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Experiments in animal farming practice: the case of decreasing the use of antimicrobials in livestock (France)

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Abstract

Many farmers are engaged in activities that can be considered as experiments, but until recently few of their practices were studied. This paper offers a first characterization of experiments by dairy, pig and poultry farmers working in organic, labelled or conventional systems. Data (40 interviews) were collected during an interdisciplinary research project on antibiotic use in livestock farming in France. First, we discuss the literature. In line with D.A. Schön's "reflective practitioner model", we agree that farmers mainly carry out informal experiments. Second, we provide an

overview of the experimental process (type of farmer's experiment (FE), period, topics, targets and length) and the outcomes (efficiency, transfer, possible impact on antimicrobials use, renewal), drawing on farmers' subjective valuation and qualitative interview data. We find that farmers carry out multiple tests, mainly with alternative medicines. There is a clear tendency of transferring positive tests for a given pathology to one another. Third, we present seven portraits of farmers to shed light on complementary dimensions of experiments: the appeal of novelty, the role of vets and technicians, and the role of farmers groups and training. Finally, we argue that much can be learned from ethnographic investigation in order to grasp what farmers are experiencing when they endeavour to solve animal health problems.

Introduction

For a long time on-farm experiments were ignored or considered as unreliable (Sumberg *et fl.*, 1997; Saad, 2002), but for over two decades now the scientific literature has been highlighting the creativity of farmers in innovation processes. Farmers are currently of interest to academic researchers, who study the concrete modalities of these on-farm experiments and stress how more participative forms of innovation are preferred to the classical top-down innovation regime (McIntyre, 2007). Endorsing the challenge of developing "resource-poor" agriculture – identified by the Bruntland Commission in 1987 (cited in Chambers *et al.,* 1989) as a "complex, diverse and risk-prone" type of agriculture – offered a key contribution by putting small farm families' agenda and needs at the heart of agricultural research and extension. While the popular Farmer First Movement has not challenged scientific practices as much as expected, the idea of farmer-centred innovation has advanced considerably in recent decades. In a wide range of agricultural contexts and countries the issue revolves no longer around the reliability and reproducibility of farmer's empirical experiments, and rather around the understanding of their logic and process in a "co-learning" perspective between scientists and practitioners.

The existing literature devoted to small farmers' creativity draws particular attention to farmers engaged in agro-ecological transitions. To manage their specific agro-ecosystem, these farmers carry out numerous experiments, repeated over long-term scales, that constitute factors of resilience (Vogl *et al*., 2015; Kummer *et al.*, 2012; Chantre and Cardonna, 2014). Experiments related to animal husbandry have lower visibility than those related to cropping and to soil, seed, pest and fertilizer management, although they may be very frequent. For instance, animal experiments appear in second position in the analysis of frequency of topics for Austrian organic farmers' experiments, as presented by Vogl *et al.* (2014) (according to thematic clusters on 134 experiments discussed and a 123 interview corpuses). However, little is known of farmers' experiments in animal health management, which might be as widespread as they are in human medicine (Vornax *et al.*, 2010). For example, when farmers adopt alternative medicine for themselves, they often do likewise for their animals.

This paper aims to provide the first characterization of experiments by dairy, pig and poultry farmers working in organic, labelled or conventional systems. Data (40 interviews) were collected during an interdisciplinary research project on antibiotic use in livestock farming in France (INRA/TRAJ-GISA and CASDAR programmes). First, we discuss the literature. In line with D.A. Schön's "reflective practitioner model", we agree that farmers mainly carry out informal experiments. Second, we provide an overview of the process of experimentation (type of FE, period, topics, targets and length) and the outcomes of such a process (efficiency, transfer, possible impact on antimicrobials use, renewal), drawing on farmers' subjective valuation and qualitative interview data. Third, we present seven portraits of farmers to shed light on complementary dimensions of experiments.

