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A Study of the Knowledge, Attitudes, and Behaviors of French Dairy Farmers Toward the Farm Register

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ABSTRACT

Health organizations worldwide have advocated that treatment records be required to show that antibiotics are used prudently by veterinarians and farmers alike. In 2000, the French government passed legislation making a farm register mandatory for all farms that raise animals for food production. The farm register is a comprehensive record designed to track all animal movements, treatments, and veterinary interventions on the farm. We conducted a survey to assess the knowledge, attitudes, and behaviors of dairy farmers toward the farm register, with particular emphasis on recording of antibiotic treatments. The 43 farmers interviewed belonged to veterinary health cooperatives. All farmers correctly named an antibiotic or antibiotic preparation, yet only 2 recognized the 5 components of the farm register. Farmer attitudes toward the register were globally positive, even though they named a wide variety of constraints. Nevertheless, 72% of farmers interviewed had a permanent health record, and approximately half had recorded either the last treatment (irrespective of drug class) or the last intramammary tube administered. Results were discussed in the light of health behavior change models that are applied in human medicine. We suggest that programs that seek compliance with the farm register should focus on educational interventions and bonus incentives.
Key words: record keeping, farm register, antibiotic, veterinary health cooperative

INTRODUCTION

Antibiotics became a part of the therapeutic arsenal in veterinary medicine over 50 yr ago. They have been highly instrumental in treating and preventing numerous animal diseases of bacterial origin, thereby considerably improving, not only the health of animals, but also their productivity and welfare. Conversely, resistance to antimicrobial substances is occurring among many bacterial species that are either pathogenic or commensal to food-producing animals and man.

The concern raised by the development of multiple resistances in pathogenic organisms and the realization that antibiotic use in itself is a causal factor of resistance have motivated recent calls for prudent use of antibiotics in human and veterinary medicine worldwide (European Union, 1998; WHO, 2002). The European Union raised these concerns in 1998, by hosting the "Microbial Threat" conference (European Union, 1998). The conference recommended strategies to prevent and control emergence and spread of antimicrobial resistance including the "need to collect data on the supply and consumption of antimicrobial agents" and "the adoption of a wide range of measures to promote prudent use of antimicrobials." Member countries are responding to these recommendations with measures that account for national specificities.

In France, both veterinarians and pharmacists can deliver antibiotics (Public Health Code, book II, articles L. 5141-5, L. 5141-6 and L.5141-7; http://www.legifrance.gouv.fr/html/index.html). Although in theory, antibiotics should only be administered to animals after prescription by a veterinarian, farmers in France are able to purchase antibiotics and administer them to livestock without veterinary supervision. The French government monitors the quantities of antibiotics sold by the chemical industries, but the type and quantity of antibiotics used at the farm and on the individual animal level is not known.

In June 2000, the French government passed legislation making a farm register obligatory for all farms that raise animals for food production (Anonymous, 2000). The farm register is a comprehensive record designed to track all animal movements, treatments, and veterinary interventions on the farm. The farm register contains 5 sections.

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The first section consists of the farm description with the farm's registration number, address, name of the owners and managers, name(s) of the record keepers, livestock species and breeds raised, types of animal productions, and blueprints of buildings in which animals are housed. The second section is a livestock fact sheet for each species raised: production types and system, herd veterinarian, adherence to breed books, breed/product type extension, and health services. Third is a record of all farm animal movements: arrivals (births, purchases, and loans) and departures (sales, loans, or death). Fourth is a comprehensive health record, in chronological order with all treatments (preventive and curative) for each animal or group of animals noted, whether preceded by a veterinary examination or not. Records include animal identification number, type of drug administered, dose, mode of administration, frequency, and duration of treatment. This information can be replaced by a reference number associated with a prescription. Prescriptions, lab results, purchase orders/bills for growth promoters and medicated feeds are also included in the fourth section. The fifth section comprises a record of all visits by veterinarians, from both the public and private sector.

Given that all drug use should be recorded, a well-kept farm register could be used to effectively measure antibiotic use on the farm. The entire medical history of an individual animal could be reconstituted from the registers of the farms on which it has been maintained. This important step ensures that only animals that are free of diseases or foreign chemical substances (such as antibiotics) enter the food chain.

