Step by step towards a reduction in antibiotics in French dairy cattle farms: a typology of trajectories of change based on learning and advice

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Abstract

Since 2011, French public policy has been encouraging a reduction in the use of antibiotics in animal farming. In this context, breeders have conducted initiatives for the reduction of antibiotics in their farms. The aim of this paper is to describe their trajectories and the management changes performed to achieve this goal. Our aim is to highlight the roles of private and public advisors in achieving a reduction in antibiotics. This study was based on semi-structured interviews conducted in spring 2015 with 14 French dairy cattle farmers, their veterinarians and advisors. We employed the concept of the "trajectory of change" to examine the comparison of the technical, economic, social and organisational determinants for the reduction in antibiotics. We built a model of demedicalisation trajectories inspired by a dynamic model developed by management sciences. Our hypothesis was that not only farmers' motivations and trigger events were critical to achieving a reduction in antibiotic use, but also farmers' requests for specific advisors. We identified three trajectories of change that include : the duration of the trajectory, the levels of antibiotic reduction, the learning processes, and the specific advisors. We identified three levels of transition: (i) direct without learning, (ii) direct with learning, and (iii) step by step with learning and compared these results with the conceptual work of Hill and MacRae, "Efficiency, Substitution, redesign". Stakeholders involved in providing advice on practice changes may then build on the degree of transition of the farmer to ensure greater efficiency in their interactions.

Introduction

Antibioresistance (selection of bacteria resistant to a given antibiotic) is a public health issue that the WHO has described as a serious and growing threat. In France, the EcoAntibio plan, launched by the Ministry of Agriculture in 2011, is aimed at achieving a 25% reduction in antibiotic use in veterinary medicine in the next five years in order to reduce their contribution to antibioresistance and to preserve the therapeutic arsenal in human medicine for the coming years. In cattle, estimated exposure to antibiotics (ALEA) fell by 6.6% in 2013 in relation to 2012. However, this exposure has increased by 0.2% over the last five years.

Mastitis treatment is where the most antibiotics are used in dairy farming (Kuipers, 2015). In France, farmers apply treatment protocols defined with their veterinarians during the livestock health survey (BSE - *Bilan sanitaire d'élevage*). In their everyday work, farmers administer treatments themselves (intramammary or systemically), which they obtain at their pharmacy with a veterinary prescription. Lactation mastitis treatment using antibiotics is almost systematic and there is considerable scope for technical progress. Systematic intramammary antibiotic treatment in dry cows, even for those with a high probability of having good udder health, is also common practice in France. This attachment to antibiotic prevention is linked either to beliefs (antibiotics at drying off sound banal due to widespread words like "drying cream") ; or simply to the persistence of traditional practices, even though these have been qualified as "high risk" by ANSES and "to be abandoned in the future". Alternate solutions exist. Some farmers may use teat insert to help the udder to remain safe during the dry period or choose to treat only the cows whose probability to get a mastitis is high. However, these may be difficult to implement; it is not enough to simply remove a specific procedure (antibiotic treatment). Farmers often need to reconsider their systems as a whole. However, Ministry of Agriculture demands in terms of reducing antibiotic use appear more as recommendations aimed at stakeholders in the agricultural sector than as proposals to enable the achievement of targets set. There are therefore no real incentives for demedicalisation and procedures undertaken are voluntary.

The goal of our study is to describe and understand the demedicalisation process on farms that have initiated it (early adopters). We apply the concept of the trajectory of change to describe this process. This approach makes it easier to understand the relationship systems between the different technical, economic, and sociological elements, among others. We estimate for instance the influence of the Eco-antibio plan that the Ministry of Agriculture launched in 2011 or of the advisors on these early adopters. We also seek to identify the involvement of the farmers' professional networks in these trajectories. We examine the support strategies to be provided to farmers wishing to reduce their antibiotic use. The long-term goal is to ensure more widespread adoption of this type of approach among cattle farmers.

Material and method

Semi-structured interviews with farmers and their animal health advisors

The study is based on 14 interviews with farmers conducted in spring 2015. The farmers interviewed were recruited by expert partners of the study and by telephone interviews among information relays (animal health association (*groupement de défense sanitaire*), veterinarian professional association (*groupement technique vétérinaire*), technicians, milk recording agencies (*contrôle laitier*) etc.). The criteria used to select them were a (subjective) decrease in antibiotic use, an interest to selective treatment at drying off, registrations to a training on alternative approaches. The goal of the study was to identify farmers' motivations for reducing their use of medical inputs and to rely on their own perceptions of this reduction on the farms in question. The aim was to observe demedicalisation trajectories within different farm systems. The hypothesis was that the farming system may favor or prevent the decrease in antibiotic use. We explored two trigger factors : the intensiveness of the farming system and the labellisation of outputs. The final sample includes five farmers in conventional farming systems in the Grand Ouest region of France, six farmers in organic farming systems in the Bretagne-Pays de la Loire region and three farmers belonging to the Epoisses PDO in the Bourgogne region. We conducted semi-structured interviews using an interview grid with each farmer on their own farm and with their animal health advisors (veterinarians, technicians). The two-hour interviews focused on the context and history

of the farm, on the diseases present on the farm and their management (especially antibiotic use), and finally on the farmer's information networks and resources.

