most important factors driving this intention (Vande Velde et al., 2015). The current research aimed to dig deeper into this model for the beliefs underlying these factors, and to identify additional factors impelling this specific behaviour. Data were collected through 22 semi-structured interviews with dairy farmers. Using analytic induction analysis, data were moved between deduction and induction. Results show that the adoption process of diagnostic methods for GIN occurs through three different phases: adoption intention, actual adoption and maintenance. Low infection awareness and low priority ('top of mind') of the disease are important barriers for adopting sustainable GIN control. Secondly, farmer behaviour is guided by two important social norms: the opinion of their veterinarian and their fellow farmers. However, farmers hold an incongruent relationship with both norms throughout different stages of behaviour: they do not value other farmers' opinions as a positive reference (intention phase), but follow and mimic their behaviour as a group (action phase). The veterinarian is seen as the most important positive reference, but also the responsible actor for GIN control. As such, the farmers do not hold themselves responsible for implementing sustainable control strategies. Thirdly, different types of motivations influence different sorts of behaviours. Sustainable behaviour such as use of diagnostics will be influenced by moral motives, while management behaviour such as treatment is raised by more economic motives. Finally, not only performing, but also maintaining behaviour is important to fully address the adoption of sustainable control. As such, to maintain the adoption on farm, planning could be an important contribution. These insights can be used by animal health organizations and industry by exploiting motivations, social norms and planning to encourage the uptake of diagnostic approaches in GIN control.

3.1. INTRODUCTION

Gastrointestinal nematode (GIN) infections are a common constraint in pasture-based dairy herds and cause a decrease in animal health, productivity and farm profitability (Charlier et al., 2012; Perri et al., 2011). *Ostertagia ostertagi* and *Cooperia oncophora* are known as the most widespread and most harmful GIN in grazing cattle in temperate climate areas (Höglund et al., 2010). Current control practices to prevent production losses of GIN infections in livestock depend largely on the use of anthelmintic drugs (Kaplan, 2004). However, due to the intensive use of these drugs, the industry is increasingly confronted with nematode populations resistant to commonly used anthelmintics (Sutherland & Leathwick, 2011). Reports throughout the world suggest an increasing problem of anthelminthic resistance (AR) in cattle for both *O. ostertagi* and *C. oncophora* (Geurden et al., 2015; Rose et al., 2015; Waghorn et al., 2016). This emerging AR in cattle emphasises the need for sustainable control approaches, using diagnostic methods (e.g. faecal egg counts, serum pepsinogen levels, bulk-tank milk ELISA) to enable informed and targeted treatment decisions (Charlier et al., 2014). Adoption of sustainable control practices is hampered by the low price of anthelmintic drugs and the fact that production losses due to AR are difficult to quantify (Kahn and Woodgate, 2012; Knox et al., 2012). In order to successfully implement sustainable control strategies, and change the behaviour of farmers, their current perceptions and behaviours need to be well comprehended (Garforth, 2015).

Vande Velde et al. (2015) created a framework based on socio-cognitive models: the Theory of Planned Behaviour (Ajzen, 1991) and the Health Belief Model (Rosenstock, 1974), to identify the socio-psychological factors that influence dairy farmers' adoption intention of diagnostic methods of GIN infections. The results showed that subjective norms (person's perception of social pressure by important referents) and attitude towards diagnostics (evaluation based on the expected outcomes of diagnostic methods) are the main factors influencing adoption intention of the diagnostic tools. Further, perceived behaviour control (perceived ability to perform the diagnosis) and current attitude towards anthelmintic drugs (evaluation based on the expected outcomes of anthelmintic drugs) had significant, but smaller effects on the intention to adopt diagnostics. Finally, farmers' risk perception related to AR had no significant influence on their intention to adopt diagnostic methods before implementing anthelmintic drugs on their dairy farms. This study of Vande Velde et al. (2015) was a first step in understanding how and why farmers are willing (or not) to implement diagnostic procedures in GIN control. However, to be able to provide specific advice further in-depth analyses are necessary to determine farmers' beliefs and motivations underlying

these socio-psychological factors: For the attitude concept (behavioural beliefs), it is important to know what facets motivates the farmer and what their importance is: economic outcomes (cf. productivity losses in the long-term), environmental values, animal welfare or lifestyle factors, to name a few (Valeeva et al., 2007); (2) Subjective norms (normative beliefs) are guided by different social influences, which makes it important to identify who these specific influencers are to dairy farmers (Swinkels et al., 2015); (3) Behaviour control (control beliefs) depends on the beliefs whether farmers themselves can perform a certain practice or behaviour. As such, the degree of perceived knowledge, personal confidence, and on-farm resources for implementing diagnosis can be measured; (4) risk perception of AR relates to farmers' beliefs on the severity and personal susceptibility of the risk. Important here is to gauge whether they are familiar with AR as this is an upcoming risk for the cattle industry (Geurden et al., 2015). Qualitative research is more suited to understand these factors, as it explores values and perspectives that are more difficult to grasp by using quantitative self-reports. Qualitative research, e.g. in-depth interviews, allows participants to explain their opinions and thoughts in their own words, which results in a collection of detailed and rich information.

In addition, socio-cognitive frameworks as such focus on the individual and largely dismiss the influence of external factors. These models therefore predict behaviour intentions rather than actual behaviour. The "intention-behaviour gap" is a well known concept in the field of behavioural and health psychology (Sniehotta et al., 2005) and numerous models have been suggested to explain why behavioural intention does not automatically lead to consequent actual behaviour (Sniehotta et al., 2014). More specifically, concerning farmers' behaviour, several factors were suggested to form a bridge between intention and behaviour such as habits, physical arousal, the impact of the community and culture (Ellis-Iversen et al., 2010; Feola and Binder, 2010; Garforth et al., 2013). Nevertheless, many studies in animal disease control and farm decision making still focus on the cognitive beliefs and motivations of farmers, discounting the possibility that non-intentional related factors have an impact on behaviour (Vande Velde et al., 2017). Less research has been conducted on these non-intentional factors (Christley and Perkins, 2010).

Concerning GIN control on Flemish dairy farms, a relatively high adoption intention was measured for the use of diagnostics (Vande Velde et al., 2015a). However, low actual usage of these diagnostic methods has been reported by Animal Healthcare Centre Flanders (personal communication, Jozefien Callens, 2017). Moreover, relatively poor participation (16%) of dairy farmers for a voluntary monitoring campaign of GIN

infections was measured, even though samples were collected and analysed free of charge for the farmers (Charlier et al., 2013). Furthermore, although sustainable approaches have previously been translated in applicable control programs and advises, e.g. Wormkill, WormBoss (Woodgate and Love, 2012), SCOPS and COWS (Taylor, 2012), research shows rather limited uptake of the presented advice (McArthur and Reinemeyer, 2014). In general, this suggests a relatively high intention to adopt diagnostics but low actual compliance. Therefore, this study aims to explore this intention-behaviour gap and aims to improve the understanding of actual adoption of diagnostic methods for GIN control. With two main goals, this qualitative study aims at (i) understanding the beliefs underlying the socio-psychological factors that contribute to farmers' adoption intention of diagnostic methods for GIN control and (ii) identifying additional factors that are not accounted for in cognitive models and influence the actual adoption of diagnostic methods, together with the formerly established adoption intention (e.g. regulations, habits, social network).

3.2. MATERIALS & METHODS

In-depth interviews were conducted with Belgian dairy farmers to collect the data presented in this paper. Reporting of the research followed the Consolidated Criteria for Reporting Qualitative Research guidelines (COREQ; Tong et al., 2007).

3.2.1. Recruitment of participants

The study was conducted in Flanders, Belgium. Data were collected during two timeframes: March 2014 and December 2016. Participants were selected through two different procedures. Firstly, heterogeneous purposive sampling was conducted to capture a variety of different perspectives and ensure representation of different types of dairy farmers. With the help of the Animal Healthcare Centre Flanders 10 farmers were selected with maximum variation in conditions: small/large farms; dairy only/mixed dairy and beef farm; younger/older farmers; and different provinces in Flanders. During the second period, 12 additional farmers were recruited using a snowball sampling method. The first two participants of this snowball sampling were brought forward by the authors. Afterwards, to ensure representation of different farmers, participants were asked to present acquaintances from different provinces in Flanders. The interviewer ended the quest for participants when no new information arose from the interviews and thus data saturation was achieved. Thus, 22 farmers were interviewed in total (Table 3.1.), however one interview was conducted with two

farmers at the same time, both involved in the management decisions of the farm (father and son). On average the interviews took 51 minutes.

Table 3.1.
Sample conditions of the interviewed farmers

Conditions	Levels	#
Farm type	Dairy	19
	Mixed (dairy/beef)	3
Province located	West Flanders	6
	East Flanders	6
	Antwerp	6
	Limburg	2
	Flemish Brabant	2
Farm size	Small (<149 animals)	12
	Large (>150 animals)	10
Farmer age	< 25	1
	25 - 44	7
	45 - 64	13
	> 65	1
Years in industry	< 9	4
	10 - 29	8
	> 30	10

3.2.2. Data collection

The interviews were conducted with a semi-structured pattern and consisted of four parts. The first part was set up as an announcement round for farmers to get to know their role as respondent in the interview. Short, demographic questions assessed the farmer's background and farm situation, followed by a ranking task on seven important on-farm diseases: bovine viral diarrhoea, abomasal displacement, calf diarrhoea, hypocalcaemia, mastitis, GIN infections, and claw disorders. In this particular section of the announcement round, farmers were asked to rank the diseases on importance, and to further elaborate on their decision. The purpose of this question was to familiarise the farmer with his/her role as interviewee. A ranking test is a commonly used method for face-to-face interviews, as it is a helpful tool for the respondent to start speaking on the specific subject. The task also shifts focus away from the stress some respondents encounter when being interviewed. The second part was set up to investigate their past, current and possible future behaviour related to GIN control, with special emphasis on the factors and dynamics involved in the adoption process of diagnostic methods (Table 3.2.). It is important to first get a better understanding of the perception of this disease, since there cannot be any conscious control behaviour measured if there is no disease perceived by the farmer. The third part of the interview consisted of more general questions regarding the farm as an operation, information sources, the broader community and regulations. The farmer was more encouraged to guide the conversation and provide new information that could be used to adjust the question guide for future interviews (Ritter et al., 2016).

Table 3.2.

Topics and key questions on gastrointestinal nematode (GIN) control

Topics	Key questions
Disease control on farm	Can you rank these 7 diseases and tell me why you placed them in this order?
GIN control on farm	Tell me what you know about GIN infections and what is your personal experience with this disease?
	Can you tell me what the consequences are of GIN infections?
	How do you treat your animals and are you satisfied with your approach?
	Did you come up with this treatment by yourself?
	Where did you gain information on GIN control?
Perception of anthelmintic resistance (AR)?	What is your feeling on anthelmintic drugs and the use on your farm?
	Do you think there can be consequences related to the use of anthelmintic drugs?
	Have you heard about AR? What would this mean for you?
	Do you think you can manage this problem? How?
Perceptions of diagnostic methods for GIN control	Do you have any knowledge or experience with diagnostics for GIN infections?
	Why are you using/not using them?
	Do you see any advantages/disadvantages with this use?

The last part was a short summary of the interview, made by the interviewer, to allow the farmer to confirm his/her most important statements and possibly provide more guidance or additional information. Data were collected through face-to-face interviews by one interviewer only, the first author of this paper. The interviewer is a social scientist, trained in qualitative research methods, in particular, face-to-face interviews. Moreover, semi-structured interviews tend to generate less response bias compared to structured interviews or questionnaires (Furnham, 1986). The interviews were audio-recorded and at the end of the entire collection process transcribed by a specialised firm (www.outspoken.be). All were conducted in Dutch, therefore quotes presented in this paper are translated as literally as possible and crosschecked by the authors.

3.2.3. Qualitative analyses

The transcribed interviews were analysed with the qualitative research package Nvivo11 (QSR International Pty Ltd). The coding was performed in three phases by the first author of this study. During the first phase the transcriptions were coded at the lowest level, which means segments of the text were analysed with Nvivo coding. Distinct words or sentences that a participant used were given a label, or node (e.g. "I always use a pour-on, as this is easily applicable" – pour-on is easy to use). In the second phase, labels referring to similar content were grouped and conceptualised, creating codes ('pour-on is easy to use' – ease of use – behaviour control). In the third phase, codes were linked to each other (i.e. theoretical coding), which expanded and clarified the adoption process of diagnostic methods for GIN control. Using analytic induction as analysis strategy, data were moved between deduction and induction (Thomas, 2006). Deduction takes the factors into account that are currently assessed in the scientific

literature on animal disease control, more specifically the factors identified in the framework of Vande Velde et al. (2015) (e.g. benefits: attitude towards diagnostics, barriers: attitudes towards anthelmintic drugs and the current use of anthelmintics). On the other hand, induction brings forward new elements that are emerging from the data and were not accounted for during data collection (e.g. habit, planning). Specifically, during phase two of the NVivo coding, a code frame was provided by the literature (i.e. deduction). The obtained nodes from phase one were simply fitted in one of these codes. However, some nodes were grouped together outside of the provided code frame. These groups, or newly formed codes, were each given a new name and added to the code frame (i.e. induction). The previously coded nodes had to be re-analysed bearing in mind the newly founded codes (i.e. new round of deduction), as such data was moved between these two analyses. Once all the codes were established from the data, a framework was constructed during phase three. The codes were translated into factors, which were accordingly linked to adoption (i.e. the dependent variable). These were linked through theory (i.e. deduction), or through information rising out of the data (i.e. induction). The framework will be shown in a figure for better visibility of the behaviour.

3.3. RESULTS

We found the adoption process of diagnostic methods for GIN control to occur through three different phases: adoption intention, actual adoption and maintenance. The first two phases were taken into account when conducting the interviews, as described in the introduction section of this paper. However, the maintenance phase was brought forward by the data, and points towards the upkeep of the already performed behaviour.

3.3.1. Adoption intention of diagnostics in GIN control

Infection awareness. The concept of awareness is formed by the visibility and the perception of the consequences of GIN infections by the farmers. Most farmers associated GIN infections with production losses, while visible effects of GIN infections, such as diarrhoea and a rough hair coat, were only associated with heavy infections. This lack of visibility often resulted in a low awareness for GIN infections.

> P1: *"You can't see it. When a cow is sick because of worms, it must have been escalating considerably."*

Certain farmers even considered GIN infections to be completely invisible unless the infection was very severe. Accordingly, to some farmers, these visible consequences of

GIN infections could point to incorrect treatment or treatment failure, implicating a serious problem. Visibility of the disease would therefore have a negative connotation on their current practice. To avoid this visibility and consequently the association of malpractice, farmers believed preventive treatment to be necessary. Preventively treated animals will hardly show signs of GIN infection, which may lead towards a low awareness of the disease.

> P4: *"You should always treat against worms preventively. If you have worms, you have a big problem, don't you?"*

Moreover, some farmers believed diarrhoea caused by GIN always to be 'bubbly'. This points towards an incorrect image of GIN infections and indicates created myths on the consequences caused by GIN infections. Based on such myths farmers expect a visibility that does not exist, again decreasing the awareness of the disease.

> P13: *"When you see faeces more liquid than normal… and you can see bubbles in it."*

Top of mind. The farmer's daily occupation and management depends on his/her personal priorities, which is also the case for disease control. Most farmers ranked GIN infections low and expressed bigger concerns about other diseases such as mastitis and neonatal calf diarrhoea. Their concern about infections and diseases was mostly associated with problems they had experienced in the past.

> P6: *"If you have never experienced any problems or if you think that you don't have a problem, then you won't be occupied by it."*

Regulations and control programmes were also an important trigger for prioritisation, as farmers interviewed in 2014 ranked bovine viral diarrhoea (BVD) higher than the farmers interviewed in 2016. The concerns on BVD were raised due to new upcoming regulation on ear tags in 2015, which implicated changes in BVD control by the end of 2014. Mastitis on the other hand was a constant occupation for most respondents, and therefore ranked rather high.

> P19: *"Mastitis… yes, because it asks for constant monitoring"*

Farmers also mentioned the importance of the seasons and the weather for their disease control strategies. Some diseases are season-dependent; consequently each season changed the farmers' control approach. For example, one farmer treated his animals for GIN infections during winter, and was not concerned with it for the rest of the year.

> P2: *"Worm infections usually occur at the beginning of the winter or during winter. During summer, we don't give it much attention."*

Type of farm and animals also contributed to the ranking of GIN control. Farmers with a closed farm or no animals on pasture expressed fewer concerns on GIN infections, while farmers who had more young stock raised more concerns.

> P5: *"I don't have that many animals on the pasture. I don't say that animals in the stable don't get infected, but chances are much smaller."*

Attitude GIN control. Farmers showed an overall positive attitude towards preventive use of anthelmintic drugs for GIN control. The costs were considered relatively low, since the costs for treating an established problem would be much higher than the costs to prevent this. Anthelminthic drugs were seen as a necessary evil, as farmers believed that preventive treatment and its costs outweigh the avoided problems.

> P4: *"If you need to use it, it mostly means something negative. So you should better not use it. But it often is a necessary evil."*

Farmers' positive attitude for preventive use of anthelmintics was not only to avoid possible future treatment costs, but also to avoid production losses or to improve their current milk production. Milk production losses were considered as a current on-farm problem that needed immediate solution.

> P18: *"Now we have treated in August and September and gained spectacular profits. Now we have more milk. It was about time. Are we going to repeat this? I don't know…I'm not going to wait again until August…"*

Other farmers foresaw production losses in the future, since they believed that young stock with severe GIN infections would give less milk when older. However, some farmers also thought it to be necessary for young animals to get infected on pasture and acquire immunity against GIN. Accordingly, these farmers did hold minor negative attitudes against preventive treatment, expressing their concerns on overly protected cows.

> P5: *"Preventive treatment has its pros and cons. There are veterinarians who claim that animals need to get infected first, so they can produce antibodies … you shouldn't handle your cows like wallflowers, which can't be touched, that's not beneficial. You need to raise good, strong, robust cows, which have some resistance."*

In general, farmers thought it was important to maintain a healthy herd and 'happy cows'. Many farmers motivated this as the principal incentive of their hard work on the farm. Nevertheless, this safeguarding of animal health and welfare was frequently linked with good production levels.

P1: *"Good health and good production, it goes together. If you have healthy cows, you'll have good production."*

Attitude towards diagnostic methods. Several farmers believed it important to invest in the future with healthy cows and a sustainable environment. This investment was translated in costs such as time, money and workload. These farmers were proud of their different 'mindset', which was a motivation to comply with this sustainable behaviour.

P8: *"A lot of treatment goes to waste. That's not interesting. Not only for the costs, it's also stressful for the animals and the environment. That's also important."*

P2: *"The cost is the treatment, not the diagnosis."*

In addition, implementing diagnostics would inform them better about the infection status of GIN on their farm. Knowing and taking pride in their well-running farm was also an important motivation, both for the farmer himself and in competition with other farmers.

P19: *"You get all those overviews, like production parameters and financial results. I don't need to be the best, but I want to do it good. I don't have to be at the top, but I want to be second or third. That's a drive that I have…That's what keeps me going. It's my income. All those things are resources to achieve this…"*

Risk perception of anthelmintic resistance (AR). AR was unknown to most farmers, only few confirmed that they had previously heard of it. However, they had some knowledge of drug resistance in general, and they understood the mechanisms of how this is facilitated. Most of the farmers assigned frequent use of the drugs as a cause for resistance, and some of them related under-dosing to resistance. This general knowledge was obtained by their own or shared experience with other products used for fly or rat control, or other drugs such as antimicrobials.

