

A survey on parasite management by equine veterinarians highlights the need for a regulation change

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ABSTRACT

Introduction: In-depth knowledge of the use of anthelmintics in the field, especially by veterinarians, is required to design more sustainable parasite control strategies.

Materials and methods: An online survey was sent by e-mail to 940 equine veterinary practitioners to describe their equine practice, their awareness about parasites and the management strategies they apply.

Results: Gastrointestinal parasites were generally considered (68%) as an issue of moderate importance. Drug efficacy failure was a minor or moderate issue for 47% and 48% of responders, respectively. Parasite management mostly relied on the use of systematic calendar treatments across a wide variety of horse owners (ie, riding schools, studs or hobby horse owners). Almost half of the practitioners (42%) never performed Faecal Egg Count (FEC) before drenching. Horse owners or their employees in charge of equines were reported to be the only person managing drenching in 59% of the collected answers. This was associated with the report of many off-label uses of anthelmintics and the frequent buying of drugs using the internet.

Conclusions: Given the critical situation regarding anthelmintic resistance, it seems necessary for veterinarians to reclaim parasite management and prevention as a specific topic. Implementation of stricter regulations for use of anthelmintics, like the one applied in Denmark, may make parasitic management in equids more sustainable.

recently throughout the world (Reinemeyer 2012, von Samson-Himmelstjerna 2012, Peregrine and others 2014). In France, resistant isolates have been described for each of the three available anthelmintic categories, namely benzimidazoles, pyrantel and macrocyclic lactones (Laugier and others 2012, Traversa and others 2012). Equine strongyles have hence been ranked among the top 10 major threats to equine health by the French Agency for Health and Food Safety (Anonymous 2012).

Due to increasing resistance of GIN to anthelmintics, improvements should be made to achieve a more sustainable management of parasites, developed on a farm-by-farm and horse-by-horse basis (von Samson-Himmelstjerna 2012). However, expert recommendations do not always meet success in the field, and some sociological studies performed with small ruminants breeders have demonstrated some reluctances to adopt optimised drenching schemes (Berrag and others 2009, Cabaret and others 2009). The current knowledge gathered from a few questionnaire studies of European horse owners underlines the wide application of frequent and systematic drenching schemes with a limited use of faecal egg count (FEC) analysis (O'Meara and Mulcahy 2002, Lind and others 2007, Relf and others 2012), except in Denmark (Nielsen and others 2014). These surveys also pointed out the need for veterinarians to be more involved in equine parasites management. In Denmark, the implementation of a prescription-only framework where anthelmintics are prescribed only after parasitological diagnosis resulted in repositioning veterinarians as advisors while decreasing the number of treatments (Nielsen and others 2006). This latter study, however, has been the only one carried among veterinarians. In France, only veterinarians can prescribe veterinary anthelmintics (drugs are subsequently delivered by veterinarians or by pharmacists

INTRODUCTION

Gastrointestinal nematodes (GINs) have been given more and more attention as a serious threat to equine health and welfare. Foals are particularly subject to the infection by *Parascaris equorum* (Reinemeyer and Nielsen 2009), while cyathostomins—also known as ‘small strongyles’—are the most prevalent parasitic nematodes of adult equids (Love and others 1999). Anthelmintic use has formed the cornerstone of helminth control strategies for the last 50 years, but case reports of drenching failure have been accumulating



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upon prescription by a veterinarian) but no parasitic diagnosis is required before use. This study aimed at broadening the picture by investigating the French practitioners' awareness, perception and strategies of equine parasites control with an internet questionnaire survey.

MATERIALS AND METHODS

Questionnaire sent to French equine veterinary surgeons

The survey was emailed to French veterinarians referenced as having an equine activity in the veterinary professional directory (access to the email database was provided by M. Neveux, Les Editions du Point Vétérinaire). The database contained 940 email addresses. The survey was provided online using the INRA survey interface implemented with the Limesurvey V.1.91+ software (<http://www.limesurvey.org/fr>).