The table below presents the current characteristics of farms surveyed that are relevant to understanding the trajectories of change. The situation of individuals (age, education, family situation, etc.), the way in which they carry out their work over time (work organisation, diversity of activities, etc.) and the regions in which they work are varied (Table I.).

Table I. Summary of characteristics of farms involved in demedicalisation trajectories

Bio/PDO/Conv farm, Dept	Year of installation, training	Nb AWU / herd size, other activities on farm	Stable, average, SCC tank (C/1000L)	Building - installation (construction, renovation)/ dairy cows breeds	Feed/ Evolution farming practices	Evolution pro network	Salient health event	Treatment: 1st intention mastitits/ Dry cows
Org 1 (1994) 44	1986, BEPA	4 / 85 dairy cows	7000 kg,	/**Crossbreeds**	**Pasture system** / suckled calves / Curative hoof trimming	1989, farmers' exchange group 1995, organic cooperative	1992, ill calves nursery	Homeo/ Homeo or antibiotics on cow with SCC <1 000 000 (1997)
Org 2 (2012) 35	1983, BTA	2 / 45 dairy cows, rural holiday cottages, production honey, jam, oil	6800 kg, 190 000	2006, Construction new building with solar panels 2014, dryer in barn/ **PH**	**Maize seed pasture system** / Grouped calving	CA and defence organization (GDS)	2002, slaughter of herd (BSE)	antibiotics/ selective dry off therapy
Org 3 (1992) 44	2009, BTSA	5 / 135 dairy cows	4700 kg, 170 000	Dryer in barn /**Crossbreeds**	**Pasture system** / Grouped calving , Curative trimming	Organic cooperative GAB	2010, milk quality	antibiotics/selective dry off therapy
Org 4 (2009) 29	1996, BTSA	3 / 80 dairy cows, farm bread	5000 kg, 176 000	/**Crossbreeds**	**Pasture system** / Grouped calving , annual preventive trimming	CA farmers' group	2014, calf diarrhea	aromatherapy/selective dry off therapy
Org 5 (2002)	1996, BEP	2 / 50 dairy cows	6000 kg, 173 000	/**Crossbreeds**	**Pasture system** / Calving being grouped, Curative trimming	Dairy inspection - CA	2013, milk quality	Cider vinegar/ Homeo
Org 6, 22 (2003)	1989, BTS	3 / 66 dairy cows (increase up to 75)	7000 kg, >200 000	Dryer in barn/**Crossbreeds**	**Pasture system** / preventive and curative trimming	CIVAM GAB	2014, milk quality	Homeo/selective dry off therapy

PDO a, 52 (2001)	1994, BEPA expertise cow/pig farming, Inseminator licence	2 / 44 dairy cows	6500 kg, 250 000	2000 new building/ **Montbéliardes**	**Pasture system** / Use of gloves in stalls	Another farm (natural farming approach, homeo aromatherapy)	? milk quality	aromatherapy/selective dry off therapy
PDO b, 52 (2004)	1996, BTS AXE	8 / 70 dairy cows	7200 kg, > 350 000	2010, dryer in barn 2014, new milking room **Montbéliarde Brunes des Alpes**	**Pasture system** 2014, end Brunes des Alpes/ Gloves for milking/ mattress stalls		2012 milk quality	aromatherapy/ selective dry off therapy teat insert use
PDO c, 21 (2000)	1993, BAA	3 / 40 dairy cows, mustard seed cultivation	8000 kg,	**Montbéliarde Simmental**	2000, change breed (before PH), calving box, curative trimmingf	neighbours, veterinarian	2007, Tuberculosis slaughter of herd	Ointment aromatherapy/antibiotics
Conv 1, 49	2007, BTSA ACSE	2 / 74 dairy cows	7700 kg, 227 000	2009, new building **Normandes/PH**	**Pasture system (+maize)** 2013, milking hygiene, reforms 2014, veal boxes	Normande breed union, CIVAM	2007 to 2013 insufficient milk quality	aromatherapy (2014), antibiotics + phytotherapy
Conv 2, 56	1997, BEPA	2 / 90 dairy cows	8900 kg, 245 000	2012, Milking robot/ **PH**	**Pasture system (+maize)** 2012, cell reforms, 2013 Test calf aromatherapy	Group 12 farmers exchange +++, Defence organisation GDS (aromatherapy)	2008, FCO 2012, problems with robot installation	aromatherapy (2013), antibiotics
Conv 3, 49	1999, BTSA	2,5 / 40 dairy cows + pig	10 300 kg, 115 000	2014, Stalls 40 places/**PH**	Clay (Org), 2015 biosafety separation male female calves, emptying nursery once a year	Cooperative, vet. advice, CUMA	2012 IBR, before 2013 milk quality, 2014 calf diseases	antibiotics, selective dry off therapy (2011) teat insert use
Conv 4, 50	1991, BEPA	1,5 / 38 dairy cows	6000 kg, 217 000	2002 upgrading to building standards, 2009 dryer in barn /**Normandes**	**Pasture system** , add multi-vitamin complex end grass silage, 2013 end of trimming	Farmers' group	2004, milk quality	antibiotics
Conv 5, 35	2007, BAC pro	2 /53 dairy cows, + labelled chicken	7700 kg, 250 000	**Crossbreeds**	**Pasture system** , halved maize production in 5 years	Farmers' group-Obsalim	2010, parasitism	aromatherapy- Homeo-cider vinegar, antibiotics