P14: *"The more they come in contact with the product. It's the same with antibiotics. There are some antibiotics where the cows don't give much of a reaction. It will be a bit of the same…"*

Antimicrobial resistance is well known among the farmers. On the one hand, respondents acknowledged the severity of the problem and recognised the role played here by the dairy industry. On the other hand, some of the interviewed farmers expressed negative feelings towards resistance as it is often associated with farmers' malpractices. Some farmers even denied this problem and pointed towards antimicrobial use in human medicine.

P5: *"I think that problems with antibiotics, they should look at humans first, and afterwards at the food industry."*

The interviewer felt a negative connotation with the word resistance during the interviews. Still, most farmers believed AR could be a real and existing problem. However, they did not encounter any problems with anthelmintic drugs on their own farm and believed not to be susceptible to AR. Moreover, some farmers denied responsibility of AR and blamed other sectors of animal farming. Other respondents argued that the problem is mostly caused by the older generation of farmers, but those will leave the industry soon enough and the problem would resolve itself.

P5: *"This will resolve itself, however it will take a long time. Wait another ten years… yes, the older farmers will be gone by then."*

Most farmers also thought the problem could be easily managed by altering the products used for worm control, or by implementing appropriate pasture management. Only few mentioned that they reduced their anthelmintic use and that they only treated the infected animals.

Subjective norms. Almost every farmer pointed to his/her veterinarian as the most important advisor of their farm and valued his or her opinion above all else concerning general disease control. Accordingly, they based treatment of GIN infections on their veterinarian's opinion or advice.

P1: *"I treat when the veterinarian tells me to treat."*

Moreover, many stated that they regularly searched for information themselves, or came across interesting material, but always ended up asking the veterinarian what his opinion was on the matter. The relation between the farmer and the veterinarian was not only purely professional, but also more personal. Most farmers mentioned trust and a close connection as important determinants of their relationship.

P3: *"The vet is, and always will be, a confidant for the enterprise. I think that he definitely is an important person… he knows the people on the farm personally."*

Colleague dairy farmers were not consulted for their opinion on GIN infection treatment, because a large part of the interviewed farmers assumed that their fellow farmers had no knowledge of GIN control, let alone of diagnostic methods as a more sustainable approach. Their opinion on GIN control was therefore not truly valued.

P7: *"They treat without even knowing if it is truly necessary… they don't know. They think their animals are too skinny and therefore need to be treated. That's a waste of money actually."*

Certain farmers managed their farm together with family members, and although every helping family member had his or her own specific tasks in the company, they were also valued for their opinion on different matters. Professional farm visitors also came up as valuable opinion leaders, however depending on their speciality.

> P13: *"For claws a professional hoof trimmer visits the farm. The vet comes for mastitis. The person selling milk powder also has some knowledge… So that's some sort of external advice. And stuff like BVD goes through the vet again."*

Control norms. Feasibility and ease-of-use were mentioned by most farmers as important characteristics of disease control. The methods used to diagnose GIN infections should be user-friendly, otherwise they would not be suited for implementation. As such, sampling faeces was seen as an easy task but quite time consuming. Blood sampling for pepsinogen level measurement was thought to be both time and work consuming and not easy when the animals were on pasture. Moreover, some farmers mentioned that their animals would get scared of needles; this discomfort would make them less manageable and potentially dangerous.

> P4: *"You should not catch the calves every week, because in the end the animals will get scared. If they then see you coming, they're gone. And if they get older, they'll still remember it, and you'll need to be more careful"*

Sampling bulk-tank milk was mentioned to be very easy and feasible, but results only indicate the general infection status of the adult cows on the farm.

> P22: *"If it is bulk milk, it's no problem at all. But if we have to take blood, we already have so much to do… It's a lot of work taking blood."*

Some farmers mentioned that flexibility was of utmost importance for a farmer, since they encounter many unforeseen circumstances when managing their farm. Most of these situations are uncontrollable, such as the weather, but quite decisive. For example, most farmers were keen on planning the interviews only two days in advance.

> P10: *"That is in some way the problem of our profession… In agriculture, you are so dependent on external factors. Like my dad says: you plan to do something tomorrow, but it suddenly starts raining… You don't know in advance. In other sectors it is easier."*

3.3.2.   Actual adoption of diagnostics in GIN control

Community. Most farmers were devoted to the community they belonged too, and *vice versa* the community had much influence on the farmer. Farmers' meetings were organised to communicate and teach on specific topics such as disease control or new

management practices. The content of these meetings was mostly devoted to a 'hot topic' in the dairy community. Farmers stated that the topic of the meeting mostly determined conversations between the farmers afterwards. Furthermore, it unconsciously determined the farmers' near future management, as most of them confirmed they eventually implemented some discussed advises on their own farm.

> P2: *"Go to meetings and courses where you see your colleagues. The topic of this meeting leads the conversation."*

No meetings were setup specifically for GIN control to the farmers' knowledge. Without such a meeting farmers are not inclined to talk about this topic and therefore not motivated to plan future activities on GIN control.

> P1: *"No one ever talks about worm infections… So, it doesn't get my attention."*

About half of the interviewed farmers also enjoyed farmers' meetings for their social aspect. However, many of them were disappointed since the participation to these meetings is decreasing and consequently the community feeling is disappearing. Farmers pointed towards two main reasons for this decrease. Firstly, the workload of many farmers is increasing, which makes it difficult for some farmers (mostly new to the business) to attend activities that require absence from the farm. Secondly, new ways of communication make it unnecessary to gather information from such meetings. The internet not only provides enormous amounts of information, it also unites farmers on new levels (e.g. forums). The new generation younger farmers state that the farmers' community is not disappearing, but evolving in a different, more modern way.

Habits. Many farmers were rather satisfied with their current GIN control approach. They indicated not encountering any problems with GIN infections on their farms, or with the functionality of the used anthelmintic drugs.

> P8: *"Otherwise I wouldn't continue doing this, of course. I'm quite assured. I've experienced through the years that it works… I learned to follow it up through my vet and my own experience."*

Consequently, farmers do not see any reason to change this current GIN control on their farms. Changing their practice would not only imply more work, but also rethinking their strategy, since some farmers stated that their current GIN control has become a routine. These routines are difficult to break, hence difficult for them or others to change their current practices.

> P1: *"… it's too difficult. If farmers have a certain system, and it needs to be changed? That's quite difficult."*
>
> P5: *"To teach a farmer something new, that is often difficult."*

Only few farmers mentioned that allowing someone new with a fresh view on the enterprise could compensate this blindness by routine and habits.

P8: *"I believe that everyone is at risk of 'farm-blindness', you need to give access to someone else on your farm once in a while."*

Responsibility. Some farmers believed it was the responsibility of their veterinarian to perform a diagnosis for GIN infection on their farm, since he/she was their main advisor for disease control. Some farmers claimed that they intended to perform a diagnosis for GIN control, but that their veterinarian discouraged them, which led to non-compliance of the behaviour.

P2: *"He discouraged me to determine the pepsinogen levels for my herd, at that moment."*

An explanation could be that those farmers show little self-confidence and put their veterinarians' decision above their own opinion.

P2: *"I find it always hard to go against a vet, he holds a university degree and I don't. I find it difficult to tell him what we are going to do, although I have the right to do so…. it still is a threshold."*

3.3.3. Maintenance

Surprisingly, numerous interviewed farmers mentioned that they had performed diagnosis for GIN infections in the past, mostly on request of their veterinarian, or offered for free by a pharmaceutical company.

P19: *"past years we tested through bulk tank milk… through a programme of a firm…the vets get free services from these companies. So it is every time free to me"*

Only few of the farmers maintained this behaviour and claimed that they occasionally request diagnosis for GIN infections. Others did not maintain this behaviour, mostly because the test resulted in a low infection status.

P11: *"You have bulk tank milk, so we've done it a couple of times for the lactating cows. Results were negative… But that is already a couple of years ago."*

P5: *"We have done it once, testing our cows through milk, because now they can test the worm infection status. We have done it, but it was unnecessary to treat the lactating cows."*

3.4. DISCUSSION

Using inductive and deductive analysis, the results of this qualitative study were used to augment our previous model (Vande Velde et al., 2015) with additional factors as

presented in Figure 3.1. The model based on in-depth interviews with 22 dairy farmers could be divided in three different phases: the intention phase, the action phase, and the maintenance phase. Placing behaviour in these different phases is based on models from health and behaviour psychology, which try to explain the behaviour-intention gap and the dynamics of behaviour (e.g. temporal models, action models, stage models) (Sniehotta et al., 2014).
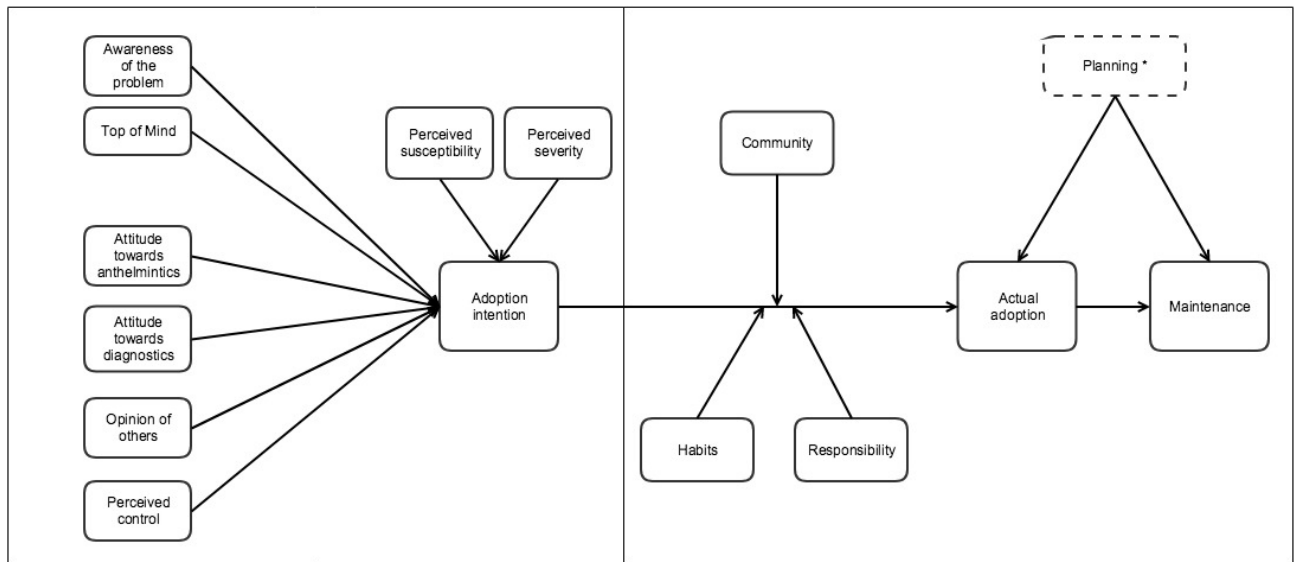
Figure 3.1.
Framework of dairy farmers adoption process for sustainable gastrointestinal nematode control
* Planning is a result of further elaboration on existing models and not directly gained from analysis.

The factors 'infection awareness' and 'top of mind' are placed in the intention phase. Both are dealing with general health management on the farm, 'infection awareness' is identified as the farmers' perception of the negative effects GIN infections can cause, while 'top of mind' considers the importance of the disease compared to other management practices on the farm. In their review on the adoption of management strategies for general disease control, Ritter et al. (2017) placed both factors under the topic 'problem awareness'. However, our results indicate that for the case of GIN infections, both factors need to be considered separately. Firstly, due to the preventive use of anthelmintic drugs in young stock and often subclinical nature of GIN infections, there is no visible image of the disease. This lack of visibility lowers the farmers' perception of the infection being present, hence decreased awareness of the problem (Norton et al., 2009). Secondly, the absence of a clinical image also reduces the farmers' perception of severity of the problem. Therefore, GIN infections are regarded as less important compared to other problems they encountered in the past, which in turn ranks the disease on a lower level for their daily management practices. Farmers will

spend their resources on issues they think are most urgent or important, and have a more severe impact (Ritter et al., 2017). Consequently, before even considering investing resources such as time and money for the adoption of diagnostic methods in GIN control, farmers will feel compelled to invest in higher priority practices. Therefore, 'infection awareness' and 'top of mind' will have an effect on the factors included in the intention phase of behaviour change in GIN control.

Previously, we found that risk perception of AR had no significant effect on the intention to change for more sustainable behaviour (Vande Velde et al., 2015). The results of this current study imply that most farmers had no knowledge on the existence of AR, and consequently no awareness of such risk. Although they were not disbelieving its existence, farmers were sceptical on the severity of and their susceptibility to the problem. They believed AR would disappear by itself or could be easily managed on farm by making small changes in their current GIN control practices. Moreover, most farmers are relatively happy with their current control and they do not encounter any problems with the used anthelmintics, which further weakens the perception of AR. This positive attitude towards their current use of anthelmintics was also seen as a barrier for adoption intention of diagnostics, with economic motives being the most important drivers of this positive attitude (Vande Velde et al., 2015). The relatively low cost of anthelmintic drugs makes it easier for the farmer to decide on preventive treatment (Woods & Knauer, 2010). Moreover, the use of anthelmintics prevents possible production losses, which is an important motivation for farmers' behaviour (Valeeva et al., 2007) or human behaviour in general (loss-aversion; Kahneman and Tversky, (1979)).

A positive attitude towards diagnostics was found in the pride of the farmer of managing his own farm properly and keeping his cows healthy. Many studies on social and economic behaviour of farmers suggest that both are important motivations for on-farm decision making (Ritter et al., 2017). Farmers consider devoting small costs (time, money, workload), if it results in long-term benefits exceeding the investment. Similar results were found in a study on the participation to a BVD program for Australian cattle farmers (Lanyon et al., 2015). In general, farmers' attitude for preventive treatment with anthelmintics was more focussed on economic motives, while they expressed more moral and personal motivations for their attitude towards diagnostics. This is an interesting finding considering future communication strategies and advice on GIN control. The results in this study suggest that, when promoting the use of diagnostics or discouraging preventive use of anthelmintic drugs, one should focus on different motivations. Kenrick and Griskevicius (2013) suggest that a person has different egos,

and depending on a cue or situation another ego will surface. Hence, a moral cue will surface a more sustainable ego, which could advantage the adoption of diagnostic methods.

In the previous study by Vande Velde et al. (2015) subjective norms were identified as the most important factor for adoption intention of diagnostics in GIN control. As shown in the present data, the veterinarians' opinion is valued most for GIN control on the dairy farm. Other farmers' opinions on this topic were regarded as untrustworthy, for they were thought to have little knowledge of this matter. Swinkels et al., (2015) suggested other dairy farmers also to be a negative reference group amongst each other. That way, farmers want to distinguish themselves from their referents and show their own ability of being a 'good farmer'. Accordingly, they will value the opinion of their veterinarian positively, and the opinion of their referent farmer negatively.

Regarding their perception of adopting and controlling this sustainable behaviour, three important determinants arose from the analysis. For farmers in order to intent changing their behaviour, the diagnosis should be practical and easy to implement. This confirms the literature on farmers' disease control (Ritter et al., 2017). In general, flexibility was also suggested as a determinant of control, since flexibility is a way of controlling unforeseen situations, which is characteristic for farmers' practices. Translated for diagnostic methods, those should be ready at hand and operational whenever suited for the farmer.

Although the results suggested referent farmers to be a negative influential reference for farmers' intention, they also show to be a positive reference group as to actual behaviour. Seen as a community they will be inclined to follow what the others are doing, which is named in literature as descriptive norms: doing what other referents are doing (Lapinski and Rimal, 2005). Hence, the farmer is sceptical on other farmers' opinion about sustainable GIN control, but susceptible to the community's behaviour, suggesting a dual relationship between farmers. These descriptive norms partially explain the gap between intention and actual adoption of diagnostic methods. Although a farmer might intend to adopt diagnostics, if the community is not doing it, he/she will not either. Similarly, the presumed responsibility of the veterinarian came up as a second barrier to the intention-behaviour gap. Most farmers considered disease control in general to be the veterinarians' responsibility, therefore it was up to him/her to request for a diagnosis. The third factor suggested that old habits die hard (Feola and Binder, 2010). Farmers who created a routine for GIN control, will not easily deviate from it. This partially generates 'farm-blindness', as they do not see the disadvantages of

their habits. Breaking this routine would also imply more work, which is a major barrier for farmers' behaviour change.

Eventually, some respondents already used diagnostics in the past, complying with the suggested behaviour. However, not many farmers maintained this adoption of diagnostics. The maintenance or sustained control (Ellis-Iversen et al., 2010) of farmers' behaviour is not largely discussed in veterinary epidemiological literature. Therefore, insights from human health and behaviour psychology were used to elaborate on this behaviour gap during interpretation of the data. Most of the farmers who indicated use of diagnostics in the past, explained that either their veterinarian or a pharmaceutical company performed this behaviour, suggesting that they did not plan or perform this behaviour themselves. By planning, a person develops a mental representation of a future situation and a behavioural action, translating behaviour intention into blueprints for actual behaviour (Sniehotta et al., 2005). If these blueprints lack in someone's mind, it is less certain that he will perform this behaviour (repeatedly). Thus, if a veterinarian or a pharmaceutical company performed certain behaviour, the farmer will probably lack the blueprints for this behaviour. Hence, we suggest 'planning' as an explanation for the lack of maintenance in the adoption of diagnostics, and is therefore included in the model. This new factor is not directly gained from the results but more a product of elaboration of the analysis and existing behavioural models. 'Planning' as a factor is brought forward by the Health Action Process Approach Model (HAPA, Schwarzer, 2008) as an explanation for the intention-behaviour gap. HAPA suggests two stages in human health behaviour: a motivational phase (explaining one's intention) and a volitional phase (leading to actual behaviour). Once the motivational phase has achieved the intention to change behaviour, it has to be transformed into detailed instructions, hence planning. Once an action has been initiated, it has to be maintained through self-regulatory skills and strategies (Schwarzer, 2008). Therefore, a person who planned a certain behaviour will be much more willing to perform that behaviour than a person who just has the intention of doing it. Moreover, once the first blueprints are on the table, a person just has to mimic and make small adjustments as to maintain the behaviour. This new insight could also help advisors in changing farmers' behaviour in the future, by helping to plan sustainable actions. Such a role of the veterinarian of planning and preparing actions together with the farmers could be of interest for changing management practices and should be further investigated.

Some important limitations of the study should be addressed when interpreting the obtained information. Firstly, only one person conducted the interviews, which makes the collected data vulnerable for interviewer bias. Similarly, only one researcher coded

the transcripts, which makes the results vulnerable for researcher bias. Secondly, with qualitative research methods the aim is to obtain as much information as possible, and not to represent the general thoughts of the population. Since, the main purpose of qualitative research is to generate new information that is mostly been overlooked by quantitative research. The goal is to represent all categories and subcategories of a population, which is established through methods such as purposive sampling until saturation is achieved. The representation of the population could, on the other hand, again be verified with a quantitative measurement of the acquired framework. Therefore, qualitative and quantitative research are complementary. Finally, the research population is limited to dairy famers in Flanders, and although the results could be used as a trend for other sectors or regions, these should certainly not be extrapolated for interpretation of their behaviour.

