# Farmer Action Groups- A participatory approach to reducing antimicrobial use on UK dairy farms

Lisa Morgans[a], Sarah Bolt[b], Lisa van Dijk[c], Henry Buller[d], Maria P. Escobar[a], Kristen Reyher[a], David Main[e]

[a] *University of Bristol, Lisa.morgans@bristol.ac.uk; Maria.Escobar@bristol.ac.uk; Kristen.reyher@bristol.ac.uk*

[b] *Kingshay consultancy, Sarah.bolt@kingshay.co.uk*

[c] *Royal Agricultural University, Lisa.vanDijk@rau.ac.uk*

[d] *University of Exeter, H.Buller@exeter.ac.uk*

[e] *Royal Agricultural University, David.main@rau.ac.uk*

**Abstract:** *This research assesses the potential of peer-to-peer support through Farmer Action Groups (FAGs) to achieve practical, farmer-led changes to reduce antimicrobial usage and improve herd health and welfare. FAGs seek to harness local-level experience and expertise.*

*Five FAGs were established in the South West of England, each made up of 5-8 dairy farmers that met approximately every six weeks to discuss medicine usage. Meetings involved a farm walk and facilitated discussion focussing on medicine reviews carried out on each farm to evaluate performance from participation. The outcome of each meeting was for the farmers to co-create an Action Plan for the host farm of practical measures to achieve antimicrobial reduction without adverse impacts on herd health/welfare. The Action Plans and host farm were re-visited several months later to discuss how well the Action Plans had been implemented.*

*Thirty farmers participated in the FAGs. Many more farmers were approached to participate by a variety of methods, the most successful being through specific recruitment meetings in collaboration with the levy board, Agriculture and Horticulture Development Board for Dairy (AHDB Dairy). Thirty Action Plans were created with an average of 10 steps on each. Farmers involved have implemented changes such as re-designing sheds to reduce the incidence of disease and increasing discussions with their veterinarians. On average more than half of the actions had been attempted by the 2nd FAG meeting. The sharing of successes and challenges within a cohesive group of farmers has given participating farmers the confidence to reduce reliance on antimicrobials.*

***Keywords:*** *Participatory, dairy farmers, antimicrobial use, empowerment*

## Introduction

### Human Behaviour change

Changes to certain farming practices have often been brought about by legislative action and/or penalties (e.g. outlawing of the conventional battery cage in the European Union in 2012 (Directive 1999/74EC), milk penalties from milk buyers, etc.). Although banning the battery cage was to improve laying hen welfare and milk penalties are credited with helping improve mastitis rates in the UK (Bradley AJ, 2002), these challenges in both sectors were not completely solved by top-down policy change. The farm environment for laying hens is arguably still not optimal (Lay et al., 2011) and mastitis is still a significant health and production problem for the dairy industry (Green et al., 2007), despite initiatives such as the Dairy Mastitis Control Plan in the UK (Bradley et al., 2017). The sustainability of these top down changes is variable and it is now recognised by the likes of the World Bank that long-lasting sustainable changes - such as changes in husbandry practices - are not always possible without stakeholder's participation in their development (Sumane et al., 2017).

In recognition of these outcomes, voluntary and self-regulatory approaches to behaviour change have been employed in agriculture. In the UK, projects with farmers working collectively to improve the way they farm their land and local environment to increase biodiversity or reduce the risk of flooding has demonstrated the value of these types of approaches (“Farmer Clusters” concept, Natural England in collaboration with the Game and Wildlife Conservation Trust).

It is acknowledged that the “one size fits all” method of giving advice to elicit behaviour change is flawed (Kristensen et al., 2008; Vaarst et al., 2001; Kristensen et al., 2011) and could have a role to play in the poor uptake of veterinarian advice on farm (Jansen et al., 2010). Examples of this are farmer attitudes towards disease eradication schemes, such as Johnes control (Ritter et al., 2016) and to veterinary herd health plans (Jansen et al., 2010; Derks et al., 2014). Research has also shown that providing more information on an issue and increasing awareness of a problem does not always result in a behaviour change (Vaarst et al, 2017; Leach et al, 2010; Miller et al., 2012).