1- Farmers as reflexive practitioners embedded in socio-technical organizations

Many definitions of on-farm experiments have been given and we may consider them from two different perspectives. Inspired by a "scientific-centred model", some authors have defined criteria against which an activity may or may not be labelled an experiment. As Vogl *et al.* (2015) pointed out, the pioneering work of Sumberg and Okali (1997) insisted on two definitional attributes: "the creation and initial observation of conditions, and the observation or monitoring of subsequent results" (2015: 141). In this perspective, authors make a distinction between *proactive* and *reactive* research. They expect not only discrete actions, but a whole process in which "experiments run first on a small scale and expand if the outcome of the experiments is satisfactory": a process that requires "regular monitoring" and an "explicit mental or written plan before starting" (Vogl. *et al.*, 2015: 140). Adopting a broad view of innovation ("a farmer who is for the first time using a new land preparation method, crop rotation, crop variety etc. is an innovator"). Saad (2002: 3) considers likewise "that experimentation is the process by which the innovator generates, tests and evaluates an innovation".

Departing from this scientific approach, a "practice-centred perspective" claims that all practitioners do experiment to a greater or lesser extent, albeit not necessarily consciously. For example, Bentley (2006: 458) suggests that people experiment "naturally", that is, "compulsively, effortlessly, without achieving dramatic results, at least not every time". He admits that some experiments are original, while "others simply copy innovations that farmers have seen somewhere else" (*ibid.*: 451), and stresses the idea that "a few folk experiments will be of interest to scientists" (*ibid.*: 452). Bentley nevertheless considers that experiments are crucial for smallholders – particularly those of developing countries – who find ad hoc solutions on a daily basis in order to save labour or capital.

This second perspective echoes Schön's reflexive practitioner model. In the 1980s this philosopher and scholar gave further thought to the kind of knowing inherent in professional practice. He brought to light how practitioners solve problems in situations, drawing attention to every detail and abandoning theory to try something new, reframing the situation "in a spiral process of evaluating-acting-re-evaluating" *via* a "self reflexive conversation" (Schön, 1963: 169). This shift from technical rationality in order to cope with the messiness and uncertainty of practice is key to understanding on-farm experiments. As Schön suggested, the practitioner is not only interested in solving problems; he or she is also interested in the unpredicted effect of his or her experiments. He or she also makes partial interpretations, being able to test several hypotheses simultaneously. We may conclude that practical situations are not very suitable for controlled experiments. Bentley comes to the same conclusion, referring to Latour and Woolgar's study of *Laboratory Life* (1986): while scientists essentially work with "inscriptions", folk knowledges are by contrast poorly "inscribed". Bentley notes with humour that "an invention that took a few moments to create and a few field visits to document ultimately took a whole PhD thesis to validate" (2006: 459).

In line with D. A. Schön's "reflective practitioner model" (1983), our multidisciplinary research conjectures that livestock farmers are coping with sanitary issues by predominantly setting up informal experiments. Instead of establishing *a priori*, and hence arbitrarily, a definition of experiments in health management, we seek to draw attention to the ways in which the use of antimicrobials is moving from the "outside", in the wake of policy or market regulations and in response to social demands, as well as from the "inside", according to farmers' needs and aspirations. From this point of view, experiments constitute part of the practical tool kit that farmers apply to their animal health management. We assume that farmers are engaged in an ongoing process of testing new practices with the objectives of saving labour and reducing medical expenditures. But we also consider that other factors shape their experiments, such as animal welfare, workplace wellness, sanitary quality of products, and civic involvement to fight against antibiotic resistance: every dimension that has recently been a focus of criticism in France. Lastly, we consider it important to integrate collective actors and organizations into the experimental process. These represent two analytical standpoints that both the science-centred perspective and the practice-centred one tend to underestimate, in favour of an individual cognitive approach. In fact, the definition of "trajectories of change" is grounded in two postulates: first, change in farming practices is based not only on technical and economic factors but also on social and organizational ones; and second, change is the responsibility not of any single actor – in this case the farmer – but of the network of relations that the farmer weaves with technical and health advisors, feed or medicine distributors, and neighbouring farmers (Fortané *et al.*, 2015).