3.5. CONCLUSION

This manuscript adds to the growing body of behavioural research in veterinary epidemiology. Using a qualitative method, this study gained new insights on farmers' farm management and more specifically the adoption of diagnostics as a sustainable GIN control practice on dairy farms. Firstly, due to low infection awareness and priority of the disease most farmers did not even consider a change in GIN control. Secondly, farmers' behaviour is guided by two important social referents: their veterinarian and their peers. However, they hold an incongruent relationship with both influences throughout different stages of behaviour. Although they do not value other farmers' opinions for GIN control as a positive reference (intention phase), they follow and mimic their behaviour as a group (action phase). The veterinarian is seen as the most important positive reference, but also the responsible actor for GIN control. As such, the farmers do not hold themselves responsible for implementing sustainable control strategies. Finally, farmers' motivations are behaviour dependent. Sustainable behaviour such as use of diagnostics will be influenced by moral motives, while management behaviour such as treatment is raised by more economic motives. Planning could be an important factor not only to perform, but also to maintain behaviour on farm. These insights can be used by animal health organizations and the industry as a whole by exploiting motivations, social norms and planning to encourage the uptake of diagnostic approaches in GIN control.

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CHAPTER 4

CHANGING FARMERS' BEHAVIOUR INTENTION WITH A HINT OF WIT – THE
MODERATING INFLUENCE OF HUMOUR ON MESSAGE SIDEDNESS

Adapted from

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Abstract

This study investigates how to change farmers' unsustainable use of anthelmintic drugs. More specifically, it focuses on discouraging this behavior by using message sidedness in a humorous advertisement. The effects of the message on intentions to change behavior were measured through a cognitive and affective route of persuasion. Using a 2 (message sidedness: one-sided vs. two-sided) x 2 (humor: humorous vs. non-humorous message framing) between-subjects design (N=167), we tested the persuasiveness of the advertisement. Results show that a two-sided message without humor evoked more negative cognitive responses (e.g. negative thoughts), than a one-sided message, leading to fewer changes in behavioral intention. However, a two-sided message resulted in increased pro-environmental behavioral intention compared to a one-sided message when humor was used as a frame in the advertisement.

4.1. INTRODUCTION

Environmental problems are often rooted in aspects of traditional agricultural production, more specifically livestock farming (Islam et al., 2013). Therefore, alternative, pro-environmental approaches have been developed to mitigate biodiversity loss, dry-land salinity, and water conservation, to name but a few. Still, uptake has been insufficient and adoption of these practices rather disappointing (Price and Leviston, 2014). Many agricultural studies have focused on farmers' environmental behaviour (Borges and Oude Lansink, 2016; Burton, 2014; Yazdanpanah et al., 2014), however, less research has been conducted on the topic of changing this behaviour. One way to change behaviour is by using effective communication, although communication strategies should be well investigated before implementing them as social marketing approaches.

Gastrointestinal parasite infections are a major threat for animal health, productivity, and profitability of pasture-based dairy herds (Charlier et al., 2014). Highly efficacious and relatively inexpensive drugs were developed to prevent gastrointestinal parasite infections and concomitant production losses (Woods and Knauer, 2010). Hence, gastrointestinal parasite control in livestock now largely depends on the use of anthelmintic (anti-parasitic) drugs (Kaplan, 2004). Unfortunately, the intensive use of anthelmintics in cattle has led to environmental problems for both soil fauna (Adler et al., 2016; Beynon, 2012) and soil flora (Eichberg et al., 2016), and the development of anthelmintic resistance (Kaplan, 2004). These emerging consequences emphasise the need for sustainable control approaches with less intensive use of anthelmintics (Charlier et al., 2014). However, the benefits of anthelmintics are immediate and on an individual level, while the negative consequences affect the community and environment in a distant future (Sutherland and Leathwick, 2011). Additionally, due to previous issues on antibiotic resistance, dairy farmers feel easily attacked and under pressure when it comes to drug misuse (Chapter 2). This is especially challenging to create awareness and communicate about the threat of anthelmintic misuse in a non-offensive manner. Similar to other pro-environmental approaches, the uptake of such sustainable parasite control practices is rather limited (McArthur, 2014). Therefore, this study aims at creating a persuasive strategy to warn about the possible consequences of intensive use of anthelmintics, such as drug resistance, on one hand, and to promote the uptake of diagnostics as a sustainable approach for parasite control on the other hand.

This study was set up to investigate the effectiveness of two-sided message strategies in a social marketing campaign. This is a persuasion strategy in which the advertiser takes both sides of an issue into account. In this case, discouraging the unsustainable

behaviour but also including a minor positive argument for this behaviour. However, processing two-types of arguments requires more cognitive elaboration for the message. Humour is known to draw attention and create arousal (Cline and Kellaris, 2007). Therefore, this study included humour in the message to facilitate message processing and eventually leading to increased pro-environmental behaviour. The results presented here will be a contribution of suitable communication strategies for social marketing purposes.

4.2. LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

4.2.1. Message sidedness in social marketing

The use of two-sided argumentation in a message is a strategy derived from commercial product advertising, and research has mainly been limited to this field (Cornelis et al., 2012, 2013, 2014; Eisend, 2007). It provides both positive and negative arguments related to the product, but the positive arguments outweigh the negative ones (e.g., 'Although our product is quite expensive, it has an excellent quality'), whereas traditional one-sided messages only offer those positive arguments in favour of the communicator's proposition (Allen, 1991). Crowley and Hoyer (1994) constructed an integrative framework to explain the underlying persuasiveness of two-sided messages in commercial marketing (Crowley and Hoyer, 1994). Overall, message sidedness works effectively through an increase of perceived novelty and source credibility, while reducing negative cognitive responses (Eisend, 2006). However, most research has focused on the positive effects of source credibility as mediator of attitudinal and intentional outcomes (Eisend, 2010), and fewer studies contributed to the effects of reduced negative cognitive responses (Belch, 1981; Hastak and Park, 1990; Kamins and Assael, 1987).

In social marketing the aim is not to promote a product, but to promote desired behaviour and/or discourage undesired behaviour. Accordingly, different mechanisms are at stake here (Pope et al., 2009). By discouraging people's undesired behaviour through a message, one can induce negative feelings (Witte, 1992). By including a minor positive argument to the message, one acknowledges that all behaviours come with advantages and disadvantages, which makes the message less aggressive and more humane. Perceived negativity can include negative cognitive and affective reactions towards the message, which might mediate the effect on behavioural change. The following hypothesis is proposed:

H1: A two-sided message will lead to increased intention to change behaviour compared to a one-sided message due to a decrease in (H1a) negative affective responses and

(H1b) negative cognitive responses.

4.2.2. The Moderating Role of Humour

In light of the growing role of humour in social marketing, the current article tests the moderating impact of humour on the effects of message sidedness. Humour is known to intrigue and increase arousal, therefore it facilitates elaboration (Speck, 1991). Following the mechanism of the optimal arousal theory (Berlyne, 1971), humour is perceived as novel, surprising, and complex, and leads to enhanced attention and acceptance of an advertising message (Cline and Kellaris, 2007). However, arousal has its limits and follows an inverted U-shaped curve (Attardo, 2014). Too little or too much stimulation is regarded as unpleasant, while moderate stimulation builds just enough tension to be resolved, generating a pleasant feeling (Rothbart, 1973).

Recent studies in threat advertising have also demonstrated the beneficial impact of humour on threat persuasion (Yoon and Mayer, 2014; Yoon and Tinkham, 2013). Humour attenuates perceived negativity and facilitates persuasion for threat messages (Mukherjee and Dubé, 2012). This can be explained through two mechanisms, the cognitive and the affective route of processing. Cognitively, humour attracts attention, but demands effortful processing in order to comprehend the joke (Moyer-Guse et al., 2011). However, threat information also requires cognitive engagement due to its negative, substantive, and non-normative nature (Schimmack, 2005). Therefore, the effect of humour will depend on the level of informative value of the threat provided by the message. If the threat value is too low, humour will act as an additional stimulant that increases arousal (Yoon and Mayer, 2014). Increased arousal will induce negative feelings as too much arousal is regarded as unpleasant and too much attention will be drawn to the threat presented in the message. When threat provides more informative value, humour will divide attention for comprehension of both humour and the message arguments, which helps processing threatening information more easily. Threat processing will be neutralised by humour processing, since less attention and effort will be allocated to the threatening information (Kuiper et al., 1993). Affectively, humour creates a feeling of 'mirth' (Gulas and Weinberger, 2006), a generic affective response. Subjects do not want to ruin that mood and anticipated enjoyment by producing negative responses to the message (Young, 2008). Conversely, this positive feeling could also act as a discounting cue, rendering the message as 'just a joke' (Nabi et al., 2007). The nature of amusement will decrease the perception of the problem (Mcgraw et al., 2015), trivializing the effect of message persuasion.

Hence, following the results of humour in threat advertising (Yoon and Mayer, 2014;

Yoon and Tinkham, 2013), and the curvilinear theory of optimal arousal, we expect that the effect of humour will depend on the sidedness of the message. Message sidedness differs in the amount of informative value; a two-sided message contains more informative value compared to a one-sided message. Therefore, the tension created in a one-sided message should be resolved to a lesser extent due to limited informative value in the message. Moreover, humour will draw too much attention to the one-sided message containing only a negative argument discouraging certain behaviour. Consequently, both cognitive and affective negative responses should increase due to excessive arousal and provoked negativity. A two-sided message provides more balanced and nuanced arguments. Therefore, the informative value of the message increases. Including humour in a two-sided message with higher informative value creates optimal arousal, which divides comprehension for both humour and message arguments. Hence, a two-sided message should be more positive in persuading behaviour change than a one-sided message, and humour as moderator should strengthen this effect. The following hypothesis is proposed:

H2: The positive effect of a two-sided (vs. one-sided) message on behavioural intention through decreased negative affective (H2a) and cognitive responses (H2b) will be stronger when the ad portrays humour than when it does not.

4.3. MATERIALS & METHODS

4.3.1. Stimulus material and pre-test

The PSA was set up to discourage the misuse of anthelmintic drugs on dairy farms, as this can lead towards drug resistance and soil contamination. Message sidedness was manipulated through the use of either one-sided or two-sided argumentation in the text. The one-sided message offered only the threat component as discussed above, discouraging the undesired behaviour: "Preventive use of anthelmintic drugs can cause resistance!" The two-sided message additionally contained an argument in favour of the undesired behaviour to the message: "On one hand the preventive use of anthelmintic is very easy, on the other hand it can cause resistance!" The used stimuli are presented in the figures underneath.

Figure 4.1.
One-sided with no humour
Preventive use of anthelmintic drugs can cause resistance!

Figure 4.2.
Two-sided with no humour
On one hand the preventive use of anthelmintics is very easy, on the other hand it can cause resistance!

Figure 4.3.
One-sided with humour
Preventive use of anthelmintic drugs can cause resistance!

Figure 4.4.
Two-sided with humour
On one hand the preventive use of anthelmintics is very easy, on the other hand it can cause resistance!

A pre-test with 44 dairy farmers using a within-subjects design revealed successful manipulations. Whether the advertisement was perceived humorous or not was measured with 3 items, semantic differentials ("Not funny/Funny, Not amusing/Amusing, Not humorous/Humorous", α = .94, $M_{\text{Non-humor}}$ = 3.12 vs. M_{Humor} = 4.44, F (1, 33) = 28.66, $p < .01$, η^2 = .47). Similarly for message sidedness, if the respondents thought the message contained either one argument or two ("This message only presents negative arguments of preventive use of anthelmintics/This message presents both negative and positive arguments of preventive use of anthelmintics", $M_{\text{One-sided}}$= 4.34 vs. $M_{\text{Two-sided}}$ = 4.57, F (1, 33) = 8.1, $p < .01$, η^2 = .2). A test of within subjects-effect was performed on both humour and message sidedness, and resulted in no significant interactions (*perceived humour * perceived message sidedness F* (1, 33) = 1.8, p = .19, η^2 = .05, *perceived message sidedness * perceived humour F* (1, 33) = 2.77, p = .11, η^2 = .08)

4.3.2. Study design and participants

A 2 (message sidedness: one-sided vs. two-sided) x 2 (humour: humorous vs. non-humorous message framing) between-subjects design was employed in which participants were randomly assigned to one of the four conditions.

Six hundred dairy farmers received an invitation by email to participate in a survey set up to improve communication to farmers. The real nature of the experiment was not revealed to prevent bias and socially desirable responses. To increase the response rate, an incentive (lottery) was provided in which the participants could win an I-Pad and 20 duo film-tickets. A total of 167 farmers participated in the study, and were randomly exposed to one of four versions of the advertising message. After watching the advertisement, respondents had to complete a questionnaire measuring the manipulation checks, followed by the thought-listing task, the dependent variables and a demographic inquiry.

4.3.3. Measures

An overview of all measures used in the study can be found in Table 4.1.

Perceived humour (3 items: "Not funny/Funny, Not amusing/Amusing, Not humorous/Humorous", α = .92) and *message sidedness* (1 item: "This message only presents negative arguments of preventive use of anthelmintics/This message presents both negative and positive arguments of preventive use of anthelmintics") were measured as manipulation checks by means of semantic differentials.

Table 4.1.

The constructs used for the measurement of the variables in the moderated mediation model.

Construct label	Item label	Item statement	Item measurement
Perceived humour	Humour 1	Do you think following advertisement is:	**Not funny - Funny** Bipolar 7-point scale
	Humour 2	Do you think following advertisement is:	**Not amusing– Amusing** Bipolar 7-point scale
	Humour 3	Do you think following advertisement is:	**Not humorous – Humorous** Bipolar 7-point scale
Perceived two-sidedness	Two-sidedness 1	Did the advertisement show only negative aspects of preventive worm control, or both positive as negative?	**Only negative – Both positive as negative** Bipolar 7-point scale
Behavioural intention	Intention 1	I'll look for information on anthelmintic resistance	7-point Likert response format *
	Intention 2	I'll alert my immediate surroundings about the possible risks of anthelmintic use	7-point Likert response format
	Intention 3	I'll consult my veterinarian	7-point Likert response format
	Intention 4	I expect to use less anthelmintics preventively on my farm	7-point Likert response format
	Intention 5	I'll expect to diagnose my animals before treatment	7-point Likert response format
	Intention 6	I will use less anthelmintics preventively on my farm	7-point Likert response format
Negative affective responses	Affect 1	What did you feel after seeing the advertisement? - Fear	7-point Likert response format
	Affect 2	What did you feel after seeing the advertisement? - Worry	7-point Likert response format
	Affect 3	What did you feel after seeing the advertisement? - Guilt	7-point Likert response format
	Affect 4	What did you feel after seeing the advertisement? - Shame	7-point Likert response format

* 1 = strongly disagree; 2 = disagree; 3 = slightly disagree; 4 = neutral; 5 = slightly agree; 6 = agree; 7 = strongly agree

Negative cognitive responses were measured through a thought-listing exercise (Cacioppo et al., 1997). Participants recorded their thoughts that came to mind after they read the message, with a maximum of restriction to 6 thoughts. Each thought was coded by two independent coders on two categories: irrelevant/relevant and negative/positive. Thoughts were considered relevant if those addressed particular features of the advertisement, the message, or the behaviour itself. Cohens' Kappa was run to determine if there was agreement between the two coders. There was very good agreement on the relevance/irrelevance of the thoughts, $\kappa = .93$, $p < .001$. Irrelevant cognitions were eliminated from the analysis to reduce the level of noise in the data (e.g., "I hope I win the lottery", "I was thinking about the upcoming questions in the survey, "No thoughts"). Afterwards, a variable was created with the amount of identified negative thoughts given by each separate respondent. The variable is continuous as this is a numeric sum of the negative thoughts provided by each respondent. Negative responses were considered for the analysis ($M = .71$, $SD = 1.19$) if those were perceived relevant and negative by the coders (e.g., "Shows little knowledge of the advertisers",

"Again new costs?!", "Advertisement makes it look like we are deworming without thinking") there was a good agreement between the two coders κ = .66, p < .001.

Negative affective responses were measured using four items indicating the feelings they had after seeing the advertisement: fear and worry (anticipatory emotions), and guilt and shame (anticipated emotions) (M = 2.62, SD = 1.15, α = .86).

Farmers' intention to change behaviour was measured using 6 items (α = .81, M = 4.40, SD = 1.05).

4.3.4. Analyses

First, to explore the data the inter-correlations of the variables of interest were tested. Second, a mediation and moderated mediation analysis using Hayes' PROCESS macro (Hayes, 2013) was used to test the hypothesised models. The independent variable, sidedness of the message, was dummy coded so that 0 equalled the one-sided threat-only argument and 1 equalled the two-sided argumentation. The moderating variable, humour, was also dichotomous with 0 as no-humour included and 1 as humour included in the message. The model-mediators (i.e., cognitive and affective responses) and dependent variable (i.e., behavioural intention) were continuous. The mediation was measured through Model 4 and the moderated mediation was measured through Model 7, with 5000 bootstrap resamples and 95% bias-corrected confidence intervals (Hayes, 2013; 2015).

4.4. RESULTS

4.4.1. Manipulation Checks

The manipulation check showed that the humorous ad (M = 4.46, SD = 1.73) was perceived to be significantly more humorous than the non-humour ad (M = 2.24, SD = 1.70), F (1, 163) = 144.71, p < .001, η^2 = .15. Furthermore, the two-sided argumentation (M = 5.05, SD = 1.50) was perceived as more two-sided than the one-sided argument (M = 2.77, SD = 1.87), F (1, 163) = 88.67, p < .001, η^2 = .07.

4.4.2. Correlational Analysis

The correlation matrix shows significant inter-correlations between behavioural intention, and negative cognitive responses and negative affective responses (results shown in Table 4.2.). In addition, negative cognitive and negative affective responses were not correlated.

Table 4.2.
Correlation matrix for presented variables in model: NCR, NAR and BI

Factor	NRC	NAR	BI
NRC	1.000		
NAR	-0.081	1.000	
BI	-0.342**	0.209**	1.000

Note. Pearson correlation coefficients based on 5000 bootstrap samples are presented above (N = 167).
NRC = Negative Cognitive Responses; NAR = Negative Affective Responses; BI = Behavioural Intention
* *. Correlation is significant at the .01 level (2-tailed).

4.4.3. Mediation Analyses

The results of the mediation analysis reveal that the total indirect effect of message sidedness on behavioural intention through negative cognitive and affective responses was not significant (point estimate = -.03, 95%, CI: -.18 to .10). In particular, results show that message sidedness does not have a significant indirect effect on behavioural intention through negative cognitive responses (point estimate = -.04, 95%, CI: -.14 to .01), nor through negative affective responses (point estimate = .01, 95%, CI: -.10 to .12). These results leave both H1a and H1b unsupported. In addition, the direct effect of message sidedness on behavioural intention was not significant (c = - .14, SE = .15, 95% CI: - .47 to .14).