A summary of the questionnaire is provided in online supplementary information 1. Briefly, 23 questions distributed in six different topics aimed at describing the considered practice and the associated parasitological epidemiology according to each practitioner. The four remaining parts were dedicated to the perception of resistance to anthelmintics by veterinarians, the drenching procedures and strategies they applied and the detailed use of FEC or coproculture, that is, incubation of nematode eggs in faeces to have infective larvae hatched. A last section was dedicated to veterinary surgeons' remarks and comments. A first emailing was performed in May 2013 followed by a second one in July 2013.

Questionnaire sent to EVPC members

A short eight-question survey was sent to members of the European College of Veterinary Parasitology (EVPC) to identify what was taught in European veterinary faculties. After indicating their respective country, responders were asked about the amount of time dedicated to the management of equine parasites and to indicate the function of the person in charge of this teaching, that is, parasitologist, teaching clinician or private practitioner. The second part of this survey was dedicated to the proposed drenching strategies, that is, systematic or evidence-based drenching, and the importance given to the alternative strategies. Diplomates were also asked whether they recommended a diagnostic test before drenching and whether they considered different strategies according to the horse owner's type, that is, riding school, stud farm or leisure horse owners.

Statistical analyses

Correlations between factors were computed using the 'corr' function implemented in the Hmisc R package (<http://www.r-project.org>).

To evaluate the effect of some factors (practice size, veterinarian's age, proportion of equines in practice, number of horses in practice) on the reported use of anthelmintics, a sustainability index was constructed to rank veterinarians and identify putative clustering

patterns. One point was added to veterinarian's index for the application of each of the sustainable management practices, that is, test of efficacy before drug use and FEC-based drenching. Sustainability of annual rotation between anthelmintic classes has been questioned (Barnes and others 1995) and was therefore not given an extra point. On the contrary, one point was subtracted for both the application of a systematic drenching calendar and the lack of FEC-based approach.

Significance of the practice size, responder's age, the share of equine activity and the number of horses in practice on the sustainability index was tested using a linear model with the 'lm' function implemented in the R software.

RESULTS

Basic description of the responders

Out of the 115 received answers, 91 complete questionnaires (response rate of 9 per cent) were used for analysis. Half of French counties (n=52) were represented, including some overseas territories (Guadeloupe, Martinique and Nouvelle-Calédonie), the top represented counties being located in the Normandie and Aquitaine regions, which have an important equine activity. Basic typological features about veterinary practices are reported in Fig 1. Most of the responders were between 30 and 40 years old and worked in medium-size practices, that is, 4.5 veterinarians employees in the clinic on average (Fig 1a, b). Responders were highly specialised with more than a quarter (28 per cent) of the responders working in practice where the share of equine activity represented 100 per cent of the total occupation (Fig 1c) and more than half of the responders having at least 500 horses in their veterinary practice (Fig 1d).

Epidemiology and perception of parasites

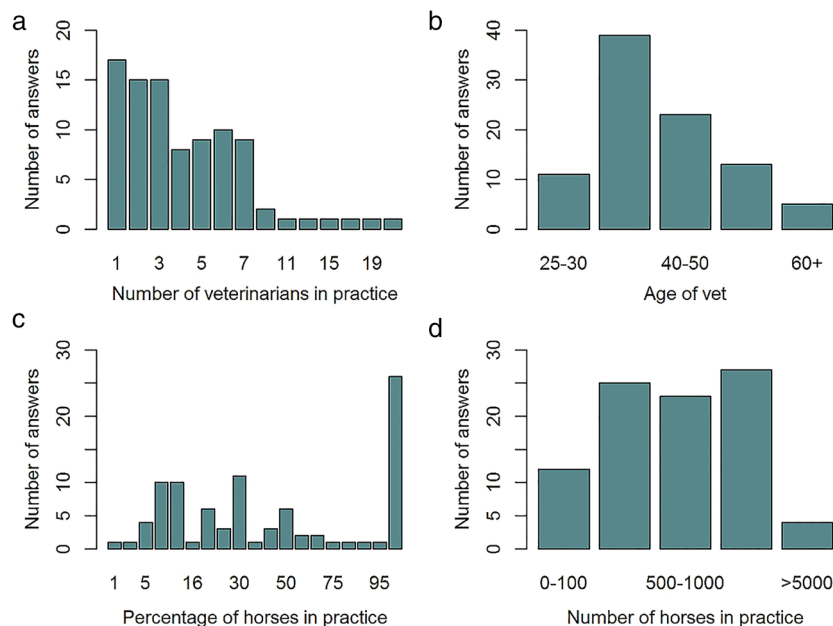
Gastrointestinal parasites were generally considered (68 per cent, Table 1) as an issue of moderate importance, that is, some clinical cases usually easily managed with anthelmintics but 27 per cent of the responders claimed frequent clinical cases with or without drugs failure (Table 1).