Creating an indicator of the level of demedicalisation

Expert sampling and the lack of factual data on monitoring of antibiotic consumption in cattle farms have not enabled the quantitative definition of antibiotic consumption over time using an indicator. However, we propose the definition of a "qualitative indicator" of the level of antibiotic use between the different farmers, according to the practices described. We will thus verify the hypothesis of a range of different levels of antibiotic use within the demedicalisation trajectories. The five levels of this indicator correspond to the different uses described by farmers during their demedicalisation trajectory. Levels 0 and 1 concern the maintenance of preventive antibiotic uses, especially with the maintenance of the systematic use of antibiotics in dry dairy cows. Level 4 corresponds to a farmer in the organic farming sample who no longer uses antibiotics to treat mastitis. The different levels are described in more detail in the following table (Table II).

Table II. Levels of coherence of antibiotic use in our sample

<table>
<tr><td>Level of coherence towards demedicalisation</td><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td></tr>
<tr><td rowspan="2">Intrinsic motivations</td><td rowspan="2">No rationale towards reduced antibiotics use</td><td rowspan="2">Increasing the efficiency of farming practices in order to reduce antibiotics use AND/OR Substituting antibiotics for alternative methods</td><td>Reduction with no more systematic preventive uses Rethinking dry cowg practices</td><td>antibiotics only for mammary pathologies and during veterinary intervention</td><td>antibiotics only during veterinary intervention</td></tr>
<tr><td colspan="3">Mobilisation of decision-making support tool for dry cows</td></tr>
<tr><td>Extrinsic motivations</td><td colspan="2">No incentive measures to reduce antibiotics use</td><td colspan="3">Possible soft incentive measures which nevertheless require consideration of every treatment</td></tr>
</table>

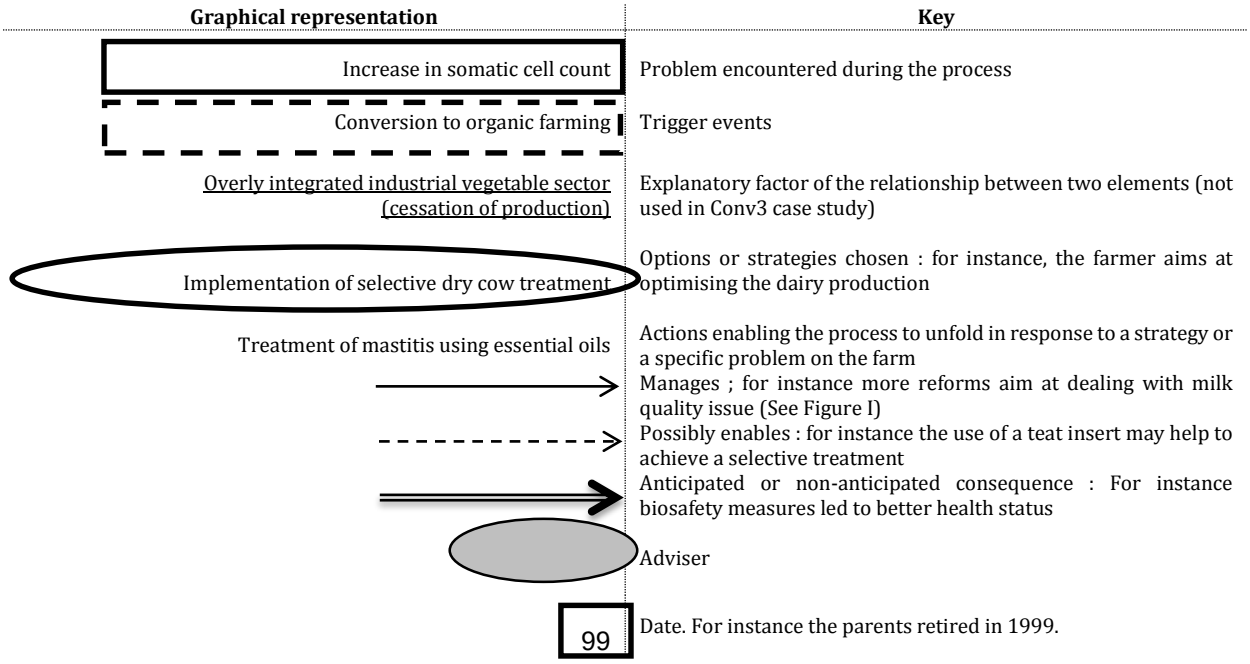
Choosing an analysis method for trajectories of change