Little is known at present about how this measure is being applied on farms. Many basic questions must be answered before the farm register can be used to track antibiotic use. For example, has the farm register been adopted by farmers? Are all treatments being recorded? A preliminary study was conducted in the Rhône-Alpes region with 2 principal objectives: 1) to evaluate the adoption levels of the register, and 2) to evaluate the register as a tool for tracking antibiotic use by comparing quantities of antibiotics purchased with quantities recorded. This report focuses on the first part of the study: the knowledge, attitudes, and behaviors of dairy farmers toward the farm register with particular emphasis on recording of antibiotic treatments. We also explored the relationship between these 3 variables, in light of social-cognitive models of health behavior change.

MATERIALS AND METHODS

We conducted a survey among dairy farmers in the Rhône-Alpes region of France who adhere to veterinary health cooperatives. The 6 cooperatives in the study are members of an umbrella organization, the Fédération des Eleveurs et Vétérinaires En Convention (**FEVEC**) (Sulpice et al., 1999). The FEVEC compiled a list of 375 eligible member farms. Only farms with dairy cows only or dairy cows and poultry were eligible for the study. Seventy-five farms (20%) were selected randomly from the list. Farmers were contacted by telephone and invited to participate in the survey. A farm visit (approximately 1 h) was scheduled with each farmer who agreed to participate in the survey.

The interviewer followed a written questionnaire that was designed to assess the knowledge, attitudes, and behavior of dairy farmers toward the farm register. Construction of the questionnaire followed the published recommendations for veterinary medicine (Vaillancourt and Martineau, 1990). Questions could be regrouped into 4 categories: 1) characterization of the farm, including size, number of workers, production per cow, adherence to a quality assurance program; 2) attitude-based questions (e.g., Do you think the register is essential, useful, not useful or other?); 3) knowledge-based questions (e.g., what are antibiotics used to treat?; recognition of the different sections of the farm register); and 4) behavior-based questions (e.g., did the farm have a register? Was the last treatment recorded? Was the last intramammary tube use recorded?). Questions in the first category were open ended; they were closed or semiclosed in the other 3 categories. Behavior questions were either answered directly by the farmer ("declared behavior"), or after verification of the register by the interviewer ("verified behavior"). Farmers' explanatory remarks and opinions also were noted, because these qualitative remarks gave insights into the attitudes and behaviors of farmers. The questionnaire was first tested with members (farmers, veterinarians, and staff) of the board of administration of a health cooperative. After minor modifications, it was again tested and timed on a dairy farm. A questionnaire (in French) can be obtained from Agence Française de Sécurité Sanitaire des Aliments upon request. Response data were coded and entered into a Microsoft Excel 2000 spreadsheet and summarized. All quantitative factors were described by a mean ± standard deviation, whereas qualitative factors were expressed as a percentage of the sample with a 95% confidence interval (**CI95%**).

The representative study sample was assessed by comparing the included farm characteristics (size, production quota, and number of cows) with those observed at national level using a z-test. The latest available national data were provided by La Maison du Lait (http://www.maison-du-lait.com/site.asp), which brings together professionals from all levels of the milk indus-

try. Dairy farm mean characteristics for 2004 were: 63.3 ha; 223,500 L production quota; and 38.7 cows. The farms surveyed are located in the hills and mountains of the Rhône-Alpes region. Therefore, we also compared the characteristics of surveyed farms with average mountain French dairy farms (in 2002: 58 ha; 211,800 L production quota; 37 cows; and 6,200 L of milk/lactation per cow; Seegers, 2002).

Relationships between the presence of a farm register (yes vs. no), the farmer's attitude (essential or useful vs. not useful), knowledge, and recording behavior toward the register were analyzed using a log-linear regression. Knowledge of the farmer was demonstrated by the number of parts of register recognized: (poor = 0 to 2 parts, fair = 3 parts, or good = 4 to 5 parts) and the recording behavior was defined by either a verified record of the last intramammary antibiotic tube used or a verified record of the last veterinary treatment (yes vs. no).