There has been a plethora of research examining changing human behaviour, in particular focussing on farmer behaviour and the relationship between veterinarians and farmers (Lam et al, 2011; Swinkels et al, 2015; Buller et al., 2015; Jansen et al., 2010; Jones et al, 2015), with much of this focussing on changing attitudes in order to change behaviour. A criticism of these approaches is that they place the emphasis on the individual and assume behaviour is based on rational decision-making, and thus changing attitudes will result in behaviour change. Escobar and Buller (2013) and Lam and colleagues (2013) say that merely focussing on changing attitudes and improving the knowledge of farmers is not working adequately to alter farmer behaviour and hence improve animal health and welfare. They argue that the farm culture, social context and farmer’s identity need to be accounted for and methods used in the social sciences could prove more insightful (Gilbert et al., 1992). Interviews or focus groups are examples of techniques often used in the social sciences to understand complex issues (Gilbert et al., 1992). Participatory Action Research (PAR) is another related methodology that focusses on bottom-up behaviour change and has frequently been used in agricultural research (Conroy et al., 2005, Kumar et al., 2002, Kleiner et al., 2012, Sumane et al., 2017, Bodin et al., 2009, Curry and Kirwan, 2014).

## Antimicrobial Resistance

Antimicrobial resistance (AMR) is a significant global concern (World Health Organisation, 2017). Estimates are that by 2050, 10 million people a year could be dying from drug resistant infections such as TB. Since the release of the Review on Antimicrobial Resistance (O'Neill, 2015), the agricultural industry has been under increasing pressure to reduce the usage of antimicrobials in food producing animals. There is significant risk that using antimicrobials in food producing animals selects for resistant bacteria that could affect humans, although the exact mechanism and pathway is still much debated (O’Neill, 2015).

The World Health Organisation has developed a list of Critically Important Antibiotics (CIA), which are to be protected for use in human health care as they are a last resort for the treatment of potentially life-threatening diseases (Collignon et al., 2016). Consequently, these classes of antibiotics are to be reduced or restricted from treatment of food producing animals. The most recent Veterinary Antibiotic Resistance and Sales Surveillance Report (VARSS) puts antimicrobial usage in food producing animals in the UK at 45mg/PCU, which is a 27% reduction from 2014 and two years ahead of targets. Significant changes in AMU have already been happening (VARRS, 2017) but a shift in the prescribing habits of veterinarians and the behaviour around using certain antimicrobials on farms still needs to occur (Buller et al., 2015; Hyde et al., 2017).

Considering the pressure on the agricultural industry around AMR and the limitations of top-down approaches as discussed, there is a need to employ new techniques. This research assesses the potential of peer-to-peer support through Farmer Action Groups (FAGs) to achieve practical, farmer-led changes to reduce antimicrobial usage and improve herd health and welfare. Prompting an attitude shift and behaviour change around AMU is well positioned to benefit from a participatory approach (Vaarst et al, 2007).

## Participatory Action Research

Participatory Action Research (PAR) works on the principle of empowerment and agency for those implementing a change. PAR requires the participants to be fundamentally central to the research (Sumane et al, 2017; Kumar et al, 2002). Sumane and colleagues (2017) use the constructivist paradigm to illustrate the importance of knowledge coming from the individuals in their specific context (Sumane et al, 2017). They argue local knowledge and hence farmer knowledge matters; "informal knowledge generated in local contexts tends to be holistic as it considers the complexity of the realities in which farms operate and integrates the many or at least several of the environmental, economic, social, financial, technical and other dimensions into a single whole." Participants should not be present simply to be studied and observed, but rather should have a say in the design of the research, the direction of the study and importantly, synthesis of the findings of the research.

The use of PAR in livestock production is well documented in rural communities in Africa, India and Indonesia since the 1980s (Waddington, 2014). Conroy describes it first beginning as Rapid Rural Appraisal (RRA), a method in which researchers aimed to collect a great deal of information, quickly and cost-effectively about a community (Conroy, 2005). It was soon realised that the impact of participatory research could have significant potential in applied research and evidence-driven interventions (Conroy et al, 2005, Stoecker.R, 2012) and can be the basis for creating livestock development programmes (Conroy et al, 2005), such as on responsible use of antimicrobials. Curry and Kirwan argue for the role of local, tacit knowledge in solving complex issues relating to the environment and food production (Curry and Kirwan, 2014). Ingram additionally puts forward the case for sustainable farming being much more complex and demanding on the skills of farmers (Ingram.J, 2006).

## Farmer Field Schools

A specific example of PAR are Farmer Field Schools (FFS) begun in the 1980s by the Food and Agricultural Organization and bought to a close in 2013 (Waddington and White, 2014). FFS are estimated to have reached 12 million farmers in over 90 countries and aimed to achieve discovery-based experiential learning for farmers in less developed countries (Waddington and White, 2014). Their main focus was on improved use of pesticides through Integrated Pest Management (IPM) but also to empower disadvantaged farmers (such as women) and to enable communities to develop skills to make them more resilient to changes in farming practice and the environment.