Where agriculture is concerned, it was Capillon in 1993 (Capillon, 1993) then Perrot in 1995 (Perrot, 1995) who first described farming trajectories with the goal of establishing typologies. But these first descriptions only compared initial states with final states through statistical analyses, without addressing the process of change itself.
In 1995, Girard established a method to model pasture feeding strategies for lactating herds of sheep. This modelling is based on a representation of farmers' actions, aimed at making these actions intelligible. The farmers' practices are studied according to their modalities (their implementation) and their arrangements, making it possible to highlight the strategy adopted. Madelrieux used this framework of analysis in 2002 to study land use changes by farmers seeking to resolve their labour problems. To establish these linkages, the tools for action mobilised to resolve the problem were first identified. Madelrieux thus proposed an analysis of trajectories through a representation of a chain reaction, which draws a causal link between events relative to the context, actions and indirect effects of actions (See Figure I). We adopted both Girard and Madelrieux's dynamic approaches to analyse the trajectories of the 14 farmers.

We seek to establish an external representation of the trajectory according to stakeholder accounts without judgement in relation to external norms. The analysis of cases conducted in this study results from the reconstruction by the farmers interviewed of the rationale for change on their farms in connection with herd health management and relationships with cattle farming sector stakeholders. In addition to farmers' motivations and trigger events for change, the goal of the

analysis is to identify within these trajectories the tools mobilised that contributed to change. These tools, resulting in a reduction in antibiotic use, can be linked to the context, the professional or family circle, the training, the previous practice changes, the trigger events on the farm… This is how we determine what farmers believe (preferably in agreement with the scientific literature) has led to better health management on their farms with demedicalisation. The choice was made to integrate the farmers' network interventions to identify their role within the trajectory (consultation when implementing an action, for example). The framework for analysis is detailed below (See Table III and Figure I as an example)).