Overall, cyathostomins were the most frequently reported parasites involved in unthriftiness cases or poor performances regardless of the age of horses (Table 2). Large strongyles (*Strongylus* species), ascarids (*P. equorum*) and tapeworm (*Anoplocephala*) were equally regarded as an important source of pathology by around 20 per cent of the responders (Table 2).

Drug use

Veterinarians were generally the cornerstone of the drenching protocols that were usually decided after discussion with the owner (74 per cent of cases, Fig 2a). Drenching was mostly conditioned on a rotation between anthelmintic drug classes (79 per cent of responders) and only four veterinarians made their choice based on an efficacy test (Fig 2b).

FIG 1: Basic description of the responders. This figure draws a picture of the main characteristics associated with responders' practice by plotting distributions of the practice sizes (a), the ages of responders (b), the proportion of horses in practice (c) and the total number of horses in practice (d). In each case, a bar plot is provided that indicates the count of responders falling in one of the indicated categories (total count of 91 responders)



Even if alternating between anthelmintic drug classes appeared to be a priority for responders, macrocyclic lactones were over-represented in the drenching arsenal (relative proportion of 63 per cent, Fig 2c). Benzimidazoles were used by nearly as many vets as ivermectin (87 per cent and 91 per cent of responders), while pyrantel was the least used drug (53 per cent of responders, Fig 2c).

Horse owners were reported to play an important role in drenching: they were the only person in charge in 59 per cent of the collected answers, while only one practitioner indicated he was the only person in charge of drenching in his practice (Fig 3a).

This was associated to a generalised off-label use, especially for big structures like stud farms and riding schools (Fig 3b). Additionally, practitioners estimated that 25 per cent of their customers on average bought anthelmintics from the internet (Fig 3c).

Perception and management of drug failures

The moderate importance given to equine parasites was positively correlated ($r=38$ per cent, $P=2 \times 10^{-4}$) to the perception of drug resistance, which was mostly

considered as a minor (42 per cent of answers, Table 1) or a moderate issue (46 per cent of answers, Table 1).

Noteworthy, more than half of the surveyed vets (61 per cent) had already suspected a reduced anthelmintic activity towards horses' nematodes (data not shown), which had generally been managed by applying another anthelmintic drug class without confirming their suspicion (see online supplementary information 2).

Drenching strategies and the use of FEC

Parasite management mostly relied on the use of systematic calendar treatments across all types of horse owners, that is, riding schools, studs or hobby horse owners (see online supplementary information 3). Almost half of the practitioners (42 per cent) never performed FEC before drenching (Fig 2d).

FEC-based drenching protocol represented 25 per cent of the answers (see online supplementary information 3) and was the most frequently applied strategy with leisure horse owners (see online supplementary information 3). Noteworthy, the use of FEC was particularly dependent of the leisure horse owners' demand, which was the second most frequent reason to perform FEC

TABLE 1: The relationship between the relative importance given to parasites and to drug failures in practice reported as a proportion of responders

	Importance of drug failure				Cumulative sum
	None	Anecdotal	Moderate	High	
Importance of parasites					
High	0.00	0.04	0.16	0.07	0.275
Medium	0.01	0.34	0.29	0.04	0.681
Low	0.00	0.03	0.01	0.00	0.044
Cumulative sum	0.01	0.42	0.46	0.11	1.00

Each number indicates the proportion of responders ranking parasites as high, medium or low priority and simultaneously considering drug failure as a null, anecdotal, moderate, high-priority issue. For each possible answer, the cumulative proportion is indicated at the bottom or at the right of the table