4.4.4. Conditional Process Analysis

The moderated mediation through negative affective responses was not significant, as the equality of the conditional indirect effects was confirmed (index of moderated mediation, humour vs. non-humour: point estimate = .03, SE = .05, 95%, CI: -.02 to .19), rejecting hypothesis H2a. In particular, results reveal an insignificant indirect effect of message sidedness on behavioural intention through negative affective responses, both neither for the humour condition (point estimate = .01, SE= .03, 95% CI: - .07 to .07) and nor for the non-humour condition (point estimate = -.03, SE= .04, 95%, CI: -.14 to .001).

Evidence supported the moderated mediation through negative cognitive responses and rejecting the equality of the conditional indirect effects in both groups (index of moderated mediation: humour vs. non-humour, point estimate = .32, 95%, CI: .12 to .64). Based on this result we can infer that the indirect effect of message sidedness on behavioural intention through negative cognition differs significantly whether humour is included or not. When the message included the humour component, there was a significant positive indirect effect of message sidedness on behavioural intention through negative cognitions (conditional indirect effect, ab = .18, SE = .09, 95% CI: .03 to .39), supporting hypothesis H2b (regression coefficients are shown in Figure 4.5. and Table 4.3.).

Table 4.3.
Unstandardised coefficients of the moderated mediation (Model 7, Hayes, 2013) with message sidedness as the independent variable (X), negative cognitive responses as mediator (M), humour as moderator (W), and behavioural intention as dependent variable (Y)

	NCR	(M)	BI	(Y)
	Coeff.	95% CI	Coeff.	95% CI
MS (X)	0.502 (.255)	-0.001, 1.004	-0.164 (0.154)	-0.468, 0.140
NCR (M)			-0.295***(0.065)	-0.422, -0.167
H (W)	1.728** (.588)	.0566, 2.889		
MS x H (X x W)	-1.101** (.365)	-1.821, -0.381		
Constant	-0.073 (.404)	-0.877, 0.724	4.611***(.321)	3.978, 5.244
	R^2 = 0.053 F (3, 163) = 3.064	$p = .03$	R^2 = 0.135 F (3, 163) = 8.461	$p < .01$

Note. MS = Message Sidedness; H = Humour; NRC = Negative Cognitive Responses; BI = Behavioural Intention
* $p < .05$, ** $p < .01$, *** $p < .001$.
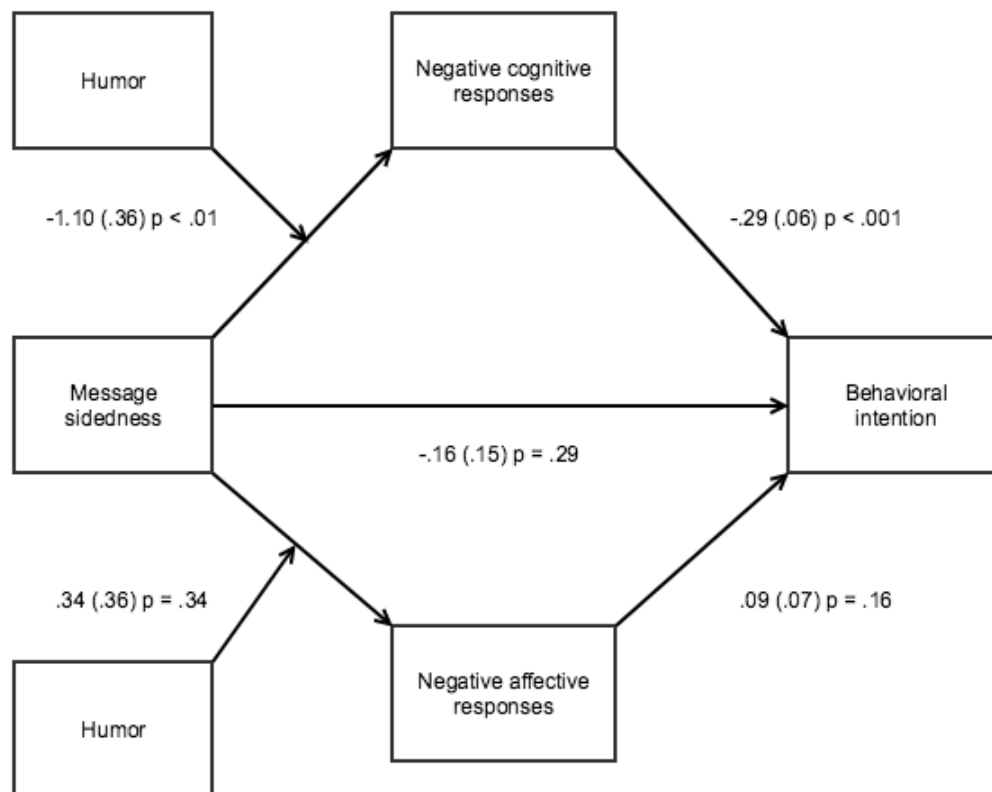Values between parentheses represent the value of the coefficients' standard error

Figure 4.5.
Coefficients of the moderated mediation (Model 7, Hayes, 2013) with message sidedness as the independent variable, negative cognitive responses and negative affective responses as mediators, humour as moderator, and behavioural intention as dependent variable

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Additionally, the mediation analysis revealed a significant negative indirect effect of message sidedness on behavioural intention through negative cognitive responses when humour was not included (conditional indirect effect, ab = - .15, SE = .08, 95% CI: - .34 to - .02).

4.5.   DISCUSSION

The general goal of this study was to provide insights for a social marketing campaign to encourage farmers' pro-social and pro-environmental behaviour, in particular for the case of anthelmintic drug-abuse and sustainable parasite control. Traditional non-profit marketing tries to encourage a certain desired behaviour, however our goal was to create awareness on the risk of anthelmintic drug-abuse and to discourage this behaviour as a first step towards farmers' behaviour change. The objective of this study was to test message sidedness as a strategy for social marketing, and whether humour could facilitate message persuasiveness and intention to change behaviour. Because two-sided messages are mainly studied in the field of commercial product advertising, there is little knowledge on the effectiveness and mechanisms of the strategy in social marketing communication. Therefore, it is important to investigate message sidedness with specific grounds of message rejection in a social marketing context, such as perceived negativity towards the message. Given in combination with humour, effectiveness may vary depending on the informative value included in the message.

An experiment was conducted with Belgian dairy farmers, in light of a future social marketing campaign against anti-parasitic drug abuse. The farmers were exposed to an advertisement containing either a one- or a two-sided message with or without humour. The main effect of message sidedness on their intention to change their behaviour was not supported, however when humour was included, a moderating effect was found. Negative responses towards the message were identified as mediators to understand the effect of the advertisement on behavioural intention. Support was found for the moderated mediation through negative cognitive responses, but not through negative affective responses. This could imply different mechanisms and routes of persuasion for communication strategies in a specific context.

In contrast to research for message sidedness in commercial marketing (Eisend, 2006), two-sided messages increased negative cognitive responses for the discouraging advertisement. This result shows an unexpected effect of message sidedness on behaviour change, therefore we elaborated on possible explanations for this undesired effect. Eisend suggested (2006) that in case of positive prior attitudes, a two-sided message would increase negative cognitive responses, since the message is perceived

counter-attitudinal and consumers are not aware of the negative information. However, this was never supported in research. Nevertheless, following this deliberation, Eisends' suggestion finds support in the theory of psychological reactance (Brehm, 1966). Psychological reactance describes peoples' reactions when faced with persuasive messages that are counter-attitudinal and attempt to limit their behavioural freedom. People will experience negative emotions and cognitions, followed by a motivation to restore that freedom (Dillard and Shen, 2005). A two-sided message presents a negative argument to discourage people from behaving in a certain undesired way, provoking psychological reactance. Additionally, a two-sided message contains a positive argument in favour of that certain behaviour. This positive argument is a supportive tool and restores peoples' former attitudes, creating arousal and a stronger motivation for freedom restoration. Consequently, two-sided messages will increase reactance and result in more negative responses.

Another plausible explanation is found in the theory of hyperbolic discounting. This theory proposes a difference in peoples' preferences for an immediate reward against a future reward (Frederick et al., 2002). Correspondingly, delayed consequences of certain behaviour will be less effective in changing a persons' behaviour than immediate consequences. Accordingly, providing a two-sided message for a delayed consequence (cf. anthelmintic resistance) with an immediate reward (ease of use) will be less effective than presenting a one-sided message. Because the one-sided message presents only the threat related to this behaviour, people will anticipate and discount the negative consequences. However, in the two-sided message the immediate reward will trump the anticipated consequence, and lead to poorer message effectiveness. Although this study was not set up to control for hyperbolic discounting or psychological reactance, these can be valuable explanations for the reversed results found in this study. However, this reasoning is inconclusive and demands additional research to confirm this discussion. Moreover, future studies could focus on both discouraging and encouraging a certain behaviour, as this study was limited to one. One could explore if similar negative effects of two-sided argumentation in social marketing occur for both situations.

Second, humour is identified as a moderator for message sidedness in social marketing. The hypotheses are supported and using humour is an effective strategy for two-sided persuasion, rather than one-sided persuasion. The one-sided message provides low informative value and humour will act as an additional stimulant to create negative arousal. Whereas, if the two-sided message provides the right level of informative value, attention will be divided between humour and the message. Results showed no effect for

the affective route of persuasion, which could imply superiority for the cognitive mechanism for humorous persuasion in social marketing. However, this study focused on perceived negativity due to the threat message, therefore only negative affective responses were included. Research by Yoon et al. (2015) showed similar insignificant effects of humour on negative emotions, but attributed the effect of humour in threat advertising through positive emotions (happiness and hopefulness). Future research could provide more in-depth information on different affective mechanisms of humour in threat persuasion and message sidedness, since both strategies lack research in this field.

Finally, this study stresses the importance of research when translating a communication strategy from one field to another. While some practitioners feel that marketing practices can be easily applicable from the for-profit field to the non-profit field, others stress that this dominant exchange paradigm is currently ill equipped, and maybe some marketing practices do not apply to the context of non-profit organizations (Pope et al., 2009). This study presented an unexpected negative effect of two-sided argumentation on negative cognitive responses, contrary to the commercial marketing literature (Eisend, 2007). Similarly, in commercial advertising the effects of humour are supported through the affective mechanism, rather than the cognitive mechanism, which is somewhat contradicted by the results in this study. However, these statements are based solely on the results of this single study and should be acknowledged as possible chance finding. Another limitation of this study is the rather small sample size due to the limited population, the results would benefit from reproduction with other similar populations (e.g. beef-cattle farmers). These limitations present opportunities for future research on two-sided and humour advertising in an environmental or pro-social context. Nevertheless, caution is needed when translating commercial communication strategies into other communication fields. Some effects are not accounted for in commercial advertising research, which could backfire and result in undesired behavioural outcomes.

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CHAPTER 5

PUSH AND SHOVE – THE SOCIAL INFLUENCE OF ENDORSER TYPE ON FARMERS'

ENVIRONMENTAL BEHAVIOUR INTENTIONS

Adapted from

Abstract

This study investigates how to change farmers' environmental behavior, as many environmental problems are often rooted in aspects of traditional agricultural production, more specifically livestock farming. By using social influence, more specifically, injunctive norms in public service announcements (PSA), this study tries to change their intentions for more sustainable anti-parasitic drug control. It focuses on two endorser types expert vs. peer), considered as distinguished subjective norms, to change farmers' behavioral intentions. Furthermore, the endorsers' ability to either discourage (proscriptive message content), or encourage (prescriptive message content) behavior were established. The effects of both endorser and message content on behavioral intention were measured through three mediators: expertise, trustworthiness and similarity. Using a 2 (endorser type: expert vs. peer) x 2 (content type: proscriptive vs. prescriptive message) between-subjects design (N = 143), the persuasiveness of the advertisement was verified. Results show that an expert endorser (veterinarian) had a direct increased effect on behavioral intentions, compared to a peer endorser (farmer). Moreover, an indirect effect was found and mediated through similarity, which emphasises the power of the in-group for social influence and for farmers in general. The different content types had no effect on behavioral intention, not even when presented by different endorsers.

5.1.   INTRODUCTION

Pro-environmental approaches in agricultural production have been developed to mitigate biodiversity loss, dry-land salinity, and water conservation, as environmental problems are often rooted in aspects of traditional agricultural production, more specifically livestock farming (Islam et al., 2013). However, the uptake of these sustainable approaches has been insufficient and adoption of these practices rather disappointing (Price and Leviston, 2014). Farming has become a business model, creating individualism and competition (Stock and Forney, 2014). Economic motives have become a major driver in today's farming. This makes it difficult for agricultural extension education services (AEES) to stimulate voluntary and pro-environmental behaviors that merely benefit the community and the environment (Lioutas and Charatsari, 2011). Therefore, many agricultural studies have focused on how to induce farmers' environmental behavior (Battershill and Gilg, 1997; Burton, 2014; Feola et al., 2015; Mills, 2012; Yazdanpanah et al., 2014) and on the identification of the barriers and benefits for changing this behavior (Anneberg et al., 2016; Ingram et al., 2016; Mills et al., 2017; Sutherland et al., 2016). However, there is a surprising lack of studies on the marketing of AEES (Lioutas and Charatsari, 2011). To our knowledge, few studies observed experimentally how communication strategies could be used to induce a change in attitudes, intentions or behavior. More specifically, not much research has been conducted for exploring sustainable anthelmintic (anti-parasitic) drug usage in livestock farming. Therefore, this study will empirically test a combination of communication strategies to induce sustainable anthelmintic use on dairy farms.

Gastrointestinal parasite infections are a major threat for animal health, productivity, and profitability of most livestock animals, and pasture-based dairy herds in particular (Charlier et al., 2014). Relatively inexpensive, but highly efficacious drugs were developed to prevent gastrointestinal parasite infections and concomitant production losses (Woods and Knauer, 2010). As a result, gastrointestinal parasite control in livestock now largely depends on the use of anthelmintic drugs (Kaplan, 2004). Unfortunately, the intensive use of anthelmintics in cattle has correspondingly led to several environmental problems for both fauna (Adler et al., 2016; Beynon, 2012) and soil flora (Eichberg et al., 2016), and the development of anthelmintic resistance (Kaplan, 2004). These developing difficulties emphasise the need for sustainable control approaches with less intensive use of anthelmintic drugs (Charlier et al., 2014). Though, the benefits of anthelmintics are mainly for the individual farmer and immediate, while the negative consequences affect the community and environment in a distant future (Sutherland and Leathwick, 2011). Additionally, due to previous issues on antimicrobial

resistance, dairy farmers feel easily attacked and under pressure when it comes to given advice on drug misuse (Vande Velde et al., 2018). This is especially challenging for AEES to create awareness and communicate in a non-offensive manner about the threat of anthelmintic resistance. Similar to other pro-environmental approaches, the uptake of such sustainable parasite control practices is rather limited and disappointing (McArthur and Reinemeyer, 2014).

Reasoning that farmers will continue to engage in behaviour that offers them personal benefits, and given that for some environmental behaviour immediate benefits are extremely limited and not immediately visible, communication strategies should shift focus from personal benefits when promoting behavioural change. Therefore, one should use a communication strategy that may convince people to make behavioural sacrifices with little immediate personal reward (Lapinski et al., 2007; Schultz, 2014). Social influence is a technique used to increase behavioural change through emphasizing collective and normative behaviour (Nolan et al., 2008). Previous studies on the adoption of sustainable practices identified subjective norms (i.e., a distinct dimension of social influence referring to the influence of significant others), as a strong influencer of farmers' intention to change their behaviour (Borges and Oude Lansink, 2016; Martínez-García et al., 2013; Vande Velde et al., 2015). Hence, this study was set up to examine whether referring to these social influences in public service announcements (PSA) can increase farmers' pro-environmental intentions. In addition, this paper will unravel the effects of different types of endorsers (i.e. expert versus peer endorser). In this case, the veterinarian will represent the expert, and another dairy farmer the peer endorser. Moreover, this experiment will examine how the message should be designed, either focusing on promoting or discouraging a certain behaviour, and which type of endorser is best suited for either message. In conclusion, this paper will shed light on the use of social influence for a less explored field in veterinary science, which is communicating to farmers on pro-environmental behaviour.

5.2. LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

5.2.1. Social influence and social norms

Social influence can be defined as a form of motivation based on attitudes and behaviours of others in our social midst (Cialdini et al., 1990). It is an influence based on social norms, that is, the perceived approval or disapproval and behaviour of others, and the motivation to comply. Norms encourage people to behave in accordance with values and actions held by the broader community or a certain society (Terrier and Marfaing, 2015). Cialdini et al. (1991, 1990) differentiated between two types of social norms in

their *focus theory of normative conduct*: injunctive and descriptive norms. Injunctive norms indicate the attitude of others; it is the perceived approval or disapproval concerning a particular issue or behaviour that the majority of a social group holds. They guide behaviour through social pressure linked to the evaluation of a certain behaviour, by indicating what ought to be done, based on the perceived degree of social approval or social sanction when violating or not complying to that norm (Rimal and Lapinski, 2015). Descriptive norms on the other hand, refer to beliefs about the actual behaviour of a social group (Lapinski and Rimal, 2005). In contrast to an injunctive norm, a descriptive norm represents the actual behaviour without the moral component (Hamann et al., 2015). Both norms have an immediate effect on both intention and behaviour, however they do not necessarily exert the same degree of influence at all times or in all contexts (Cialdini et al., 1990). Rather, according to the theory of normative conduct, norms motivate behaviour when they become salient. Social norms can be operationalised separately and each type of norm has an independent influence on certain behaviour (Park and Smith, 2007). Thus, whether a descriptive or injunctive norm is primarily activated in any given situation should help predict which norm has greater influence on an individuals' behaviour in that particular circumstance. Both norms have been successfully applied in various environmental contexts, such as sustainable consumption, re-use of hotel linen, energy conservation, and reducing paper waist (Cialdini, 2007; Demarque et al., 2015; Goldstein et al., 2007; Hamann et al., 2015; Hardeman et al., 2017; Schultz, 2008; Smith et al., 2012). However, results indicate that emphasizing injunctive norms, compared to descriptive norms, has been more effective for situations characterised by misconducts (e.g. environmental pollution), as it focuses on what is rather right than regrettably common (Cialdini, 2003). Moreover, when both norms are in opposition, in our case farmers believe that most others use anthelmintic drugs intensively but the general norm advocates for sustainable use, it is more effective to make the injunctive norm salient (Chung and Rimal, 2016). Subjective norms, identified as a strong influence of farmers' intentions (Vande Velde et al., 2015), are to some extend a specific interpretation of injunctive norms (Chung and Rimal, 2016). Therefore, subjective norms will be used in this study to communicate on sustainable parasite control, as this specific behaviour is 'rather right than common'.

5.2.2. Modelling endorsers as subjective norms

Subjective norms, included in the theory of planned behaviour (Ajzen, 1991), refer to the perceived social pressure to enact a behaviour from important others in one's social environment, while injunctive norms is the perceived social pressure to conform and

avoid sanctions from the general social group (Chung and Rimal, 2016). As such, information is likely to affect behavioural decisions when it is provided through someone relevant compared to someone irrelevant to the subject. Modelling the right endorser (i.e., confederates who promote a recommended behaviour) for an intervention can therefore determine the success of a campaign. Two types of endorsers seem fitted to perform some sort of social pressure on the subject: peer and expert. Subjects are more likely to comply to a certain behaviour if they perceive some sort of similarity with the other person (Abrahamse and Steg, 2013), hence a peer endorser. On the other hand, an expert endorser shows authority through his/her expertise and trustworthiness on a certain topic (Friedman et al., 1976). This authority can also evoke some pressure to behave in a certain way. For farmers in particular, the veterinarian is seen as the most important advisor and expert on disease control (Ritter et al., 2017). The perceived expertise on parasite control and trustworthiness can be effective for persuading farmers into behaviour change. Instead, other farmers are perceived equals, coping with similar on-farm problems (e.g. disease outbreaks, economic demands). This similarity can also work beneficial for changing behaviours amongst peers. Therefore, both types of endorsers seem fitted to encourage the subjects' intention to change, which leads to this study's research question:

RQ*: which type of endorser will have a more positive effect on the intention to change behaviour?*

Similarity, expertise and trustworthiness are specific traits of the endorsers (Friedman et al., 1976), and are therefore likely to mediate the effect on behavioural intention.