Table III. Key to the processes

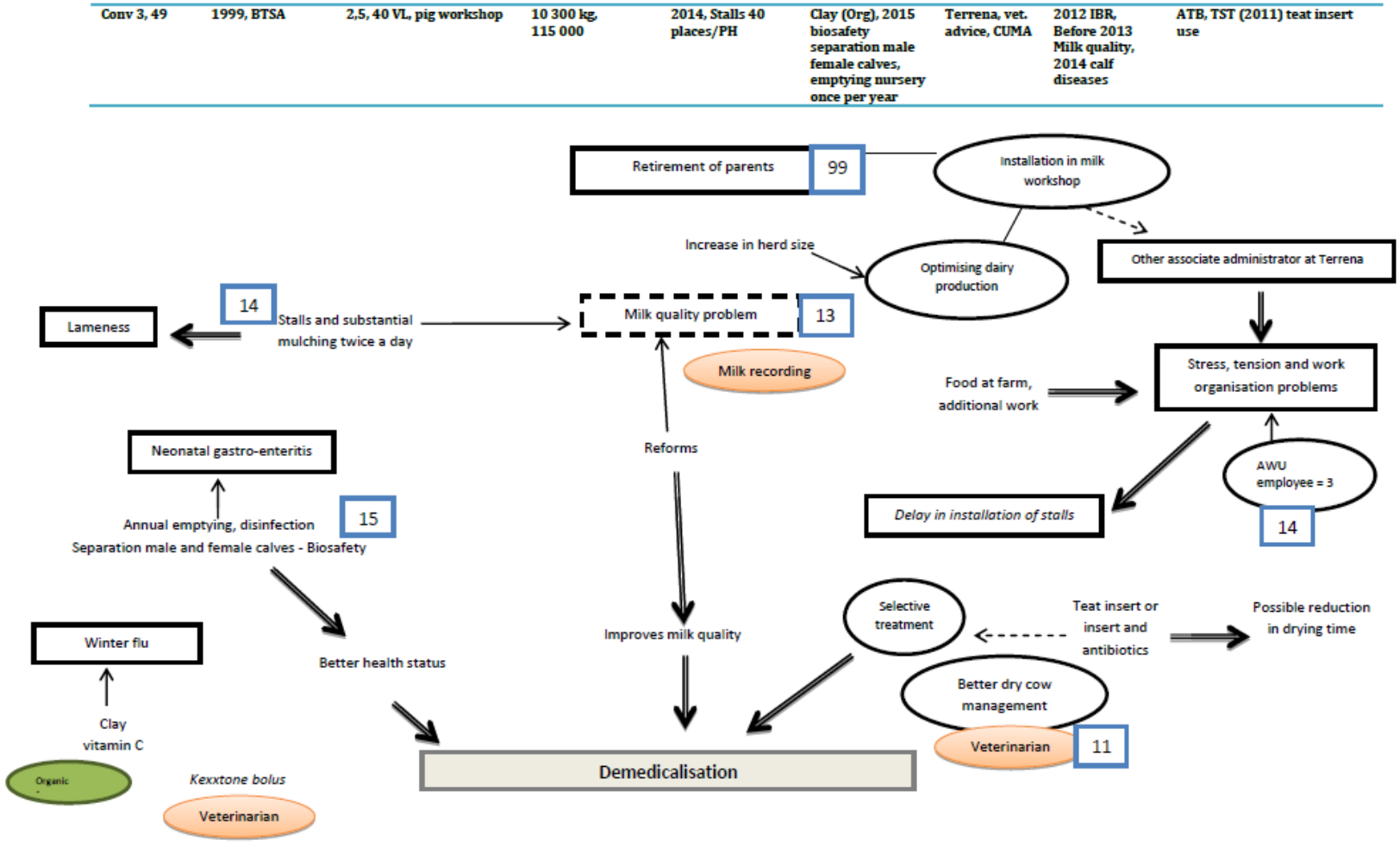


Results and discussion

Trigger events for trajectories

Even if reducing antibiotic use is a public and animal health issue, this change is not a priority for interviewees in view of all the changes taking place within a farm. Most often, actions are conducted with the goal of tackling a specific problem rather than of following a demedicalisation strategy. This means that the farmers are the first drivers of the change induced. Their motivations are based on their own strategy much more than on the institutional policy or on their advisors' recommendations. It is therefore the reflexivity of the farmer that enabled us to establish linkages between the different actions conducted within farms over time (to address problems or not) that resulted in demedicalisation.

Figure I: Example modelling of a demedicalisation trajectory



The tools used

The different tools activated by farmers leading to demedicalisation are labour and work organisation (activities within the farm and external activities): farming practices and structural adjustments, training and experimentation on alternatives to antibiotic treatment methods (See Table IV).

Table IV. Inventory of actions activating the different tools

Tools	Actions
1/ Labour and work organisation	Distribution of tasks, observation of animals, meeting with associates, holidays
2/ Farming practices and structural adjustments	Feed management, good milking practice, bedding hygiene, genetics/breeding, nursery, biosafety, milking once a day
3/ Training and experimentation on alternatives to antibiotic treatment methods	Training with veterinarians, naturopaths, farm tests

The level of demedicalisation reached

Within the 14 demedicalisation trajectories observed, there is a high degree of variability in antibiotic use observed (See Table V). The duration of these trajectories differs; the longer they are the more robust the changes undertaken and the greater the reduction in antibiotic use. We also observe coherence between the highest levels of demedicalisation and a redesign of the farm system as a whole (farmers in organic systems or similar).

Table V. Levels of antibiotic use during the trajectory for the farmers interviewed

PDOc, Conv 1, Conv 2, Conv 4	0	1			
Org 4, Org 6, PDOa, PDOb, Conv 3	0	1	2		
Conv 5	0	1	No step	3	
Org 1, Org 2, Org 3	0	1	2	3	
Org 5	0	1	2	No step	4
Level	**No consideration**	**Efficiency and/or substitution**	**No more systematic treatments**	**Restricted antibiotics**	**Antibiotics only for veterinarian use**
Farms	**Level of demedicalisation observed over time (main steps)**				

The main obstacles identified to the cessation of systematic treatments are high levels of risk aversion, the cost of teat inserts and to a certain extend the lack of advisory services. Farmers who limit antibiotic use to proven mammary pathologies have withdrawn from the productionist paradigm. However, they have at least maintained their margins due to the higher economic value of products (linked to certification) and to lower input costs.

The different demedicalisation trajectories: a typology

By associating the tools used by farmers over time, the different levels of antibiotic use identified since their installation and the trigger events, we have been able to highlight three types of demedicalisation trajectories within our sample (See Table VI). We present them here according to Hill and MacRae's ESR nomenclature (Hill & Mac Rae, 1995). 5 farmers in our sample are motivated by efficiency ; 4 farmers in our sample adopted substitution practices ; 4 farmers in our sample redesigned their farm system. There is no clear consistency between the farming system and the type of trajectory adopted. It seems that the intrinsic motivations as well as the trigger events determine the trajectory more than the farming system, or at least more than the labelling system. Some organic farms favour efficiency, whereas some conventional farmers may have implemented long term trajectories with a large reconversion of their farming system.

Table VI. Characteristics of the three types of trajectories of change: triggers, motivations, contributory factors

Type of trajectory	Triggers	Motivations	Contributory factors to demedicalisation	Method and type of support	Farms concerned	Level reached
Trajectory E (short) No learning	Milk quality problem Slaughter herds BSE – tuberculosis	Being coherent with one's conception of the job High quality milk – consumer Desire for technical> economic expertise	-Division of labour - process streamlining -Search for scientifically proven solutions -Entrepreneur profile -Expertise -Preference for expert opinions	One-off with monitoring +/- contractual relationship Veterinarian / technican Farmers – personalised advice	PDOc Org2 Org3 Conv3 Conv4	2 3 3 2 1
Trajectory S (medium) Direct with learning	High cost of treatments Installation of new farmer Organic conversion Press article	Economic Autonomy Values: "More natural treatments" Public health (antibioresistance)	-Context of development of training on alternative methods -Antibiotics substitution trials -Recomposition of work group -Broad consultation of professional group	One-off without monitoring Different training – generalist approach	PDOa Org6 Conv1 Conv2	2 2 1 1
Trajectory R (long) Progressive with learning	Economic crisis Installation of new farmer Organic conversion	Coherence between practice and conception of the job Reducing the workload Taste for innovation	-Support for conversion -Selective dry off therapy -Withdrawal from productionist paradigm (single milking practice) -Use of homoeopathy in private circle -Shared work approach: working time, organisation of tasks, experience of work, relationship work-income -Construction through discussion groups between farmers	Monitoring in monthly or bi-monthly groups (led by professional organisations) +/- formalised between farmers, farm visits, intra-group innovation	Org1 Org4 Org5 Conv5	2 2 4 3

Short trajectory without learning (5 farmers)

Short trajectories without learning are followed by farmers in relatively intensive systems or those with large farm structures. The search for efficiency is the main motivation for these farmers (5 out of 14). It is technique rather than the desire for economic gain that leads them to reduce their antibiotic use. The reduction in antibiotic use is a – sometimes unanticipated – consequence of meeting the technical objectives they have set themselves.