The project was designed to have three stages- Inception, Trialling, followed by Dissemination, whereby the groups were expected to spread the new skills and knowledge they had gained throughout the community (Waddington and White, 2014). The majority of projects had objectives that focussed on production, food security and social/community issues but they did not always succeed in empowering disadvantaged groups or disseminating learning (Waddington and White, 2014).

There were several reasons why FFS did not continue or achieve the desired results. Firstly, the Inception phase lacked adequate training of facilitators; it was deemed essential from feedback from various projects to have a well-trained and committed facilitator for the groups and this was variable within and between countries. Secondly, FFS targeted mainly well-off farmers in the communities they worked and although this was seen as advantageous in aiding dissemination, it did not help achieve the goal of empowerment for disadvantaged groups. Thirdly, there were also problems with attendance and drop out when farmers could not see the returns on their time. Dissemination was a significant problem with FFS in that existing groups felt there was a lack of assistance once the farmers were expected to continue to share skills (Waddington and White, 2014).

## Stable Schools

Despite these findings, Denmark, the UK and others have recognised the potential of participatory approaches and have introduced variations of FFS in order to improve the way farmers manage animal and plant health (Ivermayer et al., 2015). In Denmark for example, it was noted that "use of antimicrobial drugs varies widely in different herds and is complex, many different approaches can be taken. It was therefore decided that the main approach was to design individual farm and herd strategies through a participatory process using farmer groups for mutual advice and common learning" (Vaarst et al., 2007). These were similar to the FFS but were adapted to the Danish organic dairy farmer. Groups of farmers met on farm, in what were termed Stable Schools, to share knowledge and best practice and ultimately inform policy from the bottom-up instead of the traditional top-down approach (Vaarst et al., 2013).

Etienne Wenger's Community of Practice framework (1998) has many similarities with Stable Schools and the proposed method of this study. Communites of Practice are groups of people in any kind of organisation „who share a concern, a set of problems, or a passion about a topic, and who deepen their knowledge and expertise in this area by interacting on an ongoing basis". The Stable Schools were a group of likeminded farmers that shared a concern about overuse of antimicrobials. They worked together to help each other solve the problem.

The Stable Schools met every month for a year to discuss reducing AMU. The meetings involved a farm walk and then a group discussion looking at farm data. A facilitator would ensure everyone contributed on how the host farm could improve (Vaarst et al., 2007). The Stable Schools were deemed to be a success in Denmark resulting in a reduction in AMU, consequently they have been adopted into Danish agricultural legislation (Vaarst et al., 2013).

It is this model of the Stable School that has been tested and developed for this research with UK dairy farmers to reduce AMU. Work in the UK with retailers has already demonstrated the potential for farmer-led action on this issue (Van Dijk et al., 2016). The Agricultural and Horticultural Development Board (AHDB Dairy) have experience with the Stable School methodology in the UK too. With a farming population already engaged with discussion groups and evidence to suggest UK farmers enjoy discussing farm related issues with each other (Heffernan et al., 2016), there is scope for it to be very successful.

The aims of this research were to test and develop a participatory method, rooted in the philosophies of FFS and the Stable School approach. The specific goals of the study were to observe if the method could bring about a reduction in antimicrobial usage, learn how the process worked most effectively if at all, and to measure outcomes of relevance for the participating farmers and farms, which ultimately could inform policy.

## Methodology

This research builds on the Danish Stable School model (Vaarst et al., 2007). Instead of the name Stable Schools, the farmer groups are called Farmer Action Groups (FAGs) to reflect the active learning process.

### Recruitment

Recruitment of dairy farmers to the Farmer Action Groups took place from April 2016 – January 2017 and was made possible with the help of industry sponsors, AHDB Dairy and the project facilitator[b]. Various approaches were used to recruit and engage with the dairy industry and some were more successful than others. Snowballing and Chains of Referral were used to maximise recruitment reach (Penrod et al, 2003). Below is a list of the different approaches taken;

1. Presenting to a pool of producers already engaged with reducing antimicrobial usage
2. Attending agricultural shows and events
3. Liasing with veterinary practices and asking veterinarians to promote the project and recommend farmers to participate
4. Advertisements in the farming press
5. Holding specific recruitment meetings in collaboration with AHDB Dairy

Veterinarians specialising in farm animal work were chosen as the preferred method of farmer recruitment to this project, due to their close links with many dairy farmers (Lowe et al., 2009). Veterinarians are an efficient way to reach as many dairy farmers as possible, especially those regarded as 'hard-to-reach' (Ritter et al., 2016), which makes the recruitment process as inclusive as possible.