2- A qualitative study: from an overview of farmers' experiments to some portraits

To this end, we carried out semi-structured interviews with farmers and key actors of their social network. Farmers' experiments were not a specific topic on our interview grid but they do appear as a striking result. Livestock farmers clearly give much more importance to experimentation than we expected. The sample was composed of 40 farmers (27 dairy, 9 pig, 4 poultry). Twenty-eight

In this research we distinguish 5 types of Farmers' Experiment (FE) described by the farmers themselves, that we rank in order of importance of the farmers' initiative and autonomy in experimenting: 1) experiments stemming from external recommendations (veterinarians, technical advisers, feed or medicine distributors, professional press, etc.); 2) experiments developed for solving urgent or major health issues; 3) long-term experiments that farmers conduct to increase their autonomy or the farm's performance or to reduce input costs; 4) collective experiments developed in an autonomous and informal environment; and 5) collective experiments driven by agricultural extension services.

Regarding the topics of experiments, we take the farm as the unit of analysis. Farmers often try a wide range of substitutes to antimicrobials (vaccination, technical device, alternative medicines, etc.), sometimes combining several of them for the same pathology. In this case, we add the different combinations we identify on each farm, what we call "mixed cases". For example: V (Vaccination) + AM (Alternative Medicine); A (Alimentation) + TD (Technical Device) + V (Vaccination) + AM (Alternative Medicine), and so on. Finally, we have 65 topics of experiments for 40 farms.

We also characterize FE modalities, the starting date and the period of time for which they are conducted (see codification in the tables below). We take into account their concrete target (the herd, baby animals, severely infected animals, a sample).

The farmers' points of view on their experiment outcomes and the decisions they subsequently take are mostly a matter of intuitive valuation. Codification is thus based on subjective farmers' assessments. Researchers put to the side their own judgments on the reliability of the information, especially with regard to the efficiency of the FEs or their impact on the decrease of antimicrobial (AB) use. FE Efficiency and FE Impact on AB codifications are given in the table below. We also characterize FE Transfer (Same Pathology, Other Pathology, No Transfer), and FE Renewal (Yes, Probably, No more).

Along with this broad description, the seven portraits we propose aim to highlight farmers' logics of action. The cases have been selected to include every form of production and a diversity of contexts and techniques or devices experimented with: vaccinations, food supplements, essential oils, homeopathy, etc. In several cases, they lead to important and sustainable change. Some farmers implemented and tested solutions with the help of their vets and advisors or within professional organizations.

3- Experiments to cope with a growing injunction to change: some results

Livestock production is one of the main targets of public policies to limit antimicrobial medicines in France, in particular medicines that are essential for human health (ANSES 2014). This reduction would meet consumers' demands and would be beneficial to farmers' image that is regularly tainted by critical media coverage. Antimicrobials are moreover relatively expensive and farmers could stand to gain financially by cutting treatment costs. Many are therefore experimenting with new approaches to the animal health management of their flocks or herds, especially for the prevention and treatment of infectious diseases.

3-1-FE Modalities

Table 1 shows that the experiments frequently stem from external recommendations by veterinarian practitioners or other key actors of "animal health" farmer organizations (14) that conduct pilot studies in the pig and poultry sectors (5). In a similar way, FEs are self-conducted by farmers in a long-term perspective (9) or to solve emergency cases (7). A few particular FEs conducted in "informal" (non-institutional) farmer groups were identified during the inquiries. They mostly concern organic farmers experimenting treatments based on unicist homeopathy. Table 2 is congruent with Table 1: FEs take place mostly after the visit of a sanitary adviser or retailer (15+8 mix cases = 23). FEs related to disease incidence are in second position (6+6 mixed cases = 12 farms). It is interesting to note that almost one third of the farmers also use their free time to experiment (4+8 mixed cases=12). We may conclude that FEs constitute more than a problem-solving approach. Basically, they are part of the farmer's animal health management strategy.

Table 1: Types of FE

1 = External recommendations, **2** = Urgent health problems, **3** = Long-term FE, **4** = Institutional FE groups, **5** = Informal FE groups.