H1a: The effect of the peer endorser on behavioural intention will increase through similarity.

H1b,c: The effect of the expert endorser on behavioural intention will increase through expertise (H1b) and trustworthiness (H1c).

5.2.3. The moderating role of the endorser on message content

Another way of manipulating injunctive norms in messages is through worded behavioural commands (Bergquist and Nilsson, 2016). As such, normative content can be negatively or positively framed within the message using proscriptive (i.e. negatively worded) behavioural commands (i.e. injunctive norms), or prescriptive (i.e. positively worded) behavioural commands. Proscriptive messages are designed to discourage behaviour, while prescriptive messages are intended to encourage behaviour. Emphasizing injunctive norms has been demonstrated to be more effective in the context of dissuading environmentally harmful behaviours (Chung and Rimal, 2016),

however those can evoke negative responses resulting in less compliance of the behaviour (Bergquist and Nilsson, 2016). It is therefore expected that an expert endorser will be more suited to present a proscriptive message, since its authority and expertise is less likely to evoke negative responses compared to a peer endorser.

On the other hand, supporting environmentally beneficial behaviours has been more effective if presented by compatible injunctive and descriptive norms (Cialdini, 2003; Hamann et al., 2015). The descriptive norm represents the perceived behaviour of the social group (e.g. a peer group). Therefore, a prescriptive message (i.e. supporting the behaviour) is likely to be more effective when presented by a peer endorser, as a peer represents someone the subject feels related to, or identifies himself with.

H2: A proscriptive (compared to a prescriptive) message will have a greater effect on the behavioural intention when presented by an expert endorser (H2a), while a prescriptive (compared to a proscriptive) message will have a greater effect on the behavioural intention when presented by a peer endorser (H2b).

5.3. MATERIALS & METHODS

5.3.1. Stimulus material and pre-test

The PSA was set up to change current control approaches for anthelmintic use on dairy farms, since drug resistance is becoming a severe risk. Both the veterinarian and the colleague-farmer were identified as important influencers for dairy farmers in past research (Ritter et al., 2017). Accordingly, these were implemented as subjective norms and represented in the PSA by two particular types of endorsers: the peer (i.e. the colleague-farmer as a reference of the farmers' social group) and the expert (i.e. the veterinarian as the most important advisor on farm). Endorsement was operationalised both in the representation of the model (i.e. specific clothing), as in the written message (i.e. name and profession). Attractiveness was held constant throughout the different advertisements by using the same male model with a similar facial expression. Content was manipulated by discouraging unsustainable control, the proscriptive norm (i.e. "Stop improvident worm-treatment"), or encouraging sustainable control, the prescriptive norm (i.e. "Diagnose before worm-treatment"). The used stimuli are presented in the figures underneath.

A pre-test with 67 dairy farmers revealed successful manipulations for both endorser- as content type. Content type was measured through a one item semantic differential, and gauged whether the respondents thought the advertisement included an encouraging or discouraging message (i.e. "What was the focus of the message? – Encourage certain behaviour/Discourage certain behaviour"). The proscriptive norm (M

= 2.62, SD = .42) was perceived less encouraging than the prescriptive norm (M = 4.29, SD = .42), $F(1, 62)$ = 7.79, p < .001. Endorser-type was with one item, to gauge whether the veterinarian and the dairy farmer were perceived as such (i.e. "Who was shown in the advertisement? – Veterinarian/Dairy farmer"). The crosstab shown in Table 5.1. presented a successful manipulation of the endorser type ($X^2(1)$ = 52.08, p < .001).

Figure 5.1.
Peer with proscriptive norm
Stop improvident worm-treatment

Figure 5.2.
Peer with prescriptive norm
Diagnose before worm-treatment

Figure 5.3.
Expert with proscriptive norm
Stop improvident worm-treatment

Figure 5.4.
Expert with prescriptive norm
Diagnose before worm-treatment

Table 5.1.
Crosstab for endorser type pre-test

	Who was shown in the ad?		Total
Stimuli	Dairy farmer	Veterinarian	
Dairy farmer	34	1	35
Veterinarian	3	29	32
Total	37	30	67

Note. 0 cells (0,0%) have expected count less than 5. The minimum expected count is 14.33.

5.3.2. Study design and participants

A 2 (content type: proscriptive vs. prescriptive injunctive norm) x 2 (endorser type: peer (i.e. farmer) vs. expert (i.e. veterinarian)) between-subjects design was employed in which participants were randomly assigned to one of the four conditions. Three

hundred dairy farmers received an invitation by email to participate in a survey set up to improve communication to farmers. To increase the response rate, an incentive (lottery) was provided in which the participants could win an I-Pad and 20 duo film-tickets. A total of 143 farmers participated in the study. After watching the PSA, respondents had to complete a questionnaire to measure the mediating and dependent variables. An overview of all measured variables used for the study can be found in Table 5.2.

Table 5.2.
The constructs used for the measurement of the variables in the study.

Construct label	Item label	α	Item statement	Item measurement
Endorser type	Endorser		Who was shown in the advertisement?	**Veterinarian/Dairy farmer**
Content type	Content		What was the focus of the message?	**Discouraging– Encouraging** Bipolar 7-point scale
Expertise	E 1	.88	What is your opinion on the person depicted in the ad, considering treatment of worm infections:	**Not an expert – Expert** Bipolar 7-point scale
	E 2		What is your opinion on the person depicted in the ad, considering treatment of worm infections:	**Inexperienced – Experienced** Bipolar 7-point scale
	E 3		What is your opinion on the person depicted in the ad, considering treatment of worm infections:	**Unknowledgeable – Knowledgeable** Bipolar 7-point scale
	E 4		What is your opinion on the person depicted in the ad, considering treatment of worm infections:	**Unqualified – Qualified** Bipolar 7-point scale
Trustworthiness	T 1	.92	What is your opinion on the person depicted in the ad:	**Dishonest– Honest** Bipolar 7-point scale
	T 2		What is your opinion on the person depicted in the ad:	**Unreliable – Reliable** Bipolar 7-point scale
	T 3		What is your opinion on the person depicted in the ad:	**Insincere – Sincere** Bipolar 7-point scale
Similarity	S 1	.91	I have a lot in common with the person depicted in the ad	7-point Likert response format*
	S 2		I can easily identify with the person depicted in the ad	7-point Likert response format
	S 3		I resemble the person depicted in the ad well	7-point Likert response format
Behavioral intention	BI 1	.87	I'll look for information on anthelmintic resistance	7-point Likert response format
	BI 2		I'll alert my immediate surroundings about the possible risks of misuse	7-point Likert response format
	BI 3		I'll consult my veterinarian for more information	7-point Likert response format
	BI 4		I expect to use less anthelmintics preventively on my farm	7-point Likert response format
	BI 5		I'll expect to diagnose my animals before treatment	7-point Likert response format
	BI 6		I will use less anthelmintics preventively on my farm	7-point Likert response format

* 1 = strongly disagree; 2 = disagree; 3 = slightly disagree; 4 = neutral; 5 = slightly agree; 6 = agree; 7 = strongly agree

5.3.3. Analyses

First, manipulations were controlled using a cross-tabulation analysis for the endorser type, and an analysis of variance (ANOVA) for the content manipulation. Second, to explore the data, the inter-correlations of the variables used for further analyses were

tested. Finally, a mediation and moderation analysis using Hayes' PROCESS macro (Hayes, 2013) was used to test the hypothesised models. Both independent variables were dummy coded, endorser type: 0 equaled the peer endorser and 1 equaled the expert endorser, content type: 0 equaled the proscriptive norm and 1 equaled the prescriptive norm. The model-mediators (i.e., expertise, similarity, and trustworthiness), and dependent variable (i.e., behavioral intention) were continuous. The mediation was measured through Model 4, and the moderation through Model 1 (Hayes, 2013). All regression analyses were measured with 5000 bootstrap resamples and 90% bias-corrected confidence intervals.

5.4. RESULTS

5.4.1. Manipulation Checks

The proscriptive norm (M = 2.13, SD = .29) was perceived less encouraging than the prescriptive norm (M = 4.45, SD = .27), F (1, 143) = 34.40, p < .001. Furthermore, six respondents were deleted, as they could not remember which type of endorser they had seen and an additional 10 respondents were deleted as they had mistaken the endorser type. The crosstab (Table 5.3.) showed a successful manipulation of the endorser type (X^2 (1) = 100, p < .001).

Table 5.3.
Crosstab for endorser type

	Who was shown in the ad?		Total
Stimuli	Dairy farmer	Veterinarian	
Dairy farmer	64	4	68
Veterinarian	6	63	69
Total	70	67	137

Note. 0 cells (0,0%) have expected count less than 5. The minimum expected count is 33.26.

5.4.2. Correlational Analysis

The correlation matrix showed significant inter-correlations between behavioral intention and the intermediate variables: expertise (E), similarity (S), and trustworthiness (T), see Table 5.4.

Table 5.4.
Correlation matric for presented variables in the models: E, T, S, BI

Factor	E	T	S	BI
E	1.000			
T	0.671**	1.000		
S	0.373**	0.550**	1.000	
BI	0.289**	0.300**	0.264**	1

Note. Pearson correlation coefficients based on 5000 bootstrap samples are presented above (N = 127).
E = Expertise; T = Trustworthiness; S = Similarity; BI = Behavioral Intentions
**. Correlation is significant at the .01 level (2-tailed).

5.4.3. Mediation Analyses

Results of the model analysis revealed a direct positive effect of endorser type on behavioral intention (c = .37, SE = .22, 90%, CI: .01 to .73), presenting a stronger direct influence of the expert endorser on behavioral intention. The total indirect effect of the mediation was not significant (point estimate = -.11, 90%, CI: -.34 to .10). Furthermore, results show that endorser type does not have a significant indirect effect on behavioral intention through expertise (point estimate = .05, 90%, CI: -.03 to .20) or trustworthiness (point estimate = -.03, 90%, CI: -.15 to .01), rejecting both H1b and H1c. Although the expert endorser increased the perceived expertise (a = .60, SE = .26, 90% CI: .18 to 1.03), it did not affect the behavioral outcome (b = .09, SE = .11, 90% CI: -.09 to .26). The endorser type did not affect the trustworthiness of the source (a = -.31, SE = .25, 90% CI: -.73 to .11). Similarity on the other hand, was a significant mediator for the effect of endorser type on behavioral intention (point estimate = -.13, 90%, CI: -.30 to -.03). This result presents a positive effect of the peer endorser on the behavioral outcome, as it increases the perceived similarity (a = -.76, SE = .23, 90% CI: -1.15 to -.37), which subsequently has a moderate positive effect on behavioral intention (b = .17, SE = .09, 90% CI: .02 to .32), supporting H1a. Results of the mediation are shown in Figure 5.5.
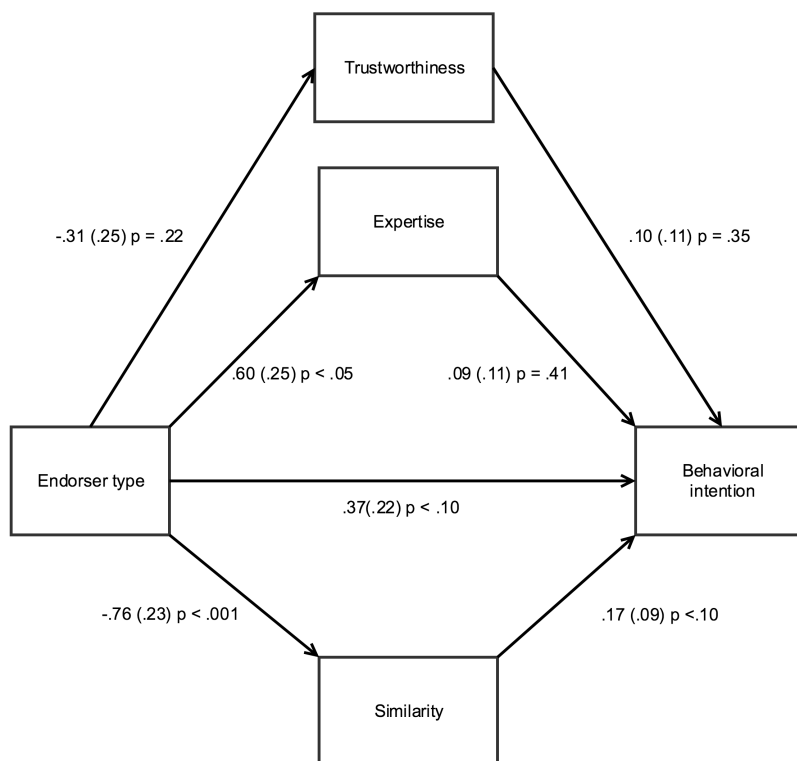

Figure 5.5.

Effect of endorser type on behavioural intentions. Coefficients of the mediation (Model 4, Hayes, 2013)

5.4.4. Moderation Analysis

The model was not significant (F (1, 120) = .03, p = .86), as such, the main effect of content type was not significant (a = .17, SE = .60, p = .78), nor was the interaction (b = -.07, SE = .39, 90%, CI: -.71 to .57), rejecting hypotheses H2a and H2b. Moreover, the conditional effects of content type (i.e. independent variable) on behavioral intention were not significant for the peer endorser (c = .10, SE = .27, 90%, CI: -.35 to .54), nor for the expert endorser (c = .03, SE = .28, 90%, CI: -.43 to .48).

5.5.   DISCUSSION

The objective of this study was to test the effect of social influence on farmers' environmental behaviour. In particular, which type of endorser is best suited to communicate pro-environmental information, and whether this affects the conditions under which certain behaviour is best promoted, otherwise discouraged. Injunctive norms were made salient through behavioural commands, and by using an endorser as subjective norm (i.e. specific injunctive norm).

The findings of this study suggest the expert as the most fitted endorser to promote pro-environmental behaviour to dairy farmers. Although the peer endorser also presented a positive effect on behavioural intentions mediated through similarity, this effect was fairly low (point estimate = -.13) compared to the direct effect of the expert on behavioural intentions (point estimate = .37). However, it should be emphasised that the nature of the expert endorser for this study is quite case specific. A veterinarian is not only seen as a distant expert, to most farmers (s)he is also one of the most reliable, personal advisers for their business (Ritter et al., 2017). A study by Smith and Louis (2008) revealed a positive influence of the in-group (i.e., groups that an individual belongs to) compared to largely ineffective influence from the out-group (i.e., groups that the individual does not belong to) on intentions and behaviour, in interaction with social norms. Therefore, we believe that the positive effect is partly due to the in-group status of the veterinarian towards the farmer. A more distant expert (e.g. food retailer) may exert less pressure as subjective norm, and subsequently decrease the influence on behavioural intentions. This effect of in- or out- group norm on different types of expert endorsers should be further examined, as these could be important assets for EAAS when promoting pro-environmental behaviour, or behaviour change in general, to farmers.

The importance of the in-group status is also supported by the mediated effect of similarity on behavioural intentions, which again emphasises the importance of personal distance in social influence. This benefits the peer, as he was perceived more

similar compared to the expert endorser. Comparable positive effects of group identity, or group proximity (i.e. the distance between self and the reference group), were reported for descriptive norms (Mabry and Mackert, 2014; Neighbors et al., 2011). To our knowledge, this was never verified for injunctive norms, or subjective norms in particular. Therefore, this study contributes additional usage of the factor 'group identity' into the social norms literature. This study proposed identity as a mediator, but it could be further tested as a moderator for social influence.

The mediators 'expertise' and 'trustworthiness' had no effect on behaviour intention, which results in no indirect effect from the endorser type through neither of the mediators. Although perceived expertise of the expert endorser was higher than that of the peer endorser, perceived trustworthiness did not differ between the two endorsers. This may be explained by the non-verbal character of trustworthiness. Other signals and cues such as 'a friendly smile' may have an effect on the trustworthiness of a person (Wood, 2006). Because this research used one and the same model for the endorser types, this non-verbal effect remained equal for both endorsers. Moreover, the effect of the veterinarian touching the cow as a form of non-verbal communication did not elevate the trustworthiness of the source. Therefore, the veterinarian is perceived as a source with more expertise, rather than being trustworthy.

The moderating role of endorser type on message content (i.e. proscriptive vs. prescriptive) is not supported throughout this study. Whether a message is set up to discourage or encourage certain behaviour, is not affected by the nature of the endorser, nor by its own content. This again suggests the importance of the person communicating the message, and to a lesser extend the message itself.

Certain limitations should be addressed for the interpretation of the discussed results. First, the specificity of the researched subjects has to be taken into account, since endorser types are very group and behaviour specific and therefore caution is required when extrapolating these research findings into pro-environmental communication strategies for other subjects or behaviours. Secondly, this is a single case study that would benefit from reproduction with other similar populations (e.g. beef-cattle farmers).

In conclusion, the effect of the endorser type as particular social influencer is confirmed for changing farmers' behavioural intentions. The expert, being a veterinarian, is proposed as more suitable for endorsing pro-environmental messages. However, one should also consider the power of group identity when using social influence in a PSA, or similar message.

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CHAPTER 6 – General Discussion

6.1. DISCUSSION OVERVIEW

The objective of this thesis was to understand Flemish dairy farmers' behaviour on the adoption of sustainable gastrointestinal nematode (GIN) control, and to apply this knowledge to develop effective communication strategies to raise awareness on this issue. The uptake of advice for sustainable control (i.e. evident-based approach depending primarily on the use of different diagnostic markers, and only secondly on the implementation of anthelmintic drugs to the targeted group of animals) is rather limited, and the need for behavioural change is growing with the emerging risk of anthelmintic resistance (AR). Moreover, little is known on factors influencing cattle farmers' behaviour for GIN control in particular. Therefore, this final chapter will assemble the main findings of the socio-epidemiological research performed within this PhD project, and how these were translated into effective communication strategies. By presenting how the results from qualitative and quantitative studies can be translated into advice and subsequently verified with communication experiments, this thesis contributes to the current knowledge within the field of veterinary parasitology on changing dairy farmers' behaviours. The chapter will begin with a brief discussion on the two main research questions and how these were tackled throughout the PhD project by each separate study, followed by a more in-depth elaboration of the results throughout the whole project. Furthermore, the limitations of this work will be discussed, along with suggestions for future research on the matter. Lastly, the chapter will present practical and evidence-based guidelines for developing a communication campaign, aimed at raising farmers' awareness on the importance of a sustainable anthelmintic use.