Geographical proximity was important for establishing each FAG because a short travel time to meetings was listed as important to participants in the Stable Schools (Vaarst et al., 2007). Consequently, FAGs developed when enough participants signed up in a given area. Each FAG consisted of 5-8 dairy farmers within 1 - 48 km of each other, with an average travel time to meetings of 15 minutes.

### Farmer Action Group meetings

Five Farmer Action Groups were established between August 2016 – January 2017. Each FAG met every 6-8 weeks on each other's farm. Each meeting was based around a farm walk and facilitated discussion (Vaarst et al., 2007), all of which were audio recorded for transcribing and analysis by the primary researcher[a].

The meetings were arranged in two phases- phase one where the group met on each other's farm for the first time and worked together to co-create an Action Plan to reduce antimicrobial use, and then phase two, where each farmer participant and their Action Plan was re-visited to discuss any changes made on farm. Six to twelve months elapsed between phase one and two meetings for each host farm to allow time to implement the Action Plan. Phase two is due to finish in June 2018.

Each FAG meeting followed a set structure that was repeated on each participant's farm (see figure 1);

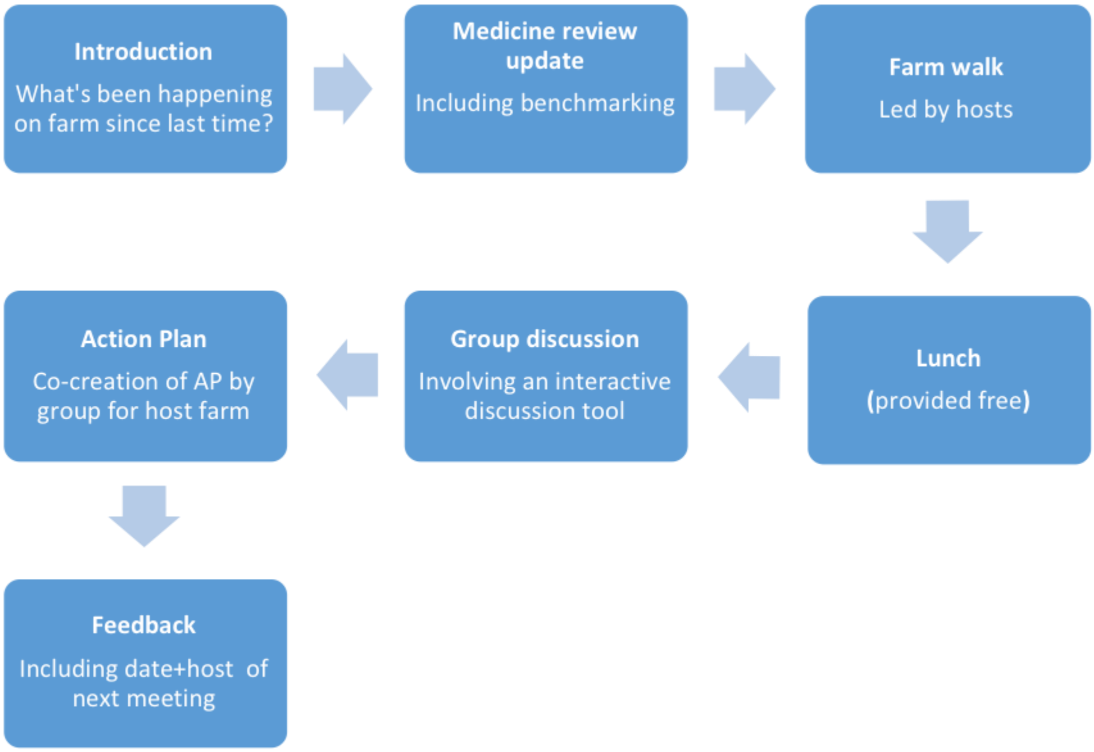


**Figure 1-** Structure of each FAG meeting.

In phase one, a pre-visit to each host farm was included to allow the researcher[a] to collect farm data, including medicine records and to ensure the farmer participant was satisfied with hosting. This was not a stipulation in the Stable School project but was deemed necessary by the researchers in order to establish a relationship of trust, which is reported to be important in participatory projects (Kumar et al., 2002). An agenda was planned with the host farmer for the subsequent meeting and this was relayed to the project facilitator[b].

After each meeting, a comprehensive meeting report was compiled and circulated to the group with details of what was discussed and decided upon. Phase two meetings were slightly shorter in duration due to a shorter farm walk where the Action Plan points were the focus of the walk and any other changes made on farm since the first meeting. This was because the authors assumed most of the group had already recently seen the hosting farm fully in the first phase of meetings.