TYPE OF FE	Farms Number
1	14
3	9
2	7
5	6
4	2
1-3	1
2-4	1
Total	40

Table 2: Period of FE

E = Emergency situation, **D** = Disease incidence, **F** = Farmer Free time, **V** = Experiments following the Visit of health advisors or sellers.

PERIOD	Farm Number
D	6
D-E	1
D-F	2
D-F-V	1
D-V	2
E	3
F	4
F-V	5
V	15
Default value	1
Total	40

Table 3 illustrates the variety of FE topics and the importance of multiple tests. In total, 65 experiments were carried out within the sample: 18 farmers carried out multiple tests with 7 different combinations of tests. This table also shows that alternative medicines are frequently explored in the FE (10 + 12 mixed cases = 22 farmers). About one third of the FE concerns alternative medicines (22/65 FE). If we consider the 18 “farmers multiple tests”, we can see that 17 of them experiment with alternative medicines. The FEs using technical tools (such as metering pump in pig production or internal teat sealant in dairy production) are also frequent (7 + 12 mix cases = 19 farms). Finally, FEs using vaccines concern just under one third of the sample (3+9 mix cases = 12 farms). These are initial findings that need to be compared to farmers’ discourse provided in the portraits below. Even if we adopted a non-normative approach to the definition of an experiment, certain cases have been excluded from our inquiry: cases where experimenting is “doing nothing” while waiting for the animal to recover on its own. This modality is also frequent in human medicine. The idea of “letting Nature” solve the problem and counting on the animal’s immune system is often found in interviews with organic farmers, but this type of farmer is under-represented in our sample. Table 4 indicates that the FEs are mainly run on a long-term basis (19 + 8 mixed cases = 27 farmers). The modality “Regularly” appears for 7 farmers (3 + 4 mixed cases). These two results confirm the main role of FEs in the management of health on farms in our sample.

Table 3: FE Topics

TD = Technical Device, **V** = Vaccination,
AM = Alternative Medicine,
A = Alimentation, **O** = Other

TOPICS	Farms Number
AM	10
TD	7
TD-V	5
AM-O	3
V	3
A-AM	2
A-AM-TD	2
AM-TD	2
AM-TD-V	2
A	1
AM-V	1
A-TD-V	1
O	1
Total	40

Table 4: FE Length

O=Once, **S** = Sometimes, **R**= Regularly,
L = Long term scale

LENGTH	Farms Number
L	19
O	5
S	5
L-O	3
R	3
L-R	2
L-O-R	1
L-R-S	1
L-S	1
Total	40

Concerning the other descriptors, on 19 farms the FEs concern the herd as a whole or the flocks (poultry) and on 14 farms, animal samples (7 + 7 mixed cases = 14 farms).

3-2- FE outcomes

Table 5 shows that the FE outcomes range from “good” (14 + 7 mixed cases = 21 farms) to “variable” (13 + 5 = 18 farms). On only 5 farms are FE outcomes said to be “weak”, and “no effect” is mentioned in 5 cases. FEs result in a “small decrease” of antimicrobial use for half of the farmers (16 + 9 mixed cases = 25) and in “no decrease” for 7 of them. In a few cases it seems that FEs result in a slight increase in the use of antimicrobials, when a failure has been followed by an over-use of antimicrobials for safety’s sake. Conversely, 15 farmers (11 + 4 mixed cases) estimate that they experienced a steep decrease of the use of antimicrobials thanks to their experiments.

Table 5 : FE Efficiency

G= Good, **V** = Variable, **W** = Weak, **Z** = Zero

EFFICIENCY	Farms Number
G	14
V	13
G-V	3
W	3
Z	2
G-V-W-Z	1
G-V-Z	1
G-W	1
G-Z	1
dv	1
Total	40

Table 6 : FE Impact on AB Use

H = High decrease, **S** = Small decrease, **N** = No decrease

IMPACT ON AB USE	Farms Number
S	16
H	11
H-S	3
N	2
N-S	2
N -S	1
N-S	1
S-H	1
S-N	1
dv	2
Total	40

Concerning FE transfers, there is a clear tendency to transfer positive tests run for a given disease to another disease (21 + 5 mix cases = 26/40 farms). For example, when a farmer gets a “good” result for the use of an essential oil complex to prevent mastitis, he uses the same product for lameness disorders. However, in one third of the cases there is no transfer (8 + 5 mixed cases = 13/40 farms). The renewal of FE is planned in more than half of the farms (22 + 4 mix cases = 26/40 farms) and is considered as possible on 9/40 farms (5+ 4 mixed cases).