6.2. A BRIEF UNRAVELLING OF THE RESEARCH QUESTIONS

The literature review presented in Chapter 1 of this dissertation exposed a lack of knowledge on farmers' behaviour for GIN control. However, this knowledge is necessary in order to persuade farmers to change their current, improvident control into sustainable practices. This led to the first research question of the PhD project: '**What drives the farmer towards the adoption of sustainable GIN control?**' Accordingly, in Chapter 2, a behavioural framework was constructed to identify the socio-psychological factors influencing dairy farmers' adoption intentions of diagnostic methods for sustainable control. This framework was verified with data from a large-scale survey, with participants selected from across the entire population of dairy farmers in Flanders. Their positive attitude towards preventive use of anthelmintics was exposed as a barrier for sustainable behaviour intentions, while on the other hand the positive

attitude they held for diagnostics led towards increased sustainable intentions. Subjective norms (i.e. perceived opinion of significant others) showed the strongest influence on the adoption intentions of diagnostics. The perceived risk of anthelmintic resistance had no effect on adoption intentions. Although the framework gave a good, general view of the farmers' intentions, specificity of the beliefs behind the exposed factors was lacking. Moreover, despite a strong adoption intention for diagnostics, actual adoption is rarely established (Chapter 1), indicating a gap between intentions and actual adoption. Accordingly, a qualitative study (Chapter 3), using in-depth interviews, was set up to elaborate further on the underlying beliefs of the framework, and the gap between intention and behaviour. The results indicated an active process of behaviour with three different phases of adoption: intention, behaviour and maintenance. Firstly, new factors were identified as additional barriers for adoption intentions: 'infection awareness' and 'top of mind' (i.e. low priority ranking of disease). Secondly, the beliefs underlying the attitude towards preventive use of anthelmintics were based on economic motives, while the attitude towards diagnostics was more influenced by moral motives. Thirdly, farmers' behaviour is guided by two important social norms: the opinion of their veterinarian and their fellow farmers. However, farmers hold an incongruent relationship with both norms throughout the different stages of behaviour: they do not value other farmers' opinions as a positive reference (intention phase), but follow and mimic their behaviour as a group (action phase). Therefore, 'community' was identified as a barrier between intention and behaviour, as well as 'responsibility' and 'habits'. Responsibility was considered a barrier as the veterinarian was seen as final responsible actor of disease control on farm. Habits on the other hand are behaviours driven by routine, which impede farmers to perform some new behaviour. Finally, for an adoption to succeed, the behaviour should be maintained, this final action is easily underestimated.

The results from this behavioural exploration urged for the second research question in this PhD project: **'how can we use this newly gained knowledge to encourage farmers to change their current GIN control?'** The question was handled in two steps, with similar methods. Public service announcements (PSA) were created with short persuasive messages, and their effectiveness verified through communication experiments. A PSA is an advertisement in the public interest with the objective of raising awareness, and eventually changing public attitudes and behaviour towards a social issue. The first step (Chapter 4) was set up to raise awareness of AR and subsequently decrease the farmers' positive attitude towards anthelmintics. Both awareness and attitude towards preventive use of anthelmintics were identified as

barriers for farmers' sustainable intentions in previous behavioural research. Therefore, this chapter was established to tackle these important barriers. Communicating about an unknown hazard can in itself be risky, as it can evoke negative responses towards the message, certainly if the damage is self-inflicted (e.g. the current improvident use of anthelmintic drugs). Both humour and two-sided argumentation are known to decrease these negative responses, and were therefore implemented in the PSA. The PSA including both strategies, and the PSA without humour or two-sidedness, resulted in effective messages for increased intentions. Thereafter, step two (Chapter 5) created a call to action to stimulate behavioural change. Here, subjective norms were used in the PSA, by using different endorsers to promote the message: the expert (a veterinarian), and the peer (a farmer). These were previously acknowledged as important drivers for adoption of sustainable control. Using an expert to stimulate adoption intentions was more effective than using a peer endorser to promote the message, although the latter did have a positive indirect effect on intentions through similarity, which emphasizes the importance of the in-group, in particular the community for a farmer.

6.3. THE INTENTION PHASE OF ADOPTION

The adoption process of diagnostic methods for GIN occurs through three different phases: adoption intention, actual adoption, and maintenance. The intention phase is a more cognitive oriented and motivational part of farmers' behaviour. It has been well documented in social veterinary epidemiology with behavioural models, where the *Theory of Planned Behaviour* (Ajzen, 1991) and the *Health Belief Model* (Rosenstock, 1974) are most commonly used to explain and predict farmers' behaviour. Chapter 2 of this thesis describes the use of these theories to predict farmers' adoption intentions of diagnostic methods. Quantitative data validated the theoretical framework (i.e. the intention phase), resulting in identified barriers (i.e. factors that negatively influence intentions) and benefits (i.e. factors that positively influence intentions). The beliefs and motivations driving these factors were examined in the qualitative study presented in Chapter 3. These data were also used to further refine the framework, and additional barriers surfaced. Figure 6.1. presents the main contributions of both studies combined, and underneath is described how this was translated into communication guidelines.
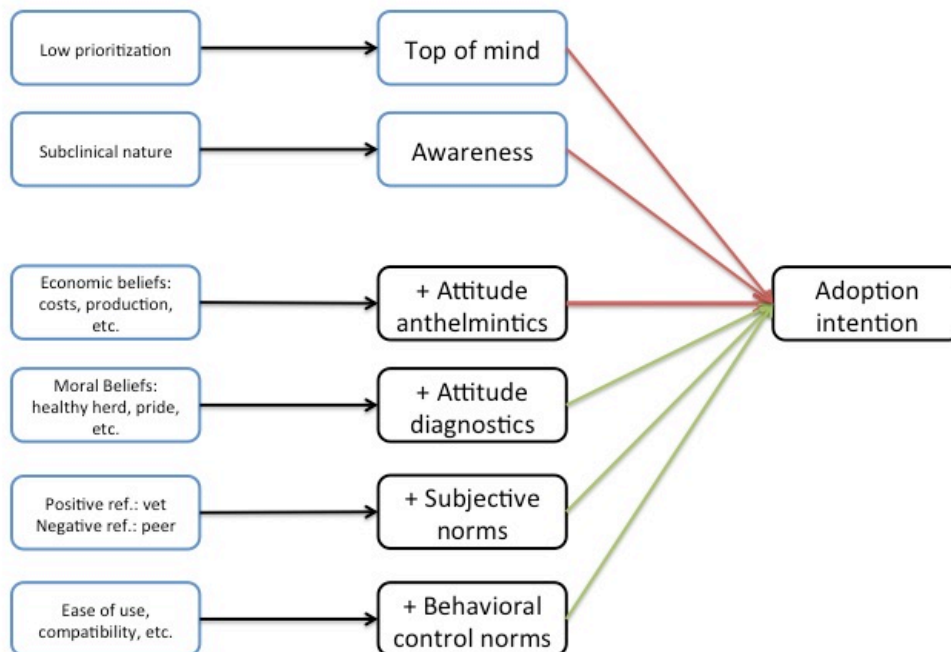
Figure 6.1.
Framework assessing adoption intention.
Note. Arrows: green = positive influence, red = negative influence. Factors: black = derived from Chapter 2 (quantitative study), blue = derived from Chapter 3 (qualitative study). + = positive

6.3.1.   The barriers of sustainable adoption intentions

The limited awareness related to consequences of a systematic use of anthelmintics lies at the root of the problematic uptake of sustainable control. GIN infections are often subclinical, which is maintained by preventive and systematic treatment by the farmers. Consequently, farmers remain oblivious of the infection status on their farm, causing low prioritization of the disease. Because of the subclinical nature of GIN infections treatment failure often remains unnoticed. Up till now, most farmers are ignorant of AR, or they believe their farm to be unsusceptible to the risk. If a risk is considered to be low, it will not motivate people to take actions and change their behaviours (Witte, 1992). The low awareness of both the disease and emerging resistance creates an effect of general contentment of their current control, i.e. treating their cattle systematically with anthelmintic drugs. Therefore, farmers often have a positive attitude towards preventive treatment with anthelmintics, subsequently inhibiting their intentions to adopt sustainable control measures. This barrier for sustainable intentions is enforced by economic reasons such as costs, time, production increase or decrease. All identified

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barriers, i.e. low awareness and risk perception, and positive attitude towards preventive treatment, make it difficult to motivate the farmer.

6.3.2. Creating awareness of a systematic anthelmintic use

The *Trans Theoretical Model* (TTM, Prochaska and DiClemente, 1982), also known as the 'stages of change', is an integrative model of therapy that both assesses an individual's readiness to act on a new healthier behaviour, and provides strategies of change to guide the individual. According to the TTM, an individual is situated at the 'precontemplation stage' when he/she is not ready to act on this new behaviour, he/she is not aware of the possible risks related to the current behaviour and does not intent to take action. Considering all the above, many dairy farmers can be situated in this precontemplation stage. Therefore, a PSA was generated in Chapter 4 to create awareness of anthelmintic resistance and decrease farmers' positive attitudes of indiscriminate preventive treatments as a first step towards behaviour change.

The PSA used two-sided argumentation (i.e. both pro and contra argument) and humour as communication strategies to generate less negative responses and eventually improved acceptance of the message. This was tested through an experimental study, and presented successful results for the PSA using both strategies combined. However, using a single strategy in the advertisement provoked more negative responses, in contrary to the literature of commercial advertisement (Eisend, 2006, 2009). This stresses the importance of research when translating a communication strategy from one field to another. While some practitioners feel that marketing practices can be easily applicable from the commercial field to the non-profit field, others stress that this dominant exchange paradigm is currently ill equipped, and some marketing approaches do not apply to the context of non-profit organizations (Pope et al., 2009). Furthermore, the PSA with only one argument and no humour also presented fruitful results, suggesting that a simple message provided to farmers can be equally effective as more complex strategies. Although the conclusion is based on a single experiment and should be further examined, 'keep it simple' or 'carefully studied' when communicating risks to farmers is a take-home message.

6.3.3. The benefits of sustainable adoption intentions

Benefits are the factors that positively influence adoption intention, and subsequently can be used as a call to action for sustainable control. Farmers had a fairly positive attitude towards diagnostic methods (Chapter 2), which can be used for promoting 'targeted treatment' (TT) (i.e. group treatment based on a marker of infection) and

'targeted selective treatments' or TST (i.e. treatment of identified individual animals) approaches on farm. TT and TST are evidence-based approaches that ensure the efficacy and sustainability of anthelmintics in the future. Therefore, the adoption of diagnostic methods remains the most important behaviour for farmers to implement. The positive attitudes towards these diagnostics are mainly formed by personal and ethical beliefs (e.g. safeguarding their animals' health, taking pride in the farm), in comparison to the more economic beliefs (e.g. reducing costs such as money and workload, production decrease or increase) for preventive anthelmintic treatment (Chapter 3). Hence, farmers' attitudes are behaviour dependent, and thus their intentions will be influenced by different motivations. Previous opinion on the adoption of sustainable worm control practices suggested persuading farmers with more economic incentives and benefits (Besier, 2012). However, this thesis suggests making recommendations for sustainable control based on moral and personal motives, as these are the drivers for farmers' adoption intentions. This could be an explanation for the failed uptake of the current advices, which are primarily based on economic outcomes as described in Chapter 1, and should be taken in consideration for future recommendations.

Finally, the subjective norms (i.e. the perceived opinion of significant others) had the largest effect on adoption intentions (Chapter 2), including the perceived opinion of the veterinarian, family members, opinion leaders, other farmers, and professional farm visitors. The veterinarian was seen as the most important advisor and key figure for disease control on farm. On the other hand, their peers (i.e. other farmers) were perceived as negative references, and their opinions were less valued concerning GIN control. However, the community as a whole did contribute to the actual uptake of sustainable control, albeit on a less conscious level, which is discussed beneath (Chapter 3). Nevertheless, the power of subjective norms on adoption intentions was of great use for sending out a 'call to action' PSA.

6.3.4. Creating a call to action for sustainable control

This 'call to action' targets the innovators and early adopters of a population. According to the *Diffusion of Innovation Theory* (Rogers, 1962), an innovation is primarily promoted through mass communication (e.g. PSA's), which is to be picked up by the early adopters of a population. Later on, the diffusion process will occur on a more personal level for the innovation to succeed in the whole community. Nevertheless, the majority of the population also processes this 'call to action', henceforth awareness of the innovation is created but additional motivation is needed to guide the community towards actual adoption. Using the *Diffusion Theory* as a tool to research and promote

innovative ideas in rural communities is nothing new and 20% of its literature is contributed by the field of rural sociology (Rogers, 2003). The *Diffusion Theory* was mostly used to investigate the introduction of new technologies and agricultural methods into the community of farmers. However, the amount of research in rural sociology is declining and today diffusion research is considered to be relatively out-dated (Rogers, 2003). Nonetheless, the theory can still be used as a general framework for guiding a community into an adoption-process.

The farmers' subjective norms were translated into endorsers (i.e., confederates who promote a recommended behaviour) for the PSA. Modelling the right endorser for an intervention determines the success of a campaign. Because the veterinarian was the most important advisor, and the key figure for disease control on farm, he was targeted as expert endorser for the 'call to action' in another communication experiment described in Chapter 5. Compared to the peer endorser (i.e. dairy farmer), the veterinarian was more effective in transmitting short behavioural messages to the farmers, suggesting that farmers were perceived as a less important reference by their peers (see Chapter 3). Moreover, the success of the expert is partly attributed to the in-group status of the veterinarian, a more distant expert (e.g. food retailer) may exert less pressure as subjective norm with less influence on behavioural intentions. The importance of the in-group status was also supported by the mediated effect of similarity on behavioural intentions, although this was more beneficial for the peer, as he was perceived more similar compared to the expert endorser. Unfortunately, the experiment was limited to the measurement of behaviour intention, the adoption of behaviour was not verified. Future PSA's could also benefit from celebrity endorsers, as those have already proven to be strong influencers for non-profit and voluntary behaviour (Knoll and Matthes, 2017; Wymer and Drollinger, 2014). Key opinion leaders (e.g. innovative farmers, respected and recognised veterinarians) of the community could be targeted for future mass campaigns.

6.4. TOWARDS ACTUAL ADOPTION

Above is explained which are the main benefits and barriers for dairy farmers' intentions to adopt sustainable GIN control, and their usage in a communication strategy to create awareness of both the risk and the treatment. However, intentions comprise the cognitive and motivational part of actual behaviour, and should be placed in a broader perspective (Fig. 6.2). Most work in veterinary socio-epidemiology is restricted to this motivational fragment of behaviour, although some of the latest research explores the possibility of other factors influencing behaviour (McAloon et al., 2017;

Ritter et al., 2017; Swinkels et al., 2015). There is a paradigm shift in veterinary socio-epidemiology, which is slowly moving towards a broader view of farmers' behaviour. Behaviour is not solely driven by intentions, but an active process with other factors that are less controlled by the farmer (e.g. industry, community, habits). Specifically for GIN control on dairy farms, this thesis points towards an intention-behaviour gap. Although adoption intentions of dairy farmers for diagnostic methods were fairly positive, actual adoption was not successful. Underneath, the main explanations for this bottleneck are presented with results from Chapter 3, together with possible strategies to overcome this.
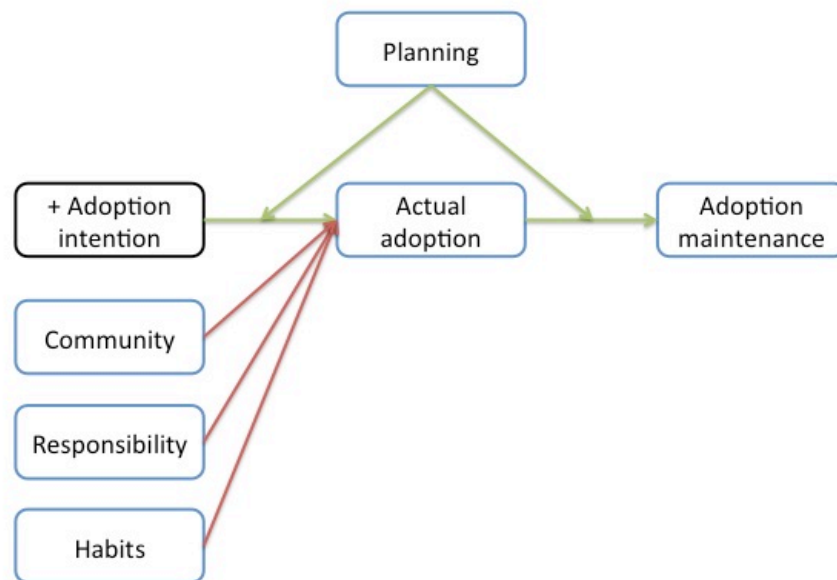

Figure 6.2.
Framework assessing adoption.
Note. Arrows: green = positive influence, red = negative influence. Factors: black = derived from Chapter 2 (quantitative study), blue = derived from Chapter 3 (qualitative study). + = positive

6.4.1. The importance of a farmers' community

As discussed above, 'farmer' as subjective norm was seen as a negative referent, but on the other hand the community as a whole did contribute to certain behaviours. GIN control is rarely discussed among farmers in the community, certainly the topic of sustainable control had been granted little to no attention in our study population. Consequently, a farmer with positive intentions to change his/her control methods will not persevere if the community does not follow. This herd-like behaviour is explained

by the *Social Norms Theory* (Lapinski and Rimal, 2005; Rimal and Lapinski, 2015), where an individual adapts his behaviour to what the majority of his reference group does or thinks (i.e. descriptive norms). Descriptive norms have an immediate effect on behaviour, therefore farmers' community was positioned between intentions and behaviour. Currently this has a negative effect on the adoption of sustainable worm control. However, by implementing certain strategies the community can turn into a positive reference group for the considered behavioural change. Benchmarking strategies have proven valuable when manipulating descriptive norms for communication campaigns (Chung and Rimal, 2016). Furthermore, the TTM considers 'helping relationships' of utmost importance between intention and actual behaviour. Thus, more community-based strategies are needed to drive the behaviour change, such as educational programmes and working groups (i.e. agricultural extension), with more attention for herding the entire community towards a behavioural shift.

6.4.2.   *Planning to take and maintain action*

Lack of planning was recognised as an explanation for failed maintenance of sustainable behaviour on dairy farms that already used some sort of diagnosis in the past. Therefore, planning could be implemented as a helpful tool for both farms that already performed a diagnosis, and farms that had never adopted such measures. Moreover, planning could also help encounter other suggested barriers for actual adoption, i.e. habits and responsibility, since planning new actions could break with old routines and habits. Furthermore, planning this action in ones' personal agenda could raise the responsibility to act, no matter the nature of the behaviour. Using face-to-face communication and more farm-specific advices, the veterinarian, or another animal health representative, could help the farmers with their planning of sustainable GIN control. This can be translated in applying diagnostic measurements for TT and TST, followed by yearly check-ups. As such, planning could also encounter the possibility of ill comprehended advises, which is currently a bottleneck for worm control in livestock (Kenyon et al., 2017). However, reality shows that farmers are not eager to pay for a sit-down with their veterinarian, and those who opt for herd health management are in the minority. Therefore, other strategies should also be considered for bringing these specific plans on the table.

6.5.   LIMITATIONS AND FUTURE OPPORTUNITIES

This thesis identified important factors that contribute to the adoption of sustainable GIN control on dairy farms, and how these can be used to persuade farmers in changing

their current behaviours. However, not everything can be unravelled in one thesis, and novel results raise novel questions. Therefore, this final chapter collects the most important limitations and how these can be addressed in the future. These limitations are subdivided in three categories, characteristic for this thesis: the object of research, the behavioural methods and theories, and the translation of results into communication strategies.