TABLE 2: Percentage of responders who observed the presence of various parasites to be the aetiology of disease, ill-thrift and poor performance within their practice

Species	Foals (%)	Adults (%)
<i>Parascaris equorum</i>	20.7	–
<i>Strongyloides</i> species	11.1	–
Cyathostomin	27.8	36.2
<i>Strongylus</i> species	19.2	21.3
<i>Anoplocephala perfoliata</i>	7.6	20.7
<i>Gasterophilus</i> species	11.1	16.1
No parasites involved	1.0	2.3
Other	3.4	0.0

For each of the given parasite species, genera or subfamily, the percentage of responders considering this species as a major aetiology in foals or adults is reported

after clinical suspicions (54 per cent and 89 per cent of responders, respectively, Table 3). A large proportion of practitioners use FEC without any particular agenda as part of clinical investigation (data not shown).

Periodical FEC sampling is usually performed in October or April (data not shown) and equally processed by the vets themselves or a reference laboratory (Table 3). A limited use of coproculture (15 per cent of responders) has been found (Table 3). The use of coproculture was significantly correlated to ranking cyathostomins as an important source of clinical cases ($r=0.22$, $P=0.04$) but not *Strongylus* species ($r=-0.17$, $P=0.11$). No significant correlation was found between the use of FEC and the rank of parasites as an aetiology of clinical cases.

Alternative strategies, mostly based on grazing strategies and targeted selective treatment (targeted to GIN and

directed to infected horses), were also advised by a large proportion of the participating practitioners (77 per cent and 63 per cent of responders for rotational grazing and targeted drenching, respectively; data not shown).

To identify putative factors associated to a more sustainable management of GIN infection, a practitioner sustainability index was constructed. None of the considered factors of variation between responders did explain a significant variation in this index. Neither the age of responders ($P=0.77$) nor the specialisation level in equine medicine, assessed by the share of equine activity ($P=0.31$) and the number of horses in practice ($P=0.37$), showed a significant effect. Geography did not significantly affect this index ($P=0.67$). However, veterinarians belonging to clinics of >10 surgeons had a sustainability index equal or above the responder's average, while greater variation was observed for remaining cases.

Survey among the teaching EVPC diplomates

The time allocated to equine parasitology greatly varies across universities from 40 minutes to 10 hours (Table 4). In most universities, parasitologists are the only teachers to be in charge of this course. Additional input from clinicians or practitioners is proposed in Sweden, the UK and in two Italian universities (Table 4).

Evidence-based approaches were not generalised to every country (8 out of the 13 responders), some countries proposing systematic drenching of foals only (France, Switzerland and Sweden). One teacher also stated that there were small differences between systematic and evidence-based approaches (data not shown).

Given the various types of equine establishments, diplomates were asked whether they took this variation into account while proposing parasite management guidelines.

FIG 2: Drug use. This figure illustrates common usage of anthelmintic compounds according to responders ($n=91$ in total). Stack bar plots, corresponding to the count of responders who answered 'yes' (in green) or 'no' (in black), illustrate the way drenching decision is made (a), how the anthelmintic compound is chosen (b), what anthelmintic compound is used (a) or the situations where drenching is performed without performing prior faecal egg count (FEC; c). BZL, benzimidazole; FECRT, Faecal Egg Count Reduction Test; IVM, ivermectin; MOX, moxidectin; PYR, pyrantel; PZQ, praziquantel.