These results concern a restricted panel, with a heterogeneous representation of the different types of animal production. It is therefore hardly possible to test some of the hypotheses, such as the existence of sector specificities regarding farmers’ experimental modalities or outcomes, or even their effects on antimicrobial use.

3-3- Trajectories of change and experiments

The aim of these portraits is not only to embody our data. They are intended to shed light on complementary dimensions that could not be taken into account in our descriptors (which remain necessarily simplistic). Three dimensions appear: 1) the articulation between farmers’ motivations or interests and the advice that they may find through training, farmers collectives or their technicians and vets; 2) the “taste” for experimentation, the appeal of novelty, the “handiwork” (in an anthropological sense); 3) the global thinking about farming practices in which experiments take place and sometimes lead to a reconsideration of their usual techniques.

Portrait 1: A conventional dairy farm (in the Maine-et-Loire French département*), around 75 cows, 2 partners. Individual experiment.*

Tests implemented on this farm focused mainly on essential oils used to treat mastitis without using antimicrobials. These tests started in 2014 after the farmer attended a training course on essential oils. He took the initiative to undertake this training with the Ille-et-Vilaine CIVAM because he could find no help on these subjects in his personal environment. Among this farmer's motivations for using essential oils, he highlighted not only the natural aspect of the treatment but also the fact that it was less invasive than an injection of antimicrobials.

Moreover, the farmer pointed out that having less mastitis on the farm enabled him to perform tests on one or two cows without taking too much risk. As soon as he reached 4 or 5 cases of mastitis at the same time, he treated directly them with antimicrobials. The farmer explained that when using essential oils, the disappearance of symptoms and the recovery did sometimes take more time than when antimicrobials were used, but according to his tests the efficacy of oils and antimicrobials was similar. In the cases of relapse or E. coli mastitis, he nevertheless used antimicrobials systematically.

Naturally curious, this farmer enjoys using different oils, which he chooses according to each cow's characteristics and applies on different areas. In addition to being curious, this farmer has quite a systemic view of herd health management, and is vigilant as regards milking hygiene, cows' positions or the genetic selection of cows with an index of positive "cells". There are many techniques in preventive treatments for mastitis.

Portrait 2: A conventional dairy farm, 40 cows, father and son family business with the grand-father's help.

According to this farmer, the key to keeping cattle in good health is to adapt the production level. His professional objectives are now geared towards a good technical-economic balance rather than pure technical performance. This choice has led to changes in his farming practice. At the moment he is generally satisfied with the sanitary situation on his farm. He has a preventive approach and pays special attention to feed, the cowshed, and hygienic milking practices.

One of the main changes he made was the implementation of selective treatment during the drying-off period. It started quite by chance, just because of a stock shortage in antimicrobials on his farm. As the results were conclusive, he applied the selective treatment (no antibiotics, only a teat obturator) on more cows, even on infected ones, which is not recommended. He then developed a more successful protocol taking into account somatic cell concentrations and production levels.

Today, he has scaled-up the selective treatment in the drying-off period. He uses no treatment in the case of cows that have a very low level of production especially when they are about to be

fattened and slaughtered. Aware of the risk, he accepts it because he is able to assess risk factors and to adapt his practices if necessary.

He developed this new practice alone, autonomously, without discussing it with his vet. This farmer feels concerned about antimicrobial reduction, which he sees as an imperative new challenge for all the farmers. He is getting ready… and would like to acquire methods or new techniques to ensure successful change change and to enhance his preventive approach. He does nevertheless still consider that antimicrobials have their role to play in a curative approach.

Portrait 3: An organic dairy farm. Brittany. About 50 cows, transition to organic farming in 2002, family farming.