Firstly, the object of research was limited to GIN control for dairy cattle farmers in Flanders. Although several similar results were obtained by studies concerning small ruminants and equines in the UK (Allison et al., 2011; Jack et al., 2017; Rose Vineer et al., 2017), important differences were observed for the uptake of sustainable control, such as awareness of AR and knowledge of GIN control. For other livestock diseases (e.g. for clinical infections, where the awareness is much higher), and in other parts of the world (e.g. cattle farms in the U.S. vs. Europe), different results and models can be expected. Using a mixed-methods approach as presented by this thesis could facilitate the understanding of farmers' behaviours, and establish similar frameworks. Furthermore, the objective of this work was to generate an overall view of dairy farmers behaviour, and did not account for differences between individual farmers. Farmers differ on many perceptions, and can be classified into several categories based on their perceptions, attitudes and behaviour (Charlier et al., 2016; Jansen et al., 2010; Ritter et al., 2016). Although this knowledge is very useful for approaching each farmer with customized advice, substantial resources are necessary to categorize the individual (e.g. time, budget, qualified researchers), and subsequently target the communication according to the identified farmer type.

Secondly, the final framework of this thesis (i.e. established to comprehend farmers' adoption of sustainable control, in Chapter 3), presents some limitations in terms of theory and methodology. The framework should again be validated with quantitative data to put weight on the factors influencing adoption and to represent the entire population. Currently, the framework lacks this certain knowledge due its partially qualitative nature (Chapter 3). Furthermore, the explanation for farmers' behaviour is restricted to factors that can be easily interpreted and fixed into a framework. However, other theories and models explaining human behaviour, which are more difficult to measure and to define, should be taken in consideration when interpreting the final results. Socio-ecological models place individuals' behaviour in micro and macro perspective, a dynamic interrelation among various personal and environmental factors (Bronfenbrenner, 1977). The agricultural innovation systems approach (AIS), is developed to investigate these fields of networks for farmers specifically. This approach

recognizes that what happens on farms is often determined by what happens in the surrounding systems, and farmers' behaviour is often an end-of-pipe decision. Dual processing models integrate both unconscious (e.g. intuitive, impulsive) and cognitive paths in the behaviour, both can be used for persuasion in their own particular way (Kahneman, 2011; Petty and Cacioppo, 1986). Action models consider the motivation-behaviour process to be active and in constant change (Schwarzer, 2008). Although the explanation of human behaviour for each theory is difficult to fixate in factors, their reasoning should be kept in mind when exploring farmers' behaviour.

On the other hand, livestock farming is a business, thus external, economic factors also influence the decision-making process. Results from behavioural research with private horse owners (Rose Vineer et al., 2017) were very similar to those of dairy farmers (Chapter 2), although both populations are moved by different context. Hence, the results obtained through these socio-psychological models take more intrinsic and individual drivers into account, without inclusion of economic rationality. These behavioural models, for farmers in particular, could benefit from the inclusion of production economics. In particular, economic models are established to optimize GIN control approaches from an economic perspective (van der Voort et al., 2017). Incorporating all the above could provide novel insights in farmers' behaviour and present a new view of decision making where socio-psychological factors and economic factors are balanced, together with the regulatory obligations in order to achieve improved animal health management. Subsequently, more targeted and farm-specific advices could be established with an eye on sustainable and profitable results.

The framework presented in Figure 6.3 includes some of the above-mentioned theories. It takes into account that farmers' decision-making is not solely based on one or another discipline but consists of a tangle of different philosophies and research areas. Considering that farmers' behaviour is just regular human behaviour, the majority of the decisions are based on intuition and unconscious paths (Kahneman, 2011). On the other hand, conscious decisions depend on the farmers' environment (e.g. community, industry, institutions), which place the individual farmer into the smallest level of a larger perspective (Bronfenbrenner, 1977). On its turn, conscious decision-making can be divided in three types of behaviour (Mills et al., 2017), initiated by three different motivations: compulsory behaviour based on regulation (external motivations; Jansen et al., 2012), incentive-driven behaviour based on economic rationality (both external and internal motivations), and voluntary behaviour driven by socio-psychological factors (internal motivations; Jansen et al., 2012). These factors (motivations) can also be found in the R.E.S.E.T model for farmers' behaviour change of Jansen et al. (2012). However,

the model does not include intuition, which is based on the assumption that people make unconscious decisions when performing certain behaviour, and should be taken into consideration when investigating farmers' behaviour in the future.
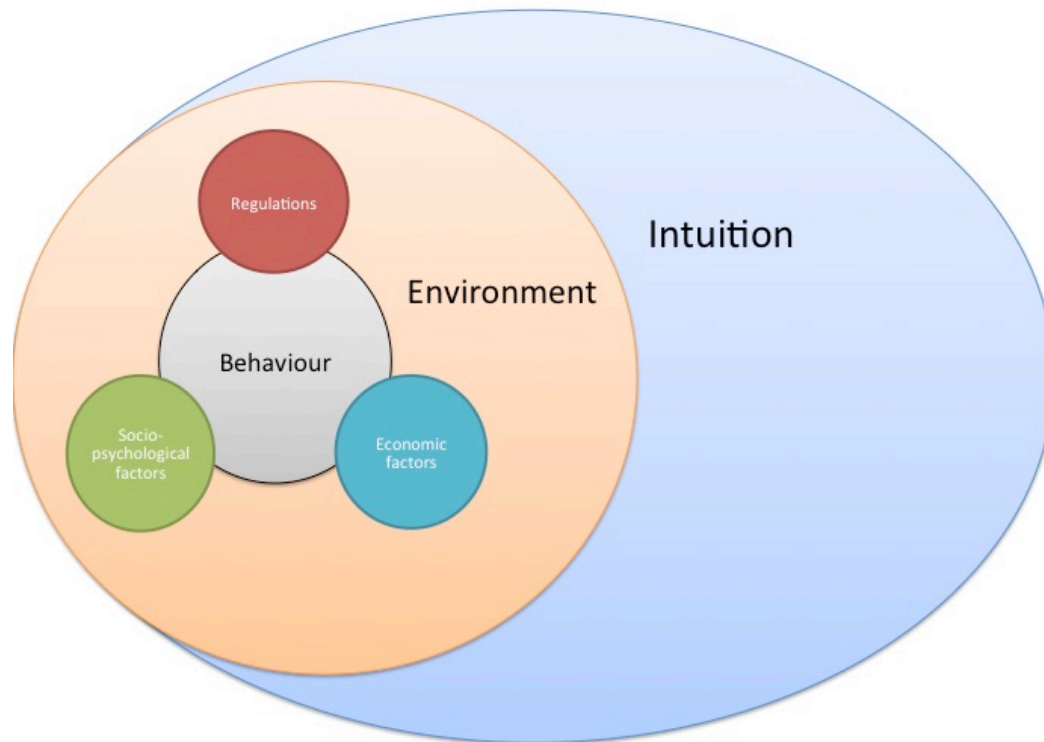

Figure 6.3.
General framework on farmers' behaviour, driven by intuition (unconscious) and conscious decisions.

Finally, the communication presented in this thesis remained limited to PSA's with short persuasive advertisements. Moreover, the experiments launched to test the used strategies and theories within the PSA's measured farmers' intentions, which only partially explain adoption. As discussed, changing a whole population's behaviour is not simply established through short persuasive messages, although it is generally considered as a good start (Baker, 1995). Farmers would also benefit from more personal communication and educational programmes in order to actually change their current, unsustainable behaviour, and to establish maintenance and behaviour change in the long run. However, this top-down approach is still an archaic look on knowledge transfer and shift should focus towards other paradigms. Wilson et al., (2015) suggested a systems approach where knowledge is build and shared through equal involvement of different stakeholders. In agricultural extension (i.e. application of scientific knowledge in agricultural practices through farmer education) different paradigms are proposed with an eye on different methods: paternalistic (i.e. top-down information exchange) vs. participatory (i.e. bottom-up) and outcomes: persuasive (behaviour change) vs.

educational (building knowledge). Empowered participatory governance (EPG) is a method to create regulation in a bottom-up approach by the population itself (Fung and Wright, 2003). It is an exercise among several different actors (stakeholders) of a population, which contribute ideas and solutions in a democratic, problem-solving debate (John et al., 2009). The outcome of this debate is self-sustained regulation, which becomes a norm when fully accepted by the population. Policy and governance regulation is still the most effective way to change a populations' behaviour (e.g. taxes on alcohol and cigarettes, speed limitation). However, governance regulation is not always applied, or foreseen in the near future. Therefore, EPG could be a good alternative for guiding behaviour that is not immediately regulated by the government. Because this lack of policy in anthelmintic prescription and usage, farmers could benefit from self-sustained regulation. Therefore, EPG in particular, or participatory agricultural extension in general, seems promising for tailoring future strategies for sustainable GIN control.

Considering behaviour is not always consciously driven (see Figure 6.3.), other methods, focussing on unconscious paths (or heuristics) can also be promising tools for future campaigns. For example, nudging is a choice of architecture that alters people's behaviour in a way without forbidding any options or significantly changing their economic incentives (Thaler and Sunstein, 2008). It can be considered as a small push to guide people in the rightful behaviour (Guthrie et al., 2010). Although this is a promising approach, the long-term effects of nudging have not been proven yet. Due to its unconscious character many presume that its positive effect will vanish along with the architectural primer (Marteau et al., 2011). Therefore, the method of choice for changing farmers' behaviours remains a more cognitive persuasion. Nevertheless, a mixture of both unconscious (e.g. nudging) and conscious (e.g. processing and generating information) may eventually have the best effect on changing farmers' behaviour in the long run (John et al., 2009).

6.6.   PRACTICAL GUIDELINES

A preliminary communication strategy (presented in Figure 6.4.) is suggested based on the results of this PhD project and the discussion above.
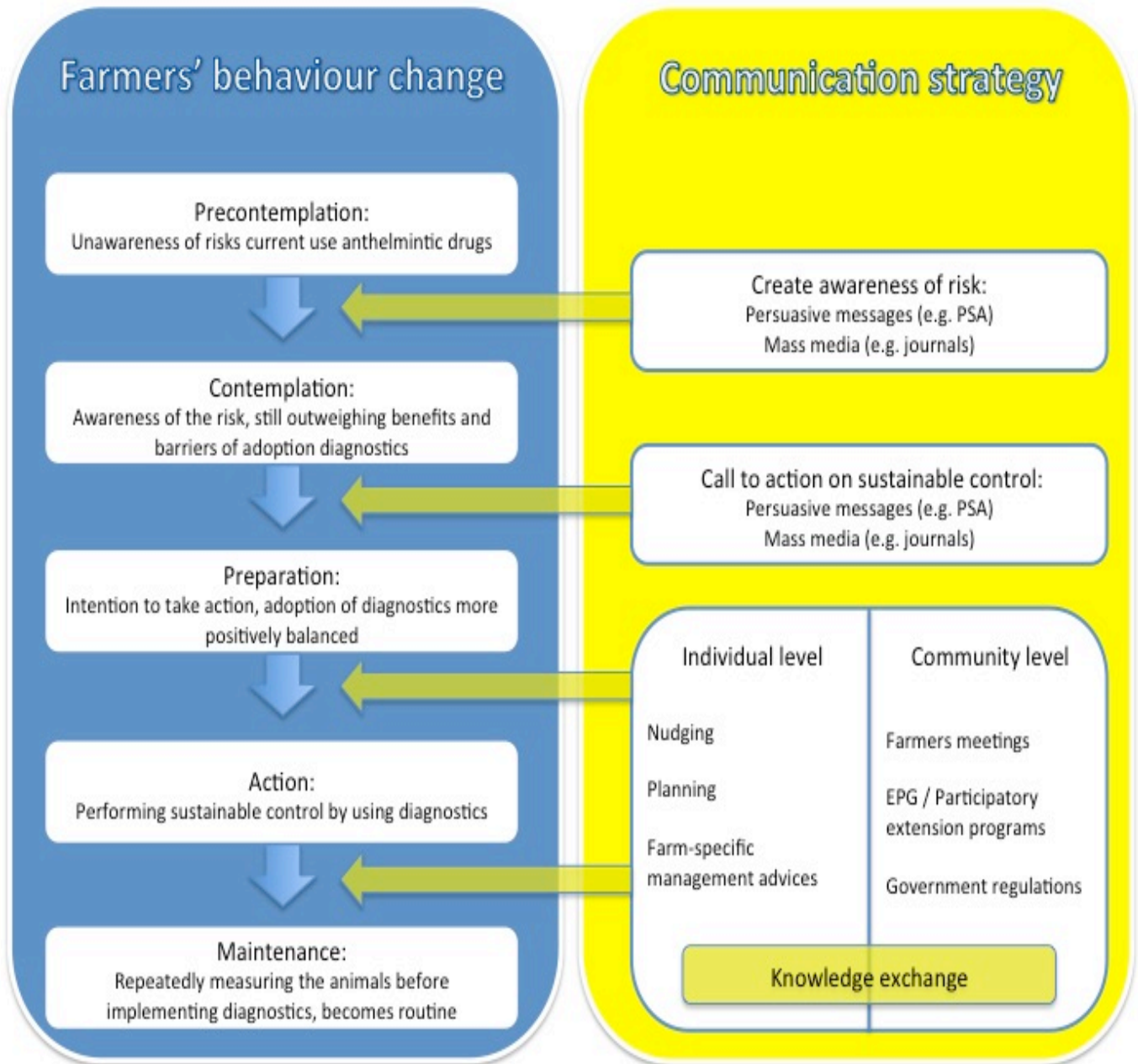
Figure 6.4.
Practical guidelines for guiding farmers towards sustainable GIN control.
Note. Blue arrows: farmers' stages of change based on the TTM (Prochaska and DiClemente, 1982), Yellow arrows: proposed communication messages/strategies depending on the stage

6.7. REFERENCES

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English summary

Gastrointestinal nematode (GIN) infections are a common constraint in pasture-based dairy herds and cause a decrease in animal health, productivity and farm profitability. Current control practices to prevent production losses of GIN infections in livestock depend largely on the use of anthelmintic drugs. However, due to the intensive use of these drugs, the industry is increasingly confronted with anthelmintic drug-resistant nematode populations. This emphasises the need for sustainable control approaches that minimise the selection pressure for anthelmintic resistance (AR). The uptake of diagnostic methods for sustainable worm control could enable more informed treatments and reduce excessive anthelmintic use. However, farmers have been slow in adopting guidelines for sustainable control. Accordingly, in order to successfully implement such control strategies and change the behaviour of farmers, their current perceptions and behaviours need to be comprehended and translated into effective communication strategies.

Chapter 1 reviewed the available literature on GIN control in cattle and concomitant threats for the dairy industry. More specifically, it focused on identifying the factors responsible for the limited uptake of current advises and possible future adoption of sustainable methods. This review demonstrates a substantial gap in literature for scientific evidence concerning farmers' behaviour (intention) in GIN control. Many reports are based on opinions and personal experiences, or are simply based on 'yes-or-no' questions with immediate relation to farmers' current or future GIN control, which results in limited insights in farmers' behaviour and unsubstantiated hypotheses. This stresses the need for more structured and scientific behavioural research, adapted from social veterinary epidemiology, a fairly young discipline with contributions from different fields, such as behavioural psychology and economy.

As a response to this emerging need, in **Chapter 2** a framework was constructed to identify the socio-psychological factors that influence dairy farmers' adoption intentions of diagnostic methods before implementing anthelmintic treatments. The framework was based on two grounded models from behavioural and health psychology: the *Theory of Planned Behaviour* (TPB) and the *Health Belief Model* (HBM), now commonly used in veterinary social sciences. Data to validate and measure the model were collected through a cross-sectional survey of Flanders' dairy farmers population ($N = 574$). In the tested model, adoption intentions (i.e. the proximal determinants of adoption, which captures the motivation to perform this behaviour) were predicted based on attitudes towards anthelminthic drugs, attitudes towards diagnostic methods (i.e. an individual's positive or negative evaluation of this particular behaviour based on the expected outcomes), subjective norms (i.e. the influence of significant others), behavioural control

(i.e. perceived ability to perform this adoption) and perceived risk (i.e. the perceived susceptibility and severity of AR in particular). The factors 'attitude towards diagnostic methods' and 'subjective norms' had the strongest, positive influence on adoption intention of diagnostic methods. 'Perceived behavioural control' had a weak, positive effect on intention. Further, 'attitude towards the use of anthelmintic drugs' had a negative effect on adoption intentions, which implicates an effect of current behaviour on future adoption. Moreover, the threat of AR is perceived fairly low, and had no effect on the adoption intentions of diagnostics.

This chapter gives a broad, general view of the drivers of sustainable GIN control using diagnostics on dairy farms. However, to be able to provide specific advice, further in-depth analyses are necessary to determine farmers' beliefs and motivations underlying these socio-psychological factors. Moreover, a relatively good intention was measured for the adoption of diagnostics, but low actual usage has been reported, suggesting a gap between intention and behaviour. Therefore, **Chapter 3** aimed to dig deeper into the established framework for the beliefs underlying this model, and to identify additional factors impelling this specific behaviour. Data were collected through 22 semi-structured interviews with dairy farmers. Results show that the adoption process of diagnostic methods for GIN occurs through three different phases: adoption intention, actual adoption and maintenance. Low infection awareness and low priority ('top of mind') of the disease are important barriers for farmers' positive intentions towards sustainable GIN control. Secondly, different types of motivations influence different sorts of behaviour. Sustainable behaviour such as use of diagnostics will be influenced by moral motives, while management behaviour such as anthelmintic treatment is raised by more economic motives. Thirdly, farmers' behaviour is guided by two important social norms: the opinion of their veterinarian and their fellow farmers. However, farmers hold an incongruent relationship with both norms throughout the different stages of behaviour: they do not value other farmers' opinions as a positive reference (intention phase), but they do follow and mimic their behaviour as a group (action phase). The veterinarian is seen as the most important positive reference, but also the responsible actor for GIN control. As such, the farmers do not hold themselves responsible for implementing sustainable control strategies. Finally, not only performing, but also maintaining behaviour is important to fully address the adoption of sustainable worm control. To perform and maintain the adoption on farm, planning could be an important contribution, which could help to surmount other suggested barriers for actual adoption, i.e. habits and responsibility.

The insights of Chapter 2 and 3 were used to create and test public service announcements (PSA), which were set up to create awareness of AR and promote sustainable control. In **Chapter 4,** the aim was to create awareness of anthelmintic resistance and to decrease farmers' positive attitudes of preventive treatments as a first step towards behaviour change. More specifically, the PSA focused on discouraging this behaviour by using message sidedness in a humorous advertisement. Two-sided argumentation (i.e. both pro and contra argument) and humour as communication strategies are known to generate less negative responses and lead towards improved message acceptance. The effects of the message on sustainable behaviour intentions were measured through a cognitive and affective route of persuasion. The cognitive route is prompted by rational thoughts, while emotions are the drivers of the affective route. Using a 2 (message sidedness: one-sided vs. two-sided) x 2 (humour: humorous vs. non-humorous message framing) between-subjects design (N = 167) the persuasiveness of the advertisement was tested. Results show that a two-sided message without humour evoked more negative cognitive responses (i.e. negative thoughts) than a one-sided message, leading to fewer changes in behavioural intentions. However, a two-sided message resulted in increased sustainable intentions compared to a one-sided message when humour was used as a frame in the advertisement. Moreover, the more simplistic PSA with only one argument and no humour presented similar results. Therefore, simple messages towards farmers can be equally effective as more complex strategies (i.e. both two-sided argumentation and humour).