### Facilitation

It is well recognised that the role of a credible facilitator can be essential to the running and success of social structures, especially farm discussion groups (Sherson et al., 2002; Vaarst et al., 2017; van Dijk et al., 2017). An external facilitator[b] was present for all the meetings in phase one (n=30) and two phase two meetings. She was employed by the funders, AHDB Dairy as a Knowledge Exchange (KE) Manager and had been using the Stable School principles in work with AHDB Dairy and the UK dairy industry prior to this project, albeit not in a research capacity. The facilitator[b] had been employed in the farming industry for more than 10 years and was well respected in the field i.e. she was in charge of the KE team in the southern region of the UK. Due to working full time for AHDB Dairy at the time of the project, the facilitator[b] was not part of any pre-visits to participant farms or formal analysis. Communication between the primary researcher[a] and the facilitator[b] occurred prior to each meeting and involved a process of reflection and critique of the process as it developed. Due to a change in circumstances for the facilitator[b], she could only complete phase one of the project. Facilitation of the majority of phase two meetings was done by the researcher[a].

## Indicators of success

The FAGs were evaluated in three ways; by quantifying the medicine usage of each farm before and after participaton via a medicine review, by evaluation of the Action Plans co-created by each FAG and by analysis of the qualitative data from transcripts of the meetings.

## Medicine Reviews

Medicine reviews were carried out for all 30 participants, covering 12 months prior to starting the project and then the 12 subsequent months. The medicine reviews had three purposes in the FAG project. Firstly, they helped with recruitment as the primary researcher's experience indicated that the UK dairy farming community were enthusiastic about having their performance benchmarked against peers. Therefore, the AMU data was benchmarked and compiled into farmer-friendly reports. Secondly, they were used as a facilitated discussion tool by the researcher and facilitator. Thirdly, they are being used as a quantifiable evaluation of participation in a FAG.

The reviews were based on vet prescription data and were assumed to be the most accurate measure of antimicrobial use on farm available for all farmer participants (Mills et al., 2018; Hyde et al., 2017). Three farms' medicine reviews were based on actual usage data from on-farm medicine records due to unavailability of vet prescription data. On farm medicine records were used to supplement vet prescription data and added an extra level of farm-specific data, such as actual course lengths for certain products, rather than using data sheet recommendations. This data was collected by the primary researcher[a] through a questionnaire at the pre-visit. Data from medicine records and vet prescription data was presented to the researchers in various formats, such as in Microsoft Excel or bespoke farm management software packages. The amount of antimicrobial used on farm over the course of the project as well as a brief costings on how much each farm spent on certain medicines was calculated from the raw data using Microsoft Excel. Descriptive analysis and statistical tests such as Chi squared are being conducted on the quantitative data at time of print.

There are many ways to measure AMU and each metric has pros and cons (Mills et al., 2018). The lack of a centralised programme to record and collate information on usage in the UK, like that which exists in Denmark (Danish Integrated Antimicrobial Resistance Monitoring and Research Program (DANMAP), 2010) or the Netherlands (Speksnijder et al., 2015) makes measuring usage particularly challenging. In human health, metrics based on daily dosages are in common use (Collineau et al., 2016) and there is a European standardised metric called Defined Daily Dose. This allows for comparison between countries (Collineau et al., 2016), rather than metrics based on weight of active ingredient. Many groups in the UK dairy industry have started measuring use using their own metrics (Mills et al., 2018).

For this project a range of metrics were used to measure AMU, partly because of the drawbacks of many of the metrics and partly because of the participatory nature of the project. By allowing the farmer participants to choose the metrics they understood and valued the most, participants could feel more empowered in the medicine review process. Collineau and colleagues (2016) describes how there is not one superior metric for measuring AMU and the individual goals of the project must be taken into account (Collineau et al., 2016). For the goal of benchmarking farms so farmers can understand their farm's AMU, a metric that is "system comprehensive" is necessary.

## Action Plans

Action Plans were co-created by each FAG at the end of each meeting in phase one. This was a key element of the Stable Schools and has been used in programmes such as the Healthy feet project (Main et al., 2012) and the Mastitis Control Plan (Green et al. 2007). Phase two evaluated the implementation and success of each host farm Action Plan. This was done via a semi-structured interview with the participant and completion of a brief questionnaire assessing whether each action had been completed, to what extent and whether the participant perceived there to be a benefit in completing each action. Phase two dicussions were used to evaulate as a group the perceived benefit of each individual action and whether there were any further actions that could be considered by the host farm.

