Antibiotic policy in Animal husbandry

Effects and Perspectives

RAAD VOOR DIERENAANGELEGENHEDEN

Covering letter

The Hague, March 2016

Excellency,

I am very pleased to present the advisory report of the Council on Animal Affairs entitled 'Antibiotic policy in animal husbandry: Effects and perspectives', which has been prepared at your request.

The Dutch government aims to promote a policy of prudent and restricted antibiotic use in both animal husbandry and human healthcare. The four main sectors of Dutch animal husbandry and veterinarians have devoted a great deal of attention in recent years to reducing the therapeutic use of antibiotics. Now that the government is considering updating its policy in this field, the Council on Animal Affairs has been asked to provide an advisory report on the effects of the current policy on animal health and welfare, and to discuss the perspectives and conditions for any further steps that may need to be taken in this direction.

The Council has found that the scientific literature on the effects of the current antibiotic policy and the information available from the field are still too limited to permit an unambiguous answer to the question of whether the current policy has an effect on animal health and welfare. Aggregated data on disease incidence, mortality, antibiotic use, risk and other factors and welfare are lacking. Furthermore, there are no reliable, objective indicators that can be used to monitor animal welfare. The Council recommends that these data be collected and more research be performed.

Both farmers and veterinarians display greater awareness of the need for responsible, restricted antibiotic use. More attention is now paid to preventive animal healthcare, where the health plan drawn up for each farm plays an important role. There are, however, large differences between sectors, and there are still farmers who use too much antibiotics, and veterinarians who prescribe too much, in each sector.

When disease occurs, the lack of timely and effective treatment can have an adverse effect on the incidence of disease and the mortality, and hence on animal welfare, on some farms. It is moreover very important to have a level playing field in Europe, and where applicable even further abroad, as regards the requirements concerning antibiotic use, animal health and welfare and new prevention and treatment methods.

Completely antibiotic-free animal husbandry is impossible without sacrifices in animal welfare. Animal diseases occur in all forms of animal husbandry. The Council approves the responsible and selective use of antibiotics in animal husbandry, with sick animals receiving quick, effective treatment.

The Council gives detailed recommendations in this advisory report concerning continued cooperation and incentives for further progress. It also recommends that more measurements should be made, more research performed and more attention paid to knowledge transfer. The RDA is convinced that these recommendations can make a big contribution to increasing the motivation and ability of those involved in Dutch animal husbandry to take further steps to reduce antibiotic use without prejudice to animal health and welfare.

The Council has enjoyed working on this topic, and hopes that this advisory report will make a useful contribution to further policy formation. It will continue to follow developments in this field with interest, and wishes you every success in your endeavours to this end.

Yours sincerely,

M.H.W. Schakenraad
Secretary, Council on Animal Affairs

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Foreword

The Dutch government aims to establish a prudent antibiotic policy, restricting the use of antibiotics in animal husbandry and human healthcare. Preventive use of these substances has been forbidden since 2012, and use as growth promoters in animal husbandry since 2006. Determined attempts have been made in recent years, with full assistance from veterinarians, to restrict the use of antibiotics for therapeutic purposes in the four main sectors of animal husbandry: dairy cattle, pigs, calves and poultry. The Dutch Ministry of Economic Affairs is updating its policy concerning the use of antibiotics in animal husbandry, and has requested advice in this connection from various bodies, including the Council on Animal Affairs (RDA). The RDA was asked in particular to make an inventory of the consequences for animal welfare of the current policy of reducing antibiotic use, and to assess the possible further steps that might be taken in this field.

The preparation of this advisory report involved not only consultation of the relevant scientific literature but also use of the practical knowledge collected by the antibiotic resistance working groups for the four above-mentioned sectors, which were set up within the framework of the Agreement on Antibiotic Resistance in Animal Husbandry (*Convenant antibioticaresistentie dierhouderij*).

The RDA would like to express its gratitude to the members of the antibiotic resistance working groups for their participation in the 'Brainbox' project (*Versnellingskamer*) and the associated survey, which has led to the collection of a great deal of practical experience; to the Louis Bolk Institute and FIDIN (the Federation of Manufacturers and Importers of Veterinary Medicine in the Netherlands) for the provision of information; to all others involved in this study for their contribution (see also the section Personal Communications, under the heading *Sources consulted*); and finally to Martijn de Groot for his editorial services and Fiona van Kaam for her contribution to the inventory of best practices.

In addition to publishing the full text of this advisory report here, the Council is simultaneously issuing a Summary, with the intention of making its opinions more widely available to the public at large.

The Hague, March 2016

Marc Schakenraad,

Secretary to the Council

Summary

Introduction

The Dutch Cabinet has a policy aimed at prudent and restricted antibiotic use to limit the development of resistance in sensitive microorganisms. Antibiotic use in the dairy cattle, pig, calf and poultry sectors of Dutch animal husbandry has been substantially reduced in recent years, with effective support from veterinarians and farmers. The Dutch Ministry of Economic Affairs is updating its policy concerning the use of antibiotics in animal husbandry, and has asked the Council on Animal Affairs (RDA) for an advisory report on the effects of the current policy of restricting antibiotic use on animal health and welfare, and for an assessment of the possible further steps that might be taken to reduce antibiotic use without prejudice to animal health and welfare.

Approach

The preparation of this advisory report involved not only consultation of the relevant scientific literature but also use of the practical knowledge collected by antibiotic resistance (ABRES) working groups[1]. This information was elicited by asking these working groups structured questions with the aid of the 'Brainbox' (Versnellingskamer) brainstorming tool from organisation consultancy The Bridge and an associated questionnaire. Further information was obtained from other relevant organisations. The RDA discussed, assessed and weighted this information, and used it as a basis for preparation of the advisory report.

Conclusions

The RDA has found that the scientific literature on the effects of the current antibiotic policy and the available field data are still too limited to permit an unambiguous answer to the question of whether this policy has an effect on animal health and welfare. The reduction of antibiotic use seems to have been accompanied by a rise in disease and mortality among calves, and by more mastitis in dairy cattle after calving. Interviewees from other sectors expressed concerns about a rise in disease and mortality