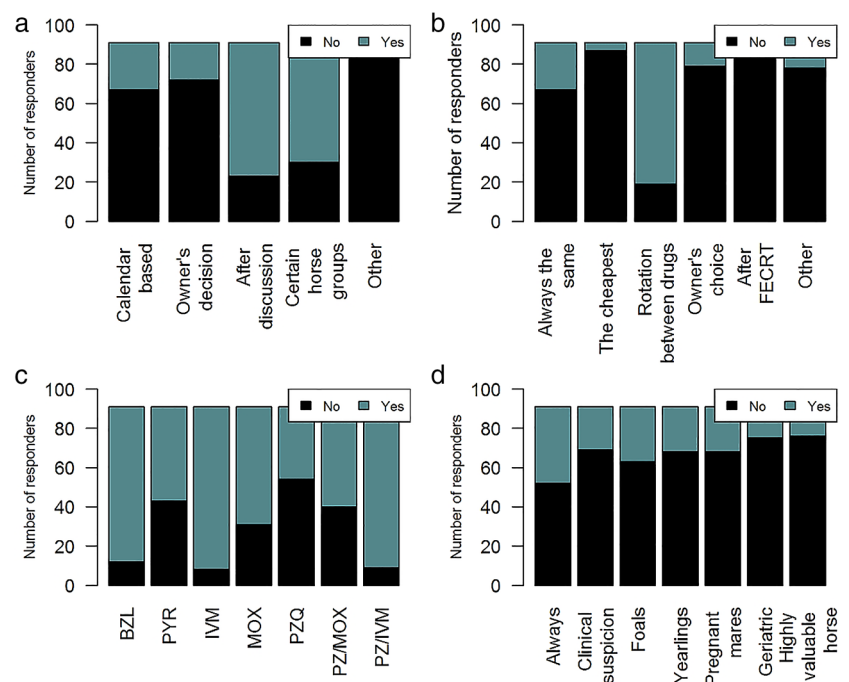
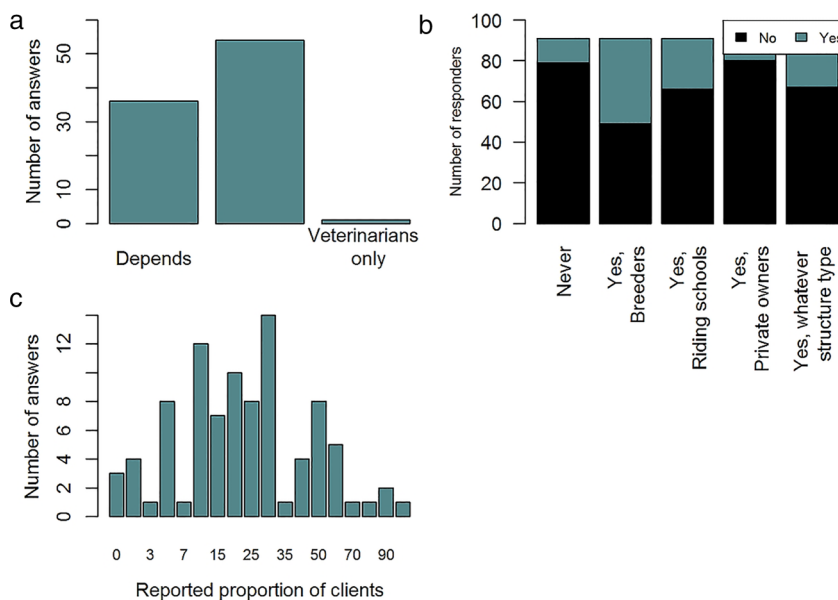


FIG 3: Risk factors potentially associated with drug failure. This figure describes the relative frequency of the person in charge of drenching (veterinarian (1 per cent of responders), horse owner (59 per cent of responders) or both (40 per cent of responders)) on (a). The frequency of some potential risk factor in the use of anthelmintic compounds is also illustrated through a stacked bar plot about the awareness of off-label use (b) and the distribution of the estimated proportion of clients (given by responders; listed on the x-axis as a percentage value) buying their anthelmintic drugs from the internet (c). In each case, plots are based on a total count of 91 responders



This difference was given attention in universities of a northern cluster (the UK, Germany, Belgium and Sweden) and one Italian university (Table 4). Among alternative strategies, FEC-based drenching and removal of faeces were the most emphasised strategies (11 and 10 out of 13 universities, respectively, see Table 4). To a lesser extent, rotational grazing is usually evoked but it was often commented as being difficult to implement in the field due to the size of available pastures.