Finally, the proportion of farmers who correctly identified that antibiotics were used to treat only bacterial diseases was compared with the French general population proportion of 30% (Ipsos, 2002) using a z-test.

Statistical tests were performed using S-Plus Software (S-Plus 2000, Professional Release 2, Mathsoft, Inc., Seattle, WA). All tests were 2-tailed and statistical significance was defined at $P < 0.05$.

RESULTS

Response Rate

Overall response rate was 61% (n = 46 farmers). Reasons for not interviewing a farmer included: 1) errors in the initial list (farmers had retired, no longer adhered to a health co-operative, or no longer fit the essential inclusion criteria; n = 8 persons), and 2) either farmers could not be reached by telephone or interviews could not be scheduled within the survey time frame. Interviews were conducted from the last week of April 2004 through the first week of July 2004. Of the 46 interviews, 43 were retained for analysis, and 3 were not included because farmers raised other livestock (pigs or beef cattle) that could be treated with the same antibiotics as dairy cattle.

Farm Characteristics

Mean farm characteristics were 49.6 ± 6.5 ha, 195,100 ± 19,700 L production quota, 31.4 ± 2.6 adult cows, and 6,900 ± 400 L of milk/lactation per cow. Farms were smaller ($P < 0.001$) than the national average, but more productive than French mountain dairy farms: although significantly smaller in acreage ($P < 0.05$) and number of cows ($P < 0.01$), quotas and production per cow were greater ($P < 0.001$). Thirty-eight of 43 farmers (86%; CI95% = 72 to 95) adhered to some form of milk quality assurance program, and all but 2 (95%; CI95% = 84 to 99] adhered to a dairy herd improvement scheme. Many farms had other activities such as raspberry, potato, or poultry production, and farm tourism.

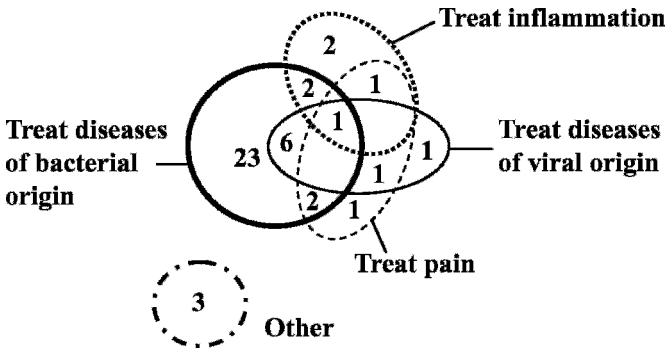

Figure 1. French dairy farmer responses to the question "What is an antibiotic used for?"

Knowledge

To the question "what is an antibiotic?" 34 farmers (79%; CI95% = 64 to 90) selected the answer "a drug that is used in treating diseases of bacterial origin," but only 23 (53%; CI95% = 38 to 69] selected just that answer (Figure 1). This response was more frequently ($P < 0.01$) given by farmers than by the national population. All farmers correctly named an antibiotic or a preparation containing an antibiotic, whereas 37 (86%; CI95% = 72 to 95] and 33 (77%; CI95% = 61 to 88) could name an antiinflammatory drug and a disinfectant, respectively.

Only 9 farmers had "good" knowledge of the register. They identified 4 or 5 sections of the farm register (21%; CI95% = 10 to 36). Ten farmers (23%; CI95% = 12 to 38) had "fair" knowledge (they picked 3 sections), and 23 (53%; CI95% = 42 to 68) had "poor" knowledge; they identified 2 or fewer sections. The record of "all visits by veterinarians" was most frequently cited (31 times), followed by the "health record" (29 times), the "record of livestock movements" (21 times), the "farm description" (16 times), and finally, the "fact sheet for each livestock species" (11 times).

Attitudes

The majority of farmers said that the farm register was useful or essential (37 of 43; 86%; CI95% = 72 to 95). Farmers listed many benefits of the register such as better communication between farm workers (5 of 37; 14%; CI95% = 5 to 29); a memory aid (20 of 37; 54%;

CI95% = 37 to 71); and a health management tool (9 of 37; 24%; CI95% = 12 to 41). They also found the register to be time consuming (17 of 37; 50%; CI95% = 29 to 63) and requiring too much paperwork (14 of 37; 38%; CI95% = 22 to 55).