Experiments that have been set up on this farm mainly concern homeopathy, but also some solutions that existed before the "antibiotic era", such as traditional remedies (for example oil or cider vinegar). The farmer learned some principles from his homeopathy training in 2002, such as the importance of watching animals and considering animal health "as a whole". Regarding treatments, he likes to develop his own recipes. He therefore buys ingredients to make his own homeopathic mixes, following some indications in the 'Boiron revue'. When he tests a treatment, he watches the animal much more closely than usual and usually waits some time before calling the vet (if the problem remains unsolved). Usually his wife does not agree with him on that. The philosophy of these experiments is to try them on just a few animals and spread them slowly to others (this includes "doing nothing", which can also yield results).

Portrait 4: A dairy farm with labelled raw cheese production, with 4 associates and 4 employees in Burgundy

Milk quality is an essential issue on this farm which produces raw cheese. The animal food system was entirely renovated a few years ago with a drying process in a barn, to improve the quality of the cheese and to acquire more autonomy. Watching and touching animals is very important to detect mastitis early. Phytotherapy (herbal medicine) is used as a preventive medicine: "*For us, animal health is observation so there are things that we are being able to treat with phytotherapy… when we see that there is a mastitis, we work with herbal medicine before using any antimicrobials*". This farmer Farmers uses treatment that he buys at a retailer but his intention is to learn quickly how to prepare his own treatments. The farmer in this case study used phytotherapy for the first time in an emergency situation (Staphylococcus that antimicrobials could not eradicate) that was impacting the farm's profitability. He did some research on the Internet in order to find new solutions: "*so we immediately stopped antimicrobials and we started to sort our herd into three groups, from the most infected to the least infected. And then we started to search for some information about herbal medicine and we got lucky 'cos someone… it was just by chance, but someone came, from a commercial organization, that was doing*

phytotherapy. So we started like that and in about 6 months, the problem was solved, all of our cows became healthy again".

Portrait 5. A multi-activity farm with vines (40 hectares) and poultry breeding (22 pens), run by a 50 year-old man and 2 employees. Collective tests on Label Rouge "yellow" broilers

The mains purpose of the tests was to identify technical improvements to be made: food intake, less antimicrobials use, water quality, etc. The farmer was on the board of directors of the farm organization. He had been running the farm since he inherited it from his father. He was breeding free-range poultry in pens, what are known as *"cabans"*. The farmer organization was running tests on the feed quality by changing/adding some components, and it needed the farmers who were members of the organization to test the feed on a flock. That was how the farmer became involved in the testing, which could be considered as teamwork initiated by the farmer organization. To him, this was a source of personal pride.

Portrait 6: A free-range poultry breeding in poultry house, Label Rouge, in the Landes Region

This multi-activity farm had 5 poultry houses of 400 m² each. Run by a 50-year-old man who had inherited the farm from his parents, it bred and force-fed various types of "label rouge" poultry (ducks, broilers, guinea fowls, turkeys) for the foie gras industry). The farmer's experiments aimed at decreasing the occurrence of digestive diseases in chickens, in the hope that this would in turn result in decreasing the use of antimicrobials. It provided a very interesting example of cross-learning between species. This farmer diversified by breeding different types of poultry. He transferred what he observed from one species to another by running tests. He solved health issues on ducks by analyzing the water and setting up a system to control the pH of the water. In particular, he wanted to see how the water's pH could improve the digestive health of broilers and guinea fowl. He also transferred the idea of a higher temperature from turkeys to broilers.

This farmer developed his own tests, without any collaboration with the technical staff of the farmer organization, but he did also exchange breeding experiences with other farmers. One of his neighbours learnt from him how to lower the pH of water. This shows how learning passes from one farmer to another. The salespersons working for agricultural hygiene companies also played an important part in that process, by offering technical alternatives to farmers.

Portrait 7: A family farm with 310 sows in Brittany. Farrow-to-finish. Installation in 1994.