DISCUSSION

This study draws a picture of the awareness and the management of nematodes in horses by French veterinary

practitioners. These data provide additional insights to the survey performed in 2006 by Nielsen and others, who investigated the management applied by practitioners under the strict Danish regulation that made evidence-based drenching (FEC) compulsory since 1999 (Nielsen and others 2006).

The response rate to this survey was considerably lower than the 52 per cent reported by Nielsen and others (2006). This may be explained by the direct phone call made in the previous study to obtain contact details (Nielsen and others 2006). Such contact strategy was not practically achievable due to the higher number of targeted practitioners (n=940). It could also be simply related to the limited interest of French veterinarians to the GIN treatments since its importance is considered as medium to low. This low response rate may bias this study's results as the motivation to respond this survey may be linked to a particular interest in parasitology or to some encountered difficulties in the field like drug-resistant parasites and frequent clinical cases. Therefore, the relatively high frequencies of reported anthelmintic resistance cases may be overestimated.

French equine practitioners were highly involved in the design of drenching strategies (74 per cent of the responders) and the choice of the drug to be used. However, drenching strategies mostly relied on systematic drenching at strategic times of the year, hence contrasting the Danish situation but being similar to other reported European results based on horse owners surveys (O'Meara and Mulcahy 2002, Lind and others 2007, Fritzen and others 2010, Hinney and others 2011, Relf and others 2012). As reported in other European countries (Fritzen and others 2010, Hinney and others 2011, Relf and others 2012), macrocyclic lactones were the most frequently used drugs. Interestingly, benzimidazoles

TABLE 3: Details about the use of FEC and coproculture in practice

Question	Percentage of responders
When do you use FEC?	
Clinical suspicion	89
Owner's request	54
For particular age class	9
FECRT (test for efficacy)	29
Monitoring the herd infection level	33
Other	9
Where are FEC performed?	
Own lab	45
Reference lab	74
Other practice	1
Use of coproculture	15

This table summarises the results about the use of FEC and coproculture by responders. For each possible answer, the percentage of responders is indicated in per cent
FEC, faecal egg count; FECRT, Faecal Egg Count Reduction Test

TABLE 4: Results from the short questionnaire survey sent to diplomates of the European College of Veterinary Parasitology about the teaching of equine parasitology

Country	Teaching time (hours)	Person in charge	Recommended drenching scheme	Differences between establishment	Alternative strategies		
					Rotational grazing	Removal of faeces	Targeted treatment
Sweden	0.7	Parasitologist and clinician	Systematic in foals/EB otherwise	Yes	Yes	Yes	Yes
Algeria	2.75	Parasitologist	Systematic	No	No	No	No
Switzerland	3	Parasitologist	Systematic in foals/EB otherwise	No	No	Yes	Yes
France	3	Parasitologist	Systematic in foals/EB otherwise	No	Yes	Yes	Yes
Spain	3	Parasitologist	Systematic	No	No	Yes	No
Switzerland	4	Parasitologist	EB	No	Yes	Yes	Yes
UK	5	Parasitologist	EB	Yes	Yes	Yes	Yes
Belgium	7	Parasitologist	EB	Yes	Yes	Yes	Yes
Italy	7	Parasitologist	EB	No	No	No	Yes
Italy	11.5	Parasitologist and clinician	EB	No	No	Yes	Yes
Italy	12	Parasitologist	EB	Yes	No	Yes	Yes
UK	15	Parasitologist and clinician	EB	Yes	No	Yes	Yes
Germany	2	Parasitologist	Systematic	Yes	No	Yes	No

Responses collected from 13 different universities (10 countries) have been summarised in the table. Time allocated for the teaching about equine parasitology is given in hours as well as the person in charge of teaching (parasitologist or parasitologist and clinician together). Recommended drenching scheme is also indicated. Other questions addressed whether differences of management between equine establishments were recommended (yes or no) or whether alternative strategies were considered. EB, evidence-based; Syst. in foals/EB otherwise, systematic drenching of foals and application of evidence-based programme in other age groups; systematic, systematic calendar-based drenching regimen

were still largely applied in France. This contrasts with a recent study that reported 94 per cent of investigated stud farms harboured benzimidazole-resistant strongyles (Traversa and others 2012) and with the multiple reports of benzimidazole failures throughout the world (von Samson-Himmelstjerna 2012). This strong reliance on anthelmintic drugs was also concomitant of a mild importance given to anthelmintic resistance, hence leading to a very limited use of drug efficacy tests. Taken together, the authors' findings underline that the anthelmintic resistance issue is somewhat underestimated by equine practitioners in France.