The trajectory followed can be described as direct without any phase of learning. It is of short duration from the trigger event identified, often a health problem (3 farmers faced milk quality problems, 2 had to deal with the culling of their cattle). The farmers then adopted new but often reversible practices. They improved their milking practices. They solved the bedding hygiene with some more sanitary emptying or a better mulching instead of new building (2 cases out of 5). As far as feed management is concerned, 3 farmers out of 5 introduced more pasture, one chose to invest to dry in barn. These changes lead to an improvement in the overall health of the herd.

Over the course of this trajectory, the farmers favour expert opinions and mobilise these experts from time to time. These farmers are demanding in terms of the information they receive, and this is why they choose advisors with recognised scientific expertise. Veterinarians and dairy inspection technicians are the preferred contacts, but they also lean on technical advisors or animal health associations. They use this information to improve their technique and their autonomy in terms of farm management. At first, the use of antibiotics is not called into question. The approach focuses on the efficiency of their uses and on preventing the emergence of the health problems encountered. Consequently, preference is given to technical adaptations of the management system already in place proposed by the veterinarian or the technician. The substitution of antibiotics for essential oils or homoeopathy is envisaged, but is not implemented by these farmers, who point to the lack of scientific proof of their effectiveness or of any well-defined protocol. They are demanding of the information used to conduct their demedicalisation trajectory.

The resolution of health problems requires continuous changes (structural investments, adaptation of practices), but changes are reversible enough so that the farmers encounter few risk. Thus, the trigger event enabled the change but the new situation produced is in continuity with the previous situation. A farmer said :"*You don't actually change your system, you adapt it […] You do a bit more prevention, but you don't revolutionise everything*". Antibiotic reduction is primarily achieved through withdrawal, by reducing the incidence of cattle diseases or by implementing selective treatments in dry cows for some farmers. Another farmer made this comment : "*But then you could say we're not stupid, if you have a healthy cow that has never had mastitis, if you use a teat insert, then you block the entrance for all possible infections during the dry period, and that will have the same effect*". (Further to information meeting at veterinary surgery). However, other farmers maintain this preventive antibiotic practice in dry cows since it does "no harm".

Direct trajectory with learning (4 farmers)

In the direct trajectory with learning, the aim is clearly to have antibiotic use decrease. This implies connecting the longer term with the short term, enabling a bifurcation in the farm trajectory. The path chosen by these 4 farmers is demedicalisation by substitution ; although all of them improved the health status of the cattle through a better feed management (all of them), new building (2 cases out of 4), a better mulching (1 case), a better reproduction management (1 case), there is no link in their recollection between this improvement and decrease in antibiotic use . Within this trajectory, we first observe a reorganisation of activity (new work organisation, recent installation, additional AWU, etc.), and this is the first tool mobilised. Work organisation enables these farmers to find time for training and to conduct experiments and tested different alternative methods to

antibiotic therapy (the use of homoeopathic products or essential oils for instance (Joly and al., 2016)). Only the substitution helps them remove antibiotic, probably because it seems less risky to them to replace a product with another than to fully withdraw it.
Only one farmer consulted on that topic his veterinarian involved in homeopathic products, which is rather rare in France. These farmers thus mobilise a network of organisations that propose training on complementary medicine. "*Two years ago I asked the GDS* (animal health protection group) *if any training was available*". It could also be an association to promote organic farming, or a professional association. One out of 4 leant on press. They undertake training to improve their skills and seek advice to coproduce solutions to achieve the goals they have set themselves. They assert their independence and seek to control the costs of medical inputs.
Two farmer profiles emerge within the direct trajectory with learning according to motivations for conducting these tests. These motivations are either economic (price of antibiotics, milk withdrawal period after treatment, etc.), or linked to their beliefs or system of values. These farmers wish "more natural treatment" and rely on animal immunity. They wish to participate to the decrease of human antibiotic resistance. They seek for a greater meaning to their job and consider that increasing observation of animals to be able to take care of them if they are ill, is part of this meaning. "*From the outset my reasons were not economic […] It was a choice: we already wanted to use different treatments [whether we earn as much money or not]*". However, the cost of antibiotics and the desire for autonomy in farm management (by reducing all types of inputs) are also strong, deep-rooted incentives in all these farmers. "*It would have been four times more expensive than antibiotics, maybe…*". "*We never throw away any milk, since we don't use antibiotics*".
Moreover, even if zootechnical changes are made at the same time, the substitution of antibiotics for alternative products is what farmers say reduces their consumption of antibiotics : "*We haven't changed anything in terms of farming techniques*". The learning required is primarily done in connection with professional organisations, then within the private sphere through the tests conducted. The protocols proposed during training do not always suit farmers, who adapt them or turn to other substitution methods. The implementation of these alternative methods brings about a shift in the framework for action (timing of intervention, period of observation) and the evaluation of disease treatment (recovery time). The tests make this transition possible. However, the changes made during this trajectory are highly reversible and in periods of crisis or stress, allopathic solutions often take precedence, as they make farmers more secure in their choice of action, and they limit risk-taking. The farmers then came back to their usual veterinarians to help them find solutions to milk quality (2 out of 4 farmers) or to get better efficacity tham alternative medicine (notably 1 farmer).