Behavior

Thirty-one farmers (72%; CI95% = 56 to 84) had a permanent farm register (ring binder, notebook, or computerized register), 3 (7%; CI95% = 1 to 19) only recorded information on an erasable white board, and 9 (21%; CI95% = 10 to 36) had no system for recording treatments. Of the 12 farmers who used a white board or had no record, 5 declared that they kept prescriptions for at least 1 yr, 5 kept them for at least 5 yr, and only 1 kept prescriptions for just the treatment period. Overall, 3 of 43 farmers (7%; CI95% = 1 to 19) acknowledged keeping prescriptions for only the duration of treatment, 16 (37%; CI95% = 23 to 53) for 1 yr, 2 for 2 yr (5%; CI95% = 1 to 16), and 22 (51%; CI95% = 35 to 67) for at least 5 yr. Thirty-eight farmers were able to provide the last prescription for veterinary drugs.

Of the 31 farmers who had permanent registers, 27 (87%; CI95% = 70 to 96) declared that they were primarily responsible for recording treatments to cows; in 3 instances, the interviewee was not the primary caretaker of the dairy cows, and therefore, did not record dairy-cattle related records; and in 1 instance "whoever took care of the animals on a given day" recorded treatments. Eighteen farmers (42%; CI95% = 27 to 58) reported keeping treatment records for replacement heifers, whereas 20 (47%; CI95% = 31 to 62) reported keeping records of systematic treatments such as deworming.

After verification, both the last treatment and the last intramammary tube used had been recorded by 18 of 31 (42%; CI95% = 72 to 95) and 22 of 31 (51%; CI95% = 35 to 68), respectively, of the farmers who had a register. Besides the obvious absence of a permanent register, the reasons given were diverse: only antibiotic treatments were recorded; only treatments for adult cows were recorded; the farmer had not yet taken the time to record the treatment but was planning to do so; and the prescription served as a record. The prescription did indeed serve as a record because even farmers that had no permanent register could cite the milk withdrawal period, dosage, and mode of administration of the last antibiotic used (Table 1).

Table 1. French dairy farmer responses to the question " For the last antibiotic treatment, can you find a record (farm register or prescription) of the following?"

Item	Farmers able to provide this information[1] (%)	Farmers able to provide this information[2] (%)
Name of antibiotic	36/41 (88)	27/31 (87)
Milk withdrawal period	33/41 (80)	25/31 (81)
Mode of administration	19/41 (46)	12/31 (39)
Identification of treated animal	26/41 (63)	23/31 (74)
Daily dose	29/41 (71)	21/31 (68)
Beginning of treatment	27/41 (66)	22/31 (71)
End of treatment	21/41 (49)	14/31 (45)

[1]Two persons did not respond to this question.

[2]Of the 31 respondents who had a permanent register.

Relationships Between Adoption of the Register and Knowledge, Attitudes, Behavior

Results of knowledge, attitude, and behavior of farmers toward the register are given in Tables 1 to 3. There were no significant relationships detected among any of these variables. The relationship between possession of a register and adherence to a quality assurance program was significant, but this is a trivial result (Table 4).

DISCUSSION

The primary objectives of this study were to assess the knowledge, attitudes, and behaviors of French dairy farmers toward the farm register. After a brief review of the survey and farm characteristics, our findings regarding the knowledge, attitudes, and behaviors of farmers will be discussed separately, and then in relation to each other, within the framework of social-cognitive models of health behavior change.