### Qualitative data

The primary researcher[a] is a qualified veterinarian and thematic analysis is ongoing using NVIVO version 10. The researcher[a] transcribed meeting audio-recordings and selected the data most pertinent to the research questions for further in depth thematic analysis. A deductive approach is being used to analyse the data to answer specific questions around the benefit and role of peer-to-peer learning in creating a behaviour change and hence a reduction in AMU (Richards et al, 2005). Coding of transcripts is being performed in a two step fashion- topic coding followed by analytical 'coding on'. Double coding will be performed by a research colleague on a selection of transcripts to ensure the coding framework is being adhered to.

Analysis of in-depth semi-structured interviews of participants and non-participants will also be conducted at the same time. A similar approach to analysis will be followed and the results assessed and reflected on in parallel in an integrative approach.

## Results

### Recruitment- successes

Holding specific lunchtime recruitment meetings was the most successful recruitment technique and was helped by the relationship with an industry partner i.e AHDB Dairy. The project facilitator[b] was pivotal in fostering links with potential participants; their reputation in the industry was a significant factor in the success of the specific recruitment meetings, as demonstrated in interviews with participants (Morgans et al., in preparation). The existing network of the primary researcher[a] was also maximised in order to recruit participants to the project.

The recruitment meetings lasted approximately two hours and food was provided. They were an ideal opportunity for the farmers to meet each other and see who else in the area would be participating. It also gave them the opportunity to ask questions about the time commitment or the use of data in the project. When fostering Communities of Practice such as the FAGs, the relationships between participants become the basis for learning and mutual respect (Wenger.E, 1998). The researchers and facilitator felt this could be achieved better in a face-to-face meeting and addressed the issues of trust around participatory projects (Conroy et al., 2005), and allowed for better informed consent (Miller et al., 2012).

### Recruitment- barriers

*Lack of time*

Despite being able to meet and speak about the project to many potential participants at once when recruiting from an exisiting pool of farmers, this method was ineffective at recruiting farmer participants. Compared to the participants recruited to the Stable School project in Denmark (Vaarst et al., 2007), who were recruited easily via the milk pool, a similar approach in the UK was surprisingly unsuccessful. This producer group were expected, as stipulated by their retailer contract, to comply with a variety of demands (Van Dijk et al., 2016). This resulted in lack of free time to commit to a further project. On speaking with various producers in this pool after the event, they voiced time as a major limiting factor (Morgans et al., in preparation). There was a concern the monthly proposed meetings were too frequent. This feedback was incorporated into the project design and consequently meetings were held every six to eight weeks.

*Veterinarian concerns*

Veterinarians were initially expected to be the most efficient method of farmer recruitment for this project, due to their close links with many dairy farmers (Lowe et al, 2009). However, this was an inaccurate assumption as some veterinarians had reservations about the project, and hence did not recruit their clients as widely as anticipated. Only one veterinary practice out of 16 approached provided a list of clients that could be contacted to participate. In particular, veterinarians mentioned the risk of poor practice and misinformation being propagated between farmers (Morgans et al., in preparation).

### Farmer Action Groups

Thirty farmer participants in five Farmer Action Groups across the South West of England took part in the project. The participants were from a variety of types of dairy farms; herd sizes varied from 60 cows to 500, calving patterns varied from spring and autumn blocks to all-year-round calving systems, some had robots while others had large teams of staff to manage. The common goal of antimicrobial reduction, despite differing systems, and lived experiences of the participants helped foster an environment of change and was similar to the FFS (Waddington and Howard, 2013) and the Stable Schools (Vaarst et al., 2007). The cumulative experience of each FAG provided solutions to shared problems and together the group could tackle how they were going to reduce reliance on antimicrobials.

**Action Plans**

Thirty Action Plans were co-created by the farmer participants, with an average of 10 practical steps on each. To date, on average 50% of the practical steps on the Action Plans have been implemented or at least attempted. Many more actions are ongoing and the farmer participants commented on not having enough time to do all of the Actions by the phase two meeting (Morgans et al., in preparation). Evaluation of the Action Plans is continuing at the time of writing alongside data collection.

The thirty Action Plans contain almost 300 practical steps, which aim to reduce the need for antimicrobials and were all co-created by the farmer participants. The actions cover a range of topics from altering ventilation in cubicle sheds to improvements in managing colostrum for calves, and have been categorised and evaluated to see relative frequency of occurrence.

Farmer participants have reported a multitude of changes on their farms because of listening to their peers in the groups and seeing other participant's farms. One farmer participant vaccinates more of their young stock since discussing respiratory disease with their FAG, which they see as having a direct impact on their antibiotic usage. Another farmer acted on suggestions from their FAG to adapt the dry cow housing so dry cows would spend more time laying. Further analysis of the Action Plans is ongoing.