Chapter 5 was set up as a 'call to action' for sustainable GIN control, the second step towards behaviour change. The chapter investigates how to change farmers' adoption intentions by using social influence, more specifically, injunctive norms. It focuses on two endorser types (expert vs. peer), considered as distinguished subjective norms, to change farmers' behavioural intentions. Furthermore, the endorsers' ability to either discourage (proscriptive message content), or encourage (prescriptive message content) behaviour were established. The effects of endorsers on behavioural intention were measured through three mediators: expertise, trustworthiness and similarity. Using a 2 (endorser type: expert vs. peer) x 2 (content type: proscriptive vs. prescriptive message) between-subjects design (N = 143) the persuasiveness of the advertisement was tested. Results show that an expert endorser (veterinarian) had a direct increased effect on behavioural intention, compared to a peer endorser (farmer). The veterinarian is the most important advisor and the key figure for disease control on farm, while the farmer is perceived as a negative reference, not valued for its opinion. Moreover, the effect was mediated through similarity, which emphasises the power of the in-group for

social influence. Finally, the different content types had no effect on behavioural intention, not even when presented by different endorsers.

Finally, **Chapter 6** assembles the main findings of the socio-epidemiological research performed within this PhD-project, and how these were translated into effective communication strategies. By presenting how the results from qualitative and quantitative studies can be translated into advice and subsequently verified with communication experiments, this chapter contributes to the current knowledge within the field of veterinary parasitology on changing dairy farmers' behaviours. Firstly, a brief discussion is given on the two main research questions and how these were addressed throughout the PhD project by each separate study. **RQ1: What drives the farmer towards the adoption of sustainable GIN control?** The first question was addressed with the results from the behavioural research presented in Chapter 2 and 3. This was followed by **RQ2: 'How can we use this newly gained knowledge to encourage farmers to change their current GIN control?'** This second question was tackled with communication experiments presented in Chapter 4 and 5. Furthermore, a general elaboration of the results throughout the whole project is discussed, following the three phases of adoption: intention, action and maintenance. Additionally, the limitations of the project are addressed, along with suggestions for future research on the matter. These limitations are subdivided in three categories, characteristic for this thesis: the object of research, the behavioural methods and theories, and the translation of the results into communication strategies. Lastly, the chapter presents practical and evidence-based guidelines for developing a communication campaign, aimed at raising farmers' awareness on the importance of a sustainable anthelmintic use.

Nederlandse samenvatting

Alle grazende runderen worden blootgesteld aan worminfecties, waaronder infecties met maagdarm-nematoden. Deze worminfecties leiden tot een verminderd dierenwelzijn en veroorzaken een daling in de productiviteit en de winstgevendheid van het melkveebedrijf. De huidige wormcontrolepraktijken zijn er voornamelijk op gericht deze productieverliezen bij melkvee te voorkomen. Wormcontrole is hierbij grotendeels gebaseerd op het preventieve gebruik van anthelminthica (anti-parasitaire geneesmiddelen). Deze worden intensief, en soms ondoordacht, ingezet op vele rundveebedrijven. Dit preventief gebruik is ontstaan doordat anthelminthica efficiënt en makkelijk kunnen toegediend worden, alsook relatief goedkoop zijn. Aan de keerzijde hiervan, wordt de veehouder door dit intensieve gebruik echter steeds vaker geconfronteerd met nematodenpopulaties die resistent zijn tegen frequent gebruikte anthelminthica. Deze ontluikende anthelminthicumresistentie (AR) bij melkvee, en rundvee in het algemeen, benadrukt de behoefte aan duurzame controlemaatregelen.

Het gebruik van diagnostische methoden (vb. mestonderzoek, tankmelkonderzoek, bloedonderzoek) die als hulpmiddel dienen bij de beslissing om al dan niet te ontwormen, maakt deel uit van een duurzame controle van worminfecties binnen de rundveesector. Deze maakt ruimte voor geïnformeerde behandelingen, en zal zo het overmatig gebruik van anthelminthica en daarmee gepaarde AR doen dalen. Tot nu toe staan veehouders vrij weerhoudend tegenover het opnemen van zulke duurzame richtlijnen, omdat deze extra werklast of kosten met zich meebrengen, en de voordelen pas na geruime tijd zichtbaar zijn. Bijgevolg is er maar een beperkte implementatie van duurzame controle binnen de melkveesector, en de veesector in het algemeen. Om duurzame controlestrategieën in de toekomst met succes door te voeren en zo het huidige gedrag van veehouders te veranderen, moeten hun risicopercepties en gedrag met betrekking tot wormcontrole goed onderzocht en begrepen worden. Vervolgens zal deze kennis zich vertalen in effectieve communicatiestrategieën die de adoptie van duurzame wormcontrole op melkveebedrijven in de hand zullen werken.

Een gebrek aan dergelijke kennis leidde tot twee onderzoeksvragen voor dit doctoraatsproject, dat opgelost werden aan de hand van een multi-methodisch onderzoek:

OV1: Wat drijft de veehouder naar de acceptatie van duurzame wormcontrole?

Om de adoptie van duurzame wormcontrole, en het gebruik van diagnostische methoden in het bijzonder, bij melkveehouders te begrijpen werd er een gedrags-model gecreëerd met geïdentificeerde factoren uit kwantitatief (hoofdstuk 2) en kwalitatief onderzoek (hoofdstuk 3).

OV2: Hoe kunnen veehouders worden aangemoedigd om hun huidige wormbestrijdingsmethode te wijzigen?

De belangrijkste bevindingen van het gedrags-model werden geïmplementeerd in persuasieve berichten met het oog op het creëren van een bewustzijn rond AR (hoofdstuk 4) en een "call-to-action" voor duurzame controle (hoofdstuk 5). Deze werden vervolgens getest aan de hand van communicatie-experimenten.

In **hoofdstuk 1** werd een grondige literatuurstudie uitgevoerd waarbij we de factoren identificeren die verantwoordelijk zijn voor de beperkte opname van huidige adviezen over wormbestrijding, en de drempels die mogelijke toekomstige adoptie van duurzame controlemaatregelen in de weg staan. Er is echter maar beperkt gefundeerd en wetenschappelijk onderzoek beschikbaar over wormcontrole door veehouders. Veel van deze geïdentificeerde factoren binnen de literatuur zijn eerder gebaseerd op meningen en persoonlijke ervaringen, alsook eenvoudige 'ja-neen vragen', wat resulteert in beperkte inzichten over het gedrag van veehouders. Dit benadrukt de behoefte aan meer gestructureerd en wetenschappelijk gedragsonderzoek, aangepast vanuit de 'sociale veterinaire epidemiologie', een vrij jonge discipline die ontstaan is uit verschillende onderzoeksgebieden, zoals gedragspsychologie en -economie.

Om hieraan tegemoet te komen, werd in **hoofdstuk 2** een theoretisch model opgebouwd om de sociaalpsychologische factoren te identificeren die aan de basis liggen van de adoptie-intentie ten aanzien van diagnostische tools van melkveehouders. Dit model werd gebaseerd op twee gefundeerde theorieën uit de gedrags- en gezondheidspsychologie: de '*Theory of Planned Behavior*' (TPB) en het '*Health Belief Model*' (HBM), die nu ook frequent ingezet worden voor sociale veterinaire epidemiologie. Om het model te valideren en te meten, werden data verzameld via een enquête bij Vlaamse melkveehouders (N = 574). In het theoretisch model werden adoptie-intenties (d.w.z. de proximale voorspeller van adoptie, deze omvangt de motivatie om tot adoptie over te gaan) voorspeld op basis van attitudes (d.w.z. de positieve of negatieve houding die een individu heeft op basis van de verwachte uitkomsten) ten opzichte van preventief gebruik van anthelminthica, attitudes ten opzichte van diagnostische tests, subjectieve normen (d.w.z. de invloed van belangrijke personen), gepercipieerde gedragscontrole (het vermogen dat iemand denkt te hebben om deze adoptie uit te voeren) en het gepercipieerde risico (de gepercipieerde vatbaarheid voor AR en de ernst van AR). De factoren 'attitude ten opzichte van diagnostische methoden' en 'subjectieve normen' hadden de sterkste positieve invloed op de adoptie van deze diagnostische methoden. De 'gepercipieerde gedragscontrole' had een zwak, positief effect op deze intentie. Verder had 'attitude ten opzichte van

anthelminthica' een negatief effect op de adoptie-intenties. Dit weerspiegelt de positieve attitude van veehouders tegenover hun huidige gedrag en hoe dit een effect heeft op toekomstige adoptie van alternatieve wormcontrole-maatregelen. Bovendien werd de dreiging van AR als vrij laag ervaren en had deze geen effect op de adoptie-intenties voor diagnostische methoden.

Dit hoofdstuk gaf een breed, algemeen beeld van de drijvende factoren achter duurzame wormcontrole op melkveebedrijven. Om echter specifiek advies te kunnen geven, zijn verdere diepgaande analyses nodig om de onderliggende motivaties of overtuigingen van de veehouders bloot te leggen, die aan de basis liggen van de geïdentificeerde sociaalpsychologische factoren. Bovendien werd een relatief sterke adoptie-intentie gemeten, maar worden er in de praktijk amper diagnostica gebruikt, wat wijst op een kloof tussen intentie en gedrag. Dit is meteen ook de veel voorkomende kritiek naar het gebruik van cognitieve gedragstheorieën zoals de TPB en HBM. Hierdoor werd **hoofdstuk 3** opgezet, om zo de motivaties te meten die aan de basis liggen van het gevalideerde model, en om dit uit te breiden naar daadwerkelijke adoptie. Hiervoor werden er factoren geïdentificeerd die de kloof tussen intentie en gedrag zouden kunnen verklaren. Data werden verzameld aan de hand van 22 semigestructureerde face-to-face interviews met melkveehouders. De resultaten toonden aan dat het adoptieproces van diagnostische methoden zich in drie verschillende fasen voordoet: adoptie-intentie, daadwerkelijke adoptie en het onderhouden van deze adoptie. Een beperkt bewustzijn van (het belang van) worminfecties en de lage prioriteit ('top of mind') van de ziekte werden geïdentificeerd als factoren die de adoptie-intenties van veehouders belemmerden. Ten tweede liggen verschillende soorten motivaties aan de grondslag van verschillend soort gedrag. Zo werd duurzaam gedrag, zoals het gebruik van diagnostiek, beïnvloed door morele motieven, terwijl bedrijfsgericht gedrag, zoals preventieve behandeling, werd gestimuleerd door meer economische motieven. Ten derde werd het gedrag van veehouders geleid door twee belangrijke sociale normen: de opinies van hun dierenarts en hun collega-veehouders. Echter, met deze laatste werd er een incongruente relatie geconstateerd doorheen verschillende fasen van de adoptie. Zo werd de mening van andere veehouders niet gewaardeerd tijdens de intentiefase, maar volgden ze de gehele groep wel naar aanloop van de effectieve adoptie. De dierenarts werd enerzijds gezien als de belangrijkste positieve referentie, maar werd tevens ook als eindverantwoordelijke gesteld voor wormcontrole op het bedrijf. Als dusdanig stellen veehouders zichzelf niet verantwoordelijk voor het implementeren van duurzame controlestrategieën op hun bedrijf. Ten slotte is niet alleen de adoptie, maar ook het handhaven van deze adoptie belangrijk om over volwaardige integratie van

duurzame wormbestrijding te kunnen spreken. Om deze adoptie uit te voeren en te behouden kan 'planning' een belangrijke bijdrage zijn. Deze zou de andere factoren die de daadwerkelijke adoptie belemmeren, zoals gewoontes en gebrek aan verantwoordelijkheid, kunnen aanpakken en leiden tot daadwerkelijke adoptie en het onderhouden van dit gedrag.

De inzichten uit hoofdstuk 2 en 3 werden gebruikt voor het opstellen en testen van berichten van algemeen nut (BAN). Deze werden opgezet om bewustzijn te creëren van AR, en om duurzame wormcontrole op melkveebedrijven te bevorderen. In **hoofdstuk 4** werd het doel vooropgesteld om de positieve attitude tegenover preventief gebruik van anthelminthica te verlagen door een bewustzijn te creëren over AR, en zo adoptie van duurzaam gedrag te stimuleren. Meer specifiek richtte de BAN zich op het ontmoedigen van preventief gebruik van anthelminthica door gebruik te maken van dubbelzijdige argumentatie in een humoristische advertentie. Zowel dubbelzijdige argumentatie (pro- en contra-argument) als humor zijn twee communicatiestrategieën die het genereren van negatieve reacties op de boodschap milderen. Dit leidt tot een betere aanvaarding van de boodschap, en dus een verhoogde kans op gedragsverandering. De effecten van deze boodschap op gedragsintentie werden gemeten via cognitieve en affectieve uitkomsten. De cognitieve uitkomsten worden geregistreerd aan de hand van rationele gedachten, terwijl emoties de drijvers zijn van de affectieve uitkomsten. Aan de hand van een 2 (argumenten: eenzijdig vs. dubbelzijdig) x 2 (advertentie: met humor versus zonder humor) 'between-subjects design' (N = 167) werd de effectiviteit van de advertentie gemeten naar adoptie-intentie toe. Uit de resultaten blijkt dat een dubbelzijdige boodschap zonder humor meer negatieve cognitieve reacties oproept (d.w.z. negatieve gedachten) dan een eenzijdige boodschap, wat leidt tot minder veranderingen in gedragsintenties. Wanneer humor werd gebruikt in de advertentie, resulteerde een dubbelzijdige boodschap echter in meer duurzame adoptie intenties vergeleken met een eenzijdige boodschap. Bovendien presenteerde de eenvoudigste BAN zonder humor en met slechts één argument vergelijkbare resultaten als de tweezijdige boodschap met humor. Daarom kunnen eenvoudige berichten aan veehouders even effectief zijn als complexere strategieën (d.w.z. zowel dubbelzijdige argumentatie als humor).

Hoofdstuk 5 werd opgezet als een 'call-to-action' voor duurzame wormcontrole, de volgende stap naar gedragsverandering. Dit hoofdstuk onderzocht hoe de adoptie-intenties van veehouders kunnen worden veranderd door gebruik te maken van sociale invloed, meer specifiek injunctienormen. Het onderzoek in dit hoofdstuk richt zich op twee soorten 'endorsers' (d.w.z. figuur die de boodschap promoot, hier: expert versus

gelijke), die in acht werden genomen als specifieke subjectieve normen. Deze subjectieve normen werden in hoofdstuk 2 reeds geïdentificeerd als sterke drijvers van adoptie-intenties. Bovendien werd het potentieel van de 'endorser' gemeten om enerzijds gedrag te ontmoedigen (d.w.z. verbiedende berichtinhoud), of anderzijds te stimuleren (d.w.z. gebiedende berichtinhoud). De effecten van het type 'endorser' op gedragsintenties werden gemeten via drie mediatoren: expertise, betrouwbaarheid en gelijkenis. Met behulp van een 2 (type 'endorser': expert versus gelijke) x 2 (type berichtinhoud: gebiedend versus verbiedend bericht) 'between-subjects design' (N = 143) werd de effectiviteit van de advertentie gemeten. De resultaten toonden aan dat een expert (vertegenwoordigd door een dierenarts) een positief, direct effect had op gedragsintentie in vergelijking met een gelijke (vertegenwoordigd door een veehouder). De dierenarts werd eerder al geïdentificeerd (hoofdstuk 3) als de belangrijkste adviseur en spil voor ziektebestrijding op het bedrijf, terwijl andere veehouders eerder als negatieve referentie werden aanzien. Bovendien werd er een indirect effect gemeten, gemedieerd door gelijkenis, waarop de gerepresenteerde veehouder beter scoorde. Dit legt de nadruk op de kracht van de in-groep (d.w.z. referentiegroep waartoe een persoon behoort) bij sociale invloed. Het directe effect van de expert overtrof echter het indirecte effect van de gelijke, wat leidde tot sterkere adoptie-intenties. Ten slotte hadden de verschillende types berichtinhoud geen effect op de gedragsintentie, zelfs niet als deze werden gebracht door verschillende 'endorsers'.

Ten slotte worden in **hoofdstuk 6** de belangrijkste bevindingen van het sociaal-epidemiologisch onderzoek binnen dit doctoraatsproject samengebracht, en wordt besproken hoe deze vertaald kunnen worden in effectieve communicatiestrategieën. Dit hoofdstuk draagt bij tot de huidige kennis over het gedrag van melkveehouders binnen de veterinaire parasitologie. Meer bepaald, hoe de resultaten van zowel kwalitatieve en kwantitatieve studies kunnen vertaald worden in preventieboodschappen en vervolgens kunnen worden geverifieerd met communicatie-experimenten specifiek naar duurzame wormcontrole toe.

In het algemeen toonde deze thesis aan dat de adoptie van duurzame wormbestrijding binnen de melkveesector gebeurt aan de hand van drie fasen: adoptie-intentie, daadwerkelijke adoptie en het onderhouden van deze adoptie. De adoptie-intentie werd belemmerd door het lage bewustzijn van zowel worminfecties alsook AR dat hieruit voortvloeit. De veehouders hadden een vrij positieve attitude tegenover preventief gebruik van anthelminthica, die ingegeven werd door economische motivaties, terwijl hun positieve attitude voor diagnostica eerder ingegeven werd door persoonlijke en morele motivaties. Deze laatste bleek ook een sterke positieve drijver te zijn van de

adoptie-intenties samen met de subjectieve normen, waarvan de veearts geïdentificeerd werd als belangrijkste persoon. De veehouders-gemeenschap werd op haar beurt weer als een belemmering gezien voor de daadwerkelijke adoptie, aangezien wormbestrijding hier niet zozeer leeft. Uiteindelijk moet de adoptie ook onderhouden worden om over effectieve gedragsverandering te kunnen spreken, wat hier nog niet het geval was. Op basis hiervan werden enkele communicatie-experimenten opgezet om het bewustzijn van AR te vergroten, alsook een 'call-to-action' te creëren om tot adoptie over te gaan. Een humoristische aanpak bij het communiceren over AR werkte goed, zolang de inhoud van de boodschap voldoende groot was. Anderzijds werkte een simpele boodschap zonder humor ook effectief. Bij de 'call-to-action' werd er geopperd om de dierenarts, als expert, in te zetten als promotor van de boodschap.

Deze resultaten kunnen als opstap dienen voor een bewustzijnscampagne rond duurzame wormbestrijding. Hoewel deze vooral op de motivaties en intenties van de melkveehouder zullen inspelen, kunnen ze voor sommige 'early adopters' meteen doorslaggevend zijn naar gedragsverandering toe. De meerderheid van de melkveehouders zal eerder overtuigd worden wanneer de volledige gemeenschap meebeweegt (vb. workshops, programma's voor kennisuitwisseling) of bij individuele en bedrijfsspecifieke planning. Dit opent alweer mogelijkheden voor toekomstig onderzoek gericht op duurzame gedragsverandering van veehouders.