The surveyed farms could be characterized as above average. First, surveyed farms are all in a hilly or mountainous region, yet productivity on the surveyed farms was better than the French average for mountain dairy farms. Average production per cow and annual milk quotas were greater, even though farm acreage and herd size were smaller. Second, 95% of the farms adhered to the Contrôle Laitier (the national dairy herd improvement program), although nationwide, the adherence rate in 2003 was only 56% (http://www.francecontrole-laitier.fr/). Third, most farms belonged to a quality assurance program (milk processing company, organic, or distributor program). Finally, farmers were members of a veterinary health cooperative. Operation of these cooperatives is different from standard veterinary clinics (Sulpice et al., 1999). Farmers pay a set yearly fee for each cow in the herd, which covers all veterinary procedures for that year, and can purchase veterinary drugs at cost. Farmers are trained to deal with routine medical events, such as mastitis and milk fever. These routine events are consigned in written flow charts. Veterinarians are called for all events that are not documented in the flow charts (diseases, symp-

Table 2. French dairy farmer attitudes and knowledge of the farm register (in 5 parts) in relation to the presence or absence of a register on farms visited

Item	Dairy farmers interviewed who possess a permanent farm register		Odds ratio	CI 95%[1]
	No	Yes		
Attitude	n (%)	n (%)		
"The register is not useful"	3 (7)	3 (7)	1.0	—
"The register is useful or essential"	8 (20)	27 (66)	3.6	0.53–24.5
Knowledge, no. of parts recognized				
Poor (0 to 2 parts)	8 (19)	16 (37)	1.0	—
Fair (3 parts)	3 (7)	7 (16)	0.78	0.14–4.40
Good (4 to 5 parts)	1 (2)	8 (19)	3.32	0.33–33.4

[1]Confidence interval (95%).

toms, changes in production, surgical procedures, and emergencies). Veterinarians also schedule routine herd health visits (at least twice annually) and government prophylactic campaign actions. The board of directors of each cooperative comprises veterinarians and farmers, who decide which training activities and themes will be covered each year. In summary, veterinary health cooperatives are mutually beneficial institutions that share costs and learning, with the objective of bettering herd health. Thus, farmers who belong to veterinary health cooperatives receive regular training and are probably better informed of the proper use of veterinary drugs than the general population of farmers.

We knew at the onset of our survey that the target population was not representative of all French dairy farmers. Nonetheless, we selected this population because antibiotic purchases could be tracked with confidence. Our results may well represent the best of what can be expected from French dairy farmers in terms of record keeping, because we were working under optimal conditions.

Overall response rate and sample size were comparable to those of other farm surveys, even though herd size and management practices vary (Faust et al., 2001; Vaarst et al., 2002; Zwald et al., 2004). Dairy farmer, veterinarian and industry opinions, and attitudes have been assessed through postal surveys (McEwen et al., 1991; Shaw et al., 1992; Payne et al., 1999) and sample sizes are considerably larger. Herein, the sample is small because we chose to interview farmers on site to verify their behavior instead of relying on reported behavior.

More than half of the French farmers surveyed responded that antibiotics are used to treat only bacterial diseases, whereas in a nationwide survey, 30% of the general population concurred (Ipsos, 2002). This difference is probably linked to the severe financial consequences of delivering milk with antibiotic residues to the processing plant. Several other dairy farmers said that antibiotics are used to treat bacterial diseases and inflammation or pain. This is explained by the nature of some commercial preparations that combine antibiotics with antiinflammatory drugs. Even if an antibiotic is administered alone, bactericidal or bacteriostatic activity may be accompanied by a reduction of the inflam-

Table 3. French dairy farmer attitudes and knowledge of the farm register in relation to the behavior of French dairy farmers interviewed who had a farm register (n = 31)

Item	Recording behavior, verified by a record of. . .							
	last use of an intramammary tube				last treatment			
	No	Yes	OR[1]	CI 95%[2]	No	Yes	OR[1]	CI 95%
Attitude	n (%)	n (%)			n (%)	n (%)		
"The register is not useful"	1 (3)	2 (6)	1.0	—	1 (3)	2 (6)	1.0	—
"The register is useful or essential"	8 (26)	20 (64)	1.34	0.08–21.71	12 (39)	16 (52)	0.54	0.03–8.26
Knowledge, no. of parts recognized								
Poor (0 to 2 parts)	7 (23)	9 (29)	1.0	—	9 (29)	7 (23)	1.0	—
Fair (3 parts)	1 (3)	6 (19)	3.14	0.27–36.38	2 (6)	5 (16)	2.47	0.32–18.72
Good (4 to 5 parts)	1 (3)	7 (23)	3.66	0.33–40.40	2 (6)	6 (19)	2.72	0.38–19.56

[1]Odds ratio.