This farmer took over the family farm in 1994. At the time it had 230 sows but he increased the herd up to 310 in 2006. Almost all the farm buildings had been renovated just before he arrived. This farmer had never changed his cooperative and had had the same technical adviser since 1996. He had also had the same vet (who worked with the coop) for many years. He considered

economic performance to be very important, and health management to be one of the main parameters of profitability. He did not however consider himself to be someone who was willing to test everything just to try to increase his performance. So the experience of his colleagues (other farmers) that he shared in some collective groups like the CETA or training courses organized by his cooperative were almost more important than 'just' the advice of his vet and technical advisor. Related to his economic motivation, he also valued his cooperative's technical and commercial strategies (he was involved in several bills of specifications) to value certain breeding practices, especially those promoting animal health and welfare:

"*This is a whole set of things. When you have projects like that, you have to get some information. You check with your vet and your technician, you ask questions. Right now, I want to renovate my boarding dock, so I asked my technician, I asked my vet. But I also belong to a working group, with some colleagues of mine. So we do a kind of a brainstorming and so you see if you're right or wrong. But it depends on our characters too. Some are more pioneering than others, they always rush into tests and innovations. Others have more of a wait-and-see approach, they do something only when they're sure it will work. I'm more in the second category*".

Conclusion: a call for further in-depth investigation

This characterization of FE in the case of decreasing the use of antimicrobials in French livestock farming brings to light a wide range of practices that are often overlooked by veterinarian practitioners and sanitary advisers. It could serve as a starting point to extend the investigation in order to obtain a fuller picture of these FEs in health management, as in the example provided by researchers for organic production (Vogl et al., 2015). Other methods are likely to be used and we assume that other issues would appear. In particular, a questionnaire survey completed by farmers would face the tricky issue of health norms and answers would be those expected by scientists and advisors. We nevertheless consider it to be of great interest to push forward this perspective. At the same time, we are convinced that much can be learned from ethnographic immersion if we wish to gain more insight into what farmers are experiencing when they try to solve health problems.

We have found that many farmers are using alternative medicine together with antimicrobials and that a large number of them do not think that essential oils or homeopathy work as well as antimicrobials. That is why they use both kinds of medicine. In some cases this contributes to incremental change in health management, while other farmers choose to redesign their whole herd management system and to stop antimicrobial use altogether. The combination of different kinds of medicine has likewise been observed by Bentley in Western Salvador. He found that smallholder farmers were using botanic and chemical pesticides alternately for managing pests.

Such a strategy of association between conventional and alternative medicine should be investigated further because it seems to be at the core of many farmers' experiments.

Overall, a majority of the farmers surveyed, whether conventional, labelled or organic, try different combinations. French dairy farmers sometimes use essential oils with local antimicrobials to prevent mastitis. This kind of practice is also found with free-range chicken farmers, even though it seems in their case that experiments are more collectively designed because of the importance of health and technical advisors in labelled production. These experiments are often designed to save on cash expenses but that does not mean that do not have other motivations for changing their practices (such as environmental or public health considerations). Farmers' experiments leading to a reduction of antimicrobial use should therefore not be analyzed as a response to a political, social or professional injunction to remove those pharmaceuticals from animal health practices. In fact, some farmers still use antimicrobials and, in the worst cases, their consumption even increases a little. Most experiments are actually driven by a (changing) way of considering farming and animal health in particular. A reduction of antimicrobials could be a consequence of these experiments but should not be considered as the only or even the primary motivation. The same conclusion can be drawn from the study of conventional pig farmers. Even though the kinds of experiment they carry out are quite different because of the socio-technical and socio-economic configuration of industrial pig production (importance of building management, feed or vaccination choices), and because of the long-term nature of their changes in practices (they not only run "tests", they also plan them over months or years), their way of constantly re-inventing herd and animal health management is clearly determined by this overall conception of farming. The question that arises here is not whether farmers should reduce antimicrobials or whether they should de-intensify their farming practices, but rather how they are trying to re-appropriate some injunctions, recommendations, and technical and scientific prescriptions in their overall activity of pig, poultry or dairy farming, that fit with their conception of their work. Ethnographic investigation would certainly more adequately document this aspect of farmers' experiments.

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