Progressive trajectory with learning (4 farmers)

The progressive trajectory with learning concerns farms that were in intensive systems and which, by taking advantage of a conversion or by signing up to a charter, have changed their system and shifted to an extensive system, which was not necessary the case for the others. The cut off in antibiotic use is then a consequence of a major change on the farm.
The new practices has improved the health status, for instance on neonatal gastroenteritis "*We simply changed, because in the previous system, when cows calved, we removed calves immediately after birth*". "*When calves are able to follow, they join the herd and find themselves with the other cows in the herd*". This trajectory obliges farmers to regularly test new cultivation techniques (with a view to improving feed for dairy cattle). The 4 of them reduce corn in the ration of dairy cows and raise pasture. They have all carried out crossbreeding to improve the overall health of the herd by making the animals more resistant. This type of management relies on feed autonomy and the hardiness of animals, which results in a withdrawal from the productionist

paradigm and therefore in demedicalisation. One of them even milks only once a day. The progressive trajectory with learning takes place over a long period (7 to 22 years), is progressive and requires learning. The added value of production linked to certification is one advantage of adopting this type of trajectory.

Thus, over the course of this trajectory, the whole farm management system is modified in terms of work organisation, practices and treatment methods (the three tools identified are mobilised). These changes conducted over the long term make it possible to reduce medical inputs and inevitably lead to a reduction in dairy production. These are gradual but irreversible changes. The goal for these farmers is therefore to reduce costs in order to maintain or increase margins. But this goal cannot be dissociated from happiness at work, the enhancement of their work, or quality of life among which spare time.

The progressive trajectory with learning is based on a redesign of the system which makes it possible to obtain healthier animals, according to farmers, and therefore to reduce antibiotic use. "*There are no more young calves to take into the nursery. So we sorted out all the health problems in one go and since we did that, we have hardly ever needed to see the vet to treat a calf*". However, it is still associated with the use of alternative methods for which learning is achieved in conjunction with practice changes. Today, learning linked to the use of alternative methods and practices to antibiotics has ended or is about to end by them.

They are willing to implement any new technique enabling them to improve their work organisation, their economic performances and their technical skills. They lean on trainings, but wish to go further. One of them has travelled to England and to New Zealand to get some insight on other farming systems. However, they break away from veterinarians, who they only call upon in an emergency, when their technical skills are required. They rely rather on the robustness of their animals and on their own capacities. A farmer related that he got angry at his associate when this one called the vet for a simple medical act he could have performed by himself. The farmers following a long-term trajectory explain (the vets do also) that their system of value is far from the vets' one. The farmers complain that the vets would use only allopathy. For their part, the vets resent the farmers intervening too late "*He lets his cows die*", because of their confidence in robustness of animals. In some cases, vets consider that a system of values too oriented towards nature regulation comes into conflict with the management of the welfare of animals.

These farmers mobilise a limited circle to accompany them, and are often part of small groups of farmers with which they share the same experiences. The 4 farmers participate to a farmer's group. Two groups were totally independent. One of these group was generated by a chamber of agriculture and was composed of 6 intensive farms and 6 extensive farms, for which the performances were compared. One group was focused on feed and accompanied by a private advisor. In each case, this reference group has followed them at the beginning of the trajectory with a subsequent detachment in the more advanced trajectories. This investment in a peer group enables them to keep abreast of emerging innovations in their environment – the decrease in antibiotic use being a withdrawal innovation - and to debate about them (Darré, 1996). The farmers involved feel confident in each other's point of view because they share the same constraints ; they feel involved in the dynamic thanks to the group's benevolent attention. At this stage of redesign, the change is robust.

Discussion

This exploratory study was conducted on a small sample of farmers, all selected for a successful medical input reduction process : a decrease in antibiotic use, an interest to selective treatment at drying off, registrations to a training on alternative approaches were used to select them. The design of the study voluntarily included in this sample farmers from different farming systems

(organic, PDO, conventional).We found that both intrinsic motivations and trigger events determine the change concerning the decrease in antibiotic use. As far as motivations are concerned, fast none of the farmers mentioned extrinsic ones ; the national Eco-antibio plan is not considered a major factor for change for instance. It is but useful to note that dairy sector is less integrated than others and that there has been no incitation of the sector yet on reduction of antibiotic use.