[2]Confidence interval (95%).

Table 4. Relationship between belonging to a quality assurance program and behavior toward the farm register on French dairy farms

Item	Belongs to a quality assurance program		OR[1]	CI 95%[2]
	No	Yes		
Possesses a permanent farm register (n = 43)	n (%)	n (%)		
No	4 (9)	2 (5)	1.0	—
Yes	8 (19)	29 (67)	7.25	(1.12–46.99)
Recorded last use of intramammary tube (n = 31)				
No	1 (3)	8 (26)	1.0	
Yes	1 (3)	21 (68)		
Recorded last treatment (n = 31)				
No	0	16 (52)	—	—
Yes	2 (6)	13 (42)	—	—

[1]Odds ratio.

[2]Confidence interval (95%).

matory response and farmers may readily assume that antibiotics have several curative properties.

Although the farmers' knowledge of antibiotics was above the national average, only 2 farmers identified all 5 sections of the register. Insufficient knowledge of the register could be explained by the lack of information campaigns after the law went into effect. Pursuant to our study, the federation of health cooperatives is developing educational materials and water-resistant health record forms that could be used in the milking parlor (where many treatments of dairy cows are completed).

Attitudes toward the register were generally positive, even among farmers that did not have a permanent register. This positive attitude was unanticipated, because many French farmers are inundated with records: annual herd health summaries, milk production records, reproduction records, herd book and performance results, animal identification passports, European Union forms, waste management plans, and so on. The register was seen by some as doubling paperwork and wasting time because much of the treatment-related information is present on the prescription. Indeed, several farmers that did not have a register were able to give precise information regarding the last antibiotic treatment after consulting the prescription. Given that prescriptions should be kept for 5 yr, and that, in theory, antibiotics should only be delivered with a prescription, a well-kept file with all prescriptions would partially double as the farm register. Regulations have provided for this eventuality. Information regarding each treatment need not be recopied into the register if it can be linked to a prescription by a reference number. Nonetheless, prescriptions are not complete records, because not all treatments, antibiotic or otherwise, follow a prescription. Moreover, the prescription is a record of what should be done, and not of what was actually done.

Record keeping is essential to understanding and promoting whole herd health. As Nelson and Redlus (1989) observed, "if you can't measure it, you can't manage it." National and international organizations also have advocated that treatment records be required to show that antibiotics are used prudently by veterinarians and farmers (Van Donkersgoed, 2000). This is only possible if record keeping is done with diligence. Although French farmers are legally required to maintain a farm register, only 72% of the farmers interviewed had a permanent register, and only half had recorded the last treatment, regardless of its nature, or the last intramammary tube used. Similar levels of antibiotic-use record keeping were reported in conventional dairy farms in the United States (Zwald et al., 2004). Given that record keeping is not obligatory on US farms (in which herds are much larger, and therefore, record keeping is more time consuming), we would have expected a much greater adoption rate on French farms.

According to the Health Belief model (Becker and Maiman, 1975), health behavior change is a function of 4 components: 1) perceived susceptibility, that is, the individual's estimate of vulnerability; 2) perceived severity, which refers to how serious or dangerous the threat seems to be; 3) perceived benefits, or the gains (such as avoiding an illness) that the individual anticipates receiving; and 4) perceived barriers, which refer to the individuals beliefs about whether they can overcome the negative consequences associated with the action (Becker and Maiman, 1975).

Here, perceived susceptibility and severity can be paralleled with how vulnerable a farmer feels toward being fined when not complying with the law, and the severity of the fine. As of July 2004, farmers and veterinarians can be fined for not recording treatments in the farm register (Anonymous, 2004), but enforcement of this regulation is in the early stages, and perceived susceptibility, vulnerability, or both is limited. Farmers

cited numerous perceived benefits. Unexpectedly, bonus payments for quality were rarely cited as a perceived benefit of the maintaining a farm register, even though it is a criterion for quality assurance programs and dairies. In fact, several farmers that did not have farm registers still adhered to a quality assurance program, and furthermore, no correlation exists between participation in such a program and good record keeping. This can be attributed to the volume of quality assurance criteria that must be fulfilled and their mode of verification. Program technicians fill out checklists in which they record presence or absence of the farm register, but do not verify the content. Finally, farmers cited several constraints to keeping a register, and these perceived barriers would have a negative effect on record keeping.