**Farmer feedback**

Feedback from the participants has been overwhelmingly positive. They gained confidence from seeing and hearing from other like-minded farmers about making changes to improve herd health. Access to alternative sources of information was one of the benefits mentioned by farmers, even if the suggestions from peers was not immediately applicable, as the comment below illustrates;

*"Always useful, fun, if not immediately relevant. Ideas not accessible from usual sources- direct from farmers!!" FAG3H6*

The Farmer Action Groups helped play a role in creating an attitude shift in farmer participants, as can be seen from the below quote;

*"Haven't used antibiotics on the lambs like we usually do, at all. This year made the decision to not use any at all, only had few [watery mouth], same percentage wise as last years …and saved two bottles of antibiotics."*

This particular participant also farmed beef and sheep and his participation in a Farmer Action Group with the focus on AMU in dairy cows had filtered into the way he also farmed his sheep, which he was eager to share with the researchers. Participants developed an awareness of the issues surrounding AMR and the antimicrobial products they were using on their farms. As the below quote demonstrates, the knowledge of some farmers helped others make a change.

*"I am the same as you. Been on Cobactan for years, loved it, worked on everything. But I had to change. I use Ubrolexin and Duphatrim injectable. And so far touch wood, it works."*

They became confident in trialling new treatment protocols and initating conversations with their vets about antimicrobial products used on their farm. Farmer participants felt empowered and encouraged by the peer-to-peer learning environment. The social support gained from discussions with other people in a similar situation going through similar issues appeared to be pivotal in fostering an attitude change. This comment on the feedback forms illustrates the learning gained from other farmers;

*"Learning from each other at every meeting"*

Further in-depth analysis of the qualitative data is ongoing and will be complete by the end of 2018.

**Antimicrobial usage**

A key objective of the research was to reduce AMU on the participant farms. Usage was measured in milligrams/kilograms (mg/kg), Animal Daily Dose, as used in the Netherlands (Speksnijder et al., 2015), milligrams of antibiotic/cow/year from only intra-mammary tubes (VARRS, 2016, 2017), Cow Calculated Courses as used by some retailer groups (Mills et al., 2018) and milligrams/1000Litres of milk. These metrics were selected after discussion with the farmer participants in each group. Highest Priority Critically Important Antibiotics (HPCIA) were also highlighted and discussed extensively. For the project, these were 3rd and 4th generation Cephalosporins, Fluoroquinolones and Macrolides and were based on World Health Organisation recommendations (WHO, 2017).

The range in AMU in year one of the project was from 1- 65mg/kg, which echoes a similar data set across a larger sample in the UK (Hyde et al., 2017). Thus far, there has been an overall decrease in the amount of Critically Important Antibiotics used by farmer participants in the project. Overall usage from year one to two has been variable between participants, and in part is dependent on the metrics chosen to measure overall AMU. Full analysis of this dataset is ongoing. The farmer participants have been quick to notice the relative weakness of some metrics and how usage of certain antibiotics can falsely lower overall AMU (Mills et al., 2018).

*Full analysis of the medicine reviews is ongoing and will be completed by June 2018.*

## Discussion

### Recruitment

Recruitment was a challenging process and benefited from using the existing networks of the project facilitator and primary researcher. Making use of existing networks in the industry is a valid and effective way of recruiting (Penrod et al., 2003). As the primary researcher was a veterinarian and therefore a member of a *respected profession*, (Lowe et al., 2009; Enticott et al., 2011) this may have had an influence on the recruitment process. Farmers value the opinion of a veterinarian and can trust that the information shared in the FAGs is valid (Atkinson et al., 2016; Kristensen.E and Jakobsen.E.B, 2011). This has implications for policy-makers wanting to engage with the UK dairy industry and reach as many dairy farmers as possible.

However, recruiting farmers via veterinarians revealed their concerns with farmer-led action on reducing AMU. These concerns warrant further research: was the topic of AMU in particular the cause of the concern? What role does knowledge play in the farmer-vet relationship and how does this impact on AMU and animal health and welfare? Further work is ongoing to understand the reasons why some farmers did not participate in the FAGs. Initial findings point to a lack of time when it comes to projects looking at AMU in the UK dairy industry.

### Farmer Action Groups

Farmer Action Groups established a Community of Practice (Wenger.E, 1998) for the participants and brought together a diverse range of dairy farmers to achieve the goal of antimicrobial reduction. The aims of the project were to reduce antimicrobial usage and to test and develop a participatory method with UK dairy farmers. Both aims have been met in some capacity; the use of CIAs has decreased for all thirty participants (Morgans et al., in preparation) and the methodology has demonstrated it can achieve practical on-farm changes that are valued and owned by the farmers.