To investigate whether this was related to the teaching provided in France to veterinarians and in other European veterinary colleges, a short questionnaire was sent to the members of the EVPC. Time allocated to the teaching of equine parasitology in France appears to be in the lower range in comparison of other countries but its content did not differ from the general trends outlined, that is, evidence-based drenching.

This study's data indicate that horse owners are largely responsible for the management of drenching in the field. This fact is likely the convergence between practitioners' and horse owners' constraints. On the one hand, vet practitioners save time required to drench every single horse in their practice to take good care of

other visits (e.g. emergencies and reproduction monitoring). On the other hand, horse owners only have to pay for the drugs and not for the extra costs of a veterinary act. This convergence of interests certainly roots to the relatively low importance given by veterinarians to parasites that may make them more inclined to deliver anthelmintics without taking care of the actual drenching itself. Horse owners feel able to manage parasites themselves since only one straightforward strategy is proposed (calendar-based system) and they have drugs at their disposal. In this case, the need to pay an added value to veterinarians may become pointless as the importance given to costs of veterinary care is one of the most important obstacles among pet owners to veterinary visits (Volk and others 2011). This would explain both the high proportion of horse owners buying their drugs from the internet and the generalised off-label usage reported in the authors' survey. No detailed information about these particular usages was available within the survey. However, information gathered in frame of another survey among French trotter breeders suggests applications of a mixture of ovine-dedicated anthelmintics or injection of bovine-formulated ivermectin are widely applied (G. Sallé and J. Cabaret, personal communication). It hence seems that parasitic management is largely not in the hands of veterinarians any

more, thus making it difficult to develop evidence-based strategies.

However, the available diagnostic tools may still be too rudimentary for designing more sustainable strategies of drenching. Indeed, evidence-based management of nematodes in horses relies on FEC (GIN parasites), which only provides an incomplete picture of the parasitic infection of horses even if recent progresses have been made in the development of quantitative biomarker of GIN pre-patent stages (McWilliam and others 2010, Andersen and others 2013). Therefore, blind drenching in late autumn still appears to be reasonable to relieve the parasite burden of horses, but the impact of such non-specific drenching on the emergence of anthelmintic resistance remains unpredictable. In addition, it seems that the strict implementation of targeted-selective treatment also leads to the re-emergence of *Strongylus* species (Nielsen and others 2012). Last but not least, short-term calculation of parasites management costs seems to discourage breeders and riding schools to perform FEC, whereas recent work by Lester and others concluded that implementing targeted-selective treatment resulted in an average annual saving of £294 per yard (Lester and others 2013). In addition, systematic drenching is easier to manage on large scale than complicated FEC-based drenching systems. The already described reluctance of sheep breeders to implement selective drenching (Cabaret and others 2009, Kenyon and Jackson 2012) also seems to apply for horse owners too (Cabaret J., personal communication).

In conclusion, this study shed light on the hurdles that remain for implementing more efficient and more sustainable drenching schemes for horses in France. The authors' findings suggest some communication efforts about the sustainability of drenches should be done for horse owners. Additionally, studies about the economic consequences of FEC-based drenching programmes should be performed for a better impact of this communication strategy. According to the European Union regulations, veterinary medicinal products for food-producing animals and products that require a precise prior diagnosis or could impede on subsequent diagnostic or treatment shall be delivered to the public upon a veterinary prescription (Anonymous 2001). However, no clear statement of a diagnosis prior anthelmintic treatment has been made as opposed to the current Danish legislation (Anonymous 1998). The broadening of the current Danish interpretation of the European Union regulations may also add more sustainability to the current management of nematodes in horses.

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Data sharing statement All the data have been published within the manuscript. Data concerning the questionnaire survey among members of the European College of veterinary parasitology are available upon request.

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