We note in our results that Hill and Mac Rae's framework on intrinsic motivations (Hill & Mac Rae, 1995) can be largely applied to our description of trajectories. The levers for reduction of antibiotic use are consistent with the ones for other changes in agriculture ; antibiotics are not considered otherwise than any other input or production practice, although it is a medicine. The progressive trajectory with learning combines the redesign of farm systems, which is the main motivation in decision-making, with the substitution of medical inputs, which is a modality of its content. The direct trajectory with learning combines motivations of efficiency and substitution and is the only one where the decrease in antibiotic consumption is a stated objective. The short trajectory without learning presents motivations of efficiency ; the decision of reducing antibiotic use often comes from an health problem the solving of which allows for the drop in antibiotic use.

There is no clear consistency between the labelling system adopted by the farmers and the trajectory followed, although the organic farming is more represented on the redesign side. In some cases, decisions occur when there is an urgent issue to solve (culling twice, quality of milk or mortality of calves 5 times each, lameness 4 times, too large an amount of work 3 times). The motivations for decision-making are also therefore to be found in the urgency of the situation (Vera, 1993). Crisis could then be used to implement new practices, if well known by advisors.

The point in our result is that we are able to combine the intrinsic motivations of farmers, the trajectory they adopted, the level of reduction in antibiotic use they reached, and the type of advice and information source chosen by farmers. Indeed the first results obtained by this study enable us to validate our underlying hypothesis on the correlation between the type of motivations and trajectory of change adopted by the farmers on the one hand and the type of advice adopted by farmers. These initial findings provide avenues for research for animal health advisors according to the type of trajectory adopted by farmers.

For farmers motivated by efficiency in a short trajectory without learning, veterinarians and technicians are mobilised as scientifically recognised experts, in a relationship of personalised advice and monitoring with their clients ; the advisors could mobilise on the selective treatment of dry cows, for example.

Farmers concerned by a direct trajectory with learning compromise between economics and the meaning of their job. They really wish to decrease their consumption in antibiotics, but can't imagine to merely withdraw antibiotics. They rely mainly on the substitution of antibiotics for alternative methods and are more likely to undertake training provided by public organisations than to contact their close advisors. We haven't yet any idea whether they would prefer their usual advisors if they used alternative medicine either. Indeed homeopathy or phytotherapy have not been taught to vets yet in France because the scientific proofs of their efficacity are considered poor. But the fact is that farmers remain alone after the training to implement new practices on their farms. Useful tools in this precise context would be top institutionalize feedback and good practice frameworks on the use of alternative medicines, especially essential oils, for which the used protocols and results are really disparate.

Farmers undergoing reconversion to conservation agriculture rely on their networks and intra-group innovation (Goulet & Vinck, 2012). Fostering communication between groups of farmers could be one avenue for sharing good practice. One of the difficulties consists in effectively reconciling the different advisory modalities and stakeholders in a collective approach to the reduction of antibiotic use in the dairy cattle sector.

Our results are then consistent with the literature on innovation in agriculture. Further research could be held to see to what extend our findings would be transferable to late adopters, according to their instrinsic motivations. The level of reduction is ironically lower on farms where the decrease in antibiotic use is one of the stated objectives. The lower use is observed on farms with a complete redesign, which have long term trajectories behind them. Considering the different levels reached, there could be a hierarchy in terms of policy to reach either the farmers who would reduce the more (efficient ones or farmers on reconversion) and/or the others. This statement also suggest that antibiotics policy could be more successful if included in a broader animal health improvement objective.

Conclusion

In this article, we used semi-structured interviews to study the antibiotic reduction trajectories of 14 French dairy cattle farmers. The practices implemented are the withdrawal of antibiotic use, substitution for alternative treatment methods and the complete redesign of the farm system. There has been no strong incentive in the dairy sector until now and the motivations of farmers are mainly intrinsic or situational. These practices are part of trajectories motivated by the search for efficiency, substitution or redesign, but also by the immediate response to a health problem. We note a correlation between the learning processes, the advice and training mobilised, and the motivations of the trajectory, but none with the labelling system.

We thus distinguish three types of trajectories. The short trajectory without learning is characterised by a principal motivation of efficiency and a high reliance on usual animal health advisors : the withdrawal of antibiotics is a consequence of the solution brought to an health or economical issue. The farmers in the direct trajectory with learning whose motivations are clearly the decrease in antibiotic use through a substitution with alternative methods, with reliance on institutional training (at least in a context where usual advisors lack competencies about alternate practices) ; and a trajectory involving the redesign of the farm system as main motivation in which farmers rely on their own social network. The level of reduction is ironically lower on farms where the decrease in antibiotic use is one of the stated objectives : this statement suggests that indirect process may be more efficient than direct ones. On top of that, trigger events are a real lever of change and should be included in the strategic reflection.

The description of these three trajectories of farmers who were the first drivers of change opens up avenues for the future adaptation of advice or public policy on reduction of antibiotic use in dairy sector. This research shows that there is no unique way to induce this change, in terms of practices as well as in terms of decision-making. A mutual adjustment between farms, institutions and advisors is needed.

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