The FAGs foster autonomy and confidence in the participants, as can be seen in the discussions from the meetings. This is similar to the principles of Stable Schools and Farmer Field Schools (FFS). A key difference in this research and the FFS is the final phase of dissemination. The Stable School project and the FAGs were designed to run for a set period, achieve the required goal and finish. There was no dissemination phase and any learning from the project was in the domain of the individual farmers. FFS deliberately planned for the learning from the groups to filter into a wider community. This is a key difference and may have implications for the longevity of such approaches as well as the feasibilty for participants.

The FAGs differ to the Stable School approach in three ways. Firstly, the use of the medicine reviews as an auditing tool to not only quantifiably evaluate the success of the FAGs in reducing AMU, but also as a facilitated discussion tool. The researcher and facilitator used the data from the medicine review to frame questions to the group and host farmer to stimulate discussion around AMU. This insight into the host farm allowed a more constructive and informed discussion, which can lead to a more relevant and useful Action Plan. The researcher and facilitator also developed a repertoire of workshop activities to help structure discussion and facilitate reflection on each host farm (Morgans et al., in preparation)

Secondly, the FAG participants were more diverse than the Stable School participants. They were not from the same milk pool; they had contracts with various different milk buyers and retailers and were producing a range of dairy products. The Stable Schools were for organic farmers, whereas the FAGs consisted of only two organic farmers, the rest were conventional farmers. This may have implications for participation and it is likely a result of the differing recruitment processes (Morgans et al., in preparation)

Thirdly, each FAG ran for approximately 20 months. Stable Schools were run for one year and then ended. The FAGs ran for a longer period because of feedback from recruitment, which suggested that UK dairy farmers would not be keen on participating every month due to time constraints. Therefore the frequency of meetings was extended to every 6-8 weeks. This enabled ongoing attendance to remain adequate.

*Lessons and Limitations*

Limitations to the Farmer Action Group approach are firstly, the risk of misinformation or bad practice being propagated if knowledgable support and faciliation is lacking. This was a concern highlighted by veterinarians involved in recruitment and highlights the issues around power of knowledge and who holds key knowledge. Farmer participants rarely mentionned concerns about this, however this did surface as an issue with a participant that dropped out of a FAG (Morgans et al., in preparation).

Moreover a re-occuring theme from the group discussions and interviews was the thirst for knowledge on the antimicrobials being used on farms and the CIAs particularly. This knowledge was generally lacking from the farmers and was provided by the researcher (i.e. what is a CIA). This knowledge is in the domain of veterinarians, but the farmer participants also felt it was relevant and necessary for their everyday practices, and they were not getting it from their veterinarians. Thus, the participation of a veterinarian in the FAGs appears critical to their legitimacy as well as their safety and effectiveness.

Another limitation of the FAGs and one encountered in recruitment was the time consuming process of participation. This was a reason why some farmers did not join the project and is widely documented in livestock participation research (Conroy et al., 2005).

The critical aspect of sharing data and opening the farm to potential strangers for comment could also be a drawback to this approach. It relies on participants being honest and happy to share (Vaarst et al., 2007). Farmers that have concerns about opening up their business may be another factor in reducing participation, which was demonstrated in interviews with non-participants (Morgans et al., in preparation).

Like with many other group activities, a facilitator is a crucial part of the approach (Vaarst et al., 2012; Sherson et al., 2002, van Dijk et al., 2017). The FAG project was helped not only in recruitment but also by the running of the groups by an experienced and credible facilitator. Many environmental schemes make use of a funded facilitator programme, such as the Countryside Stewardship Facilitation Fund in the UK, therefore it can be an expensive barrier to success if there are not funds available.

## Conclusion

This research has shown the potential value in a facilitated and farmer-led approach by using farmer knowledge and experience to reduce AMU, which is of significance when faced with the global crisis of AMR. The findings highlight gaps in advice to farmers on responsible AMU as there were certain aspects of knowledge around this subject that farmer participants felt was lacking. Furthermore, recruitment to participatory projects in the UK dairy industry can be challenging and can benefit from using existing relationships in the industry. This study contributes to the building body of literature on Participatory Action Research and the success it can have when certain sectors of society are empowered to make a change. This research supports PAR as an effective approach to solving societal issues, such as AMR. Knowledge is power (OECD, 1996) and this research has demonstrated the potential of farmers to enact change if the balance of power is re-addressed.

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