Knowledge and attitude are often seen as positive predictors of behavior change. For example, numerous authors suggest that increasing knowledge and awareness about antibiotic indications and antibiotic resistance are key components of rational antibiotic use in human medicine (Palmer and Bauchner, 1997; Bauchner et al., 1999; Trepka et al., 2001). We were unable to establish a link between the presence of a permanent register (or use of the register) and knowledge or attitudes, and this may be because of our small sample size. We suggest several other reasons for the lack of significant associations, which merit further attention.

First, there has been very little education regarding the register, and therefore farmer knowledge about the content, uses, and benefits of the farm register is limited. Information about the register is being disseminated through private and public information campaigns. As farmers learn more about the rules governing the register and the potential benefits from systematic record keeping, behaviors are likely to evolve favorably. This hypothesis could be verified through a second survey in the same population, after the FEVEC completes a round of register-related training.

We also utilized restrictive criteria to estimate behavior, unlike other models of social-cognitive predictors of behavioral change (Garcia and Mann, 2003). These are based on questionnaires in which subjects are asked to rate the likelihood of performing a task or to report whether they had performed a task ("declared" or "intended" behavior). Subjects are rarely tested on their performance ("verified behavior"), and, in essence, intention implies action. A subject may intend to do an action without in fact doing it, sometimes simply because of countervailing circumstances (Greve, 2001). For example, several farmers had not recorded the last treatment in the register, because they "had forgotten," "not gotten around to it," or "the register was at home" (i.e., not in the same place where the treatment occurred). Furthermore, a subject may often, but not always, perform an action, and his perception of his behavior will differ from his action. One farmer declared that he recorded all systematic treatments such as deworming. Yet, the last treatment he had done was, in fact, a deworming, but had not been recorded in the register. Intention-behavior discrepancies have neither been approached in questionnaire construction recommendations in veterinary medicine (Vaillancourt and Martineau, 1990), nor taken into account in surveys of farmers, veterinarians, and agri-industry representatives that we encountered in the literature. This discrepancy certainly contributes to overestimating "positive" behaviors in agriculture.

In response to the emergence of resistant bacterial pathogens, inappropriate antibiotic prescription and use are receiving increasing attention. Numerous surveys have focused on the knowledge, attitudes, and behavior of patients and physicians toward antibiotics (Bauchner et al., 1999; Buñuel Alvarez et al., 2004; Corbett et al., 2005). Few surveys focus on farmers, yet this group often "diagnoses" and treats animals with antibiotics, not necessarily under the supervision of a veterinarian (McEwen et al., 1991; Payne et al., 1999). For example, in a postal survey of over 400 California dairy farms, 82% of dairy producers reported extralabel usage of drugs (Payne et al., 1999). Even when antibiotics cannot be purchased without a veterinary prescription, as is the case in Denmark, farmers' perspectives on disease handling and treatment are fundamental to rational antibiotherapy, because farmers are the primary caregivers (Kaneene and Miller, 1992; Vaarst et al., 2002). Programs that promote prudent use of antimicrobial drugs in veterinary medicine should address the attitudes of farmers, provide knowledge of drugs and measures, and accompany behavioral changes. For this, agricultural extension specialists could draw upon behavior change models that are applied in human medicine.

CONCLUSIONS

Record keeping is often associated with productivity and herd health management. The farm register may serve another purpose: to track drug use and show that drugs are used wisely in animal production. We are currently evaluating the effectiveness of the farm register as a tool for tracking antibiotic use.

The farm register will only be effective if it is fully adopted by farmers. Inasmuch as farmers are the primary caregivers of their livestock, their knowledge, attitudes, and behavior toward the farm register (and

antibiotics) should be given full consideration. In light of learning theory, "good" behavior is motivated by knowledge and a positive attitude. Therefore, programs that seek compliance with the farm register should focus on educational interventions and bonus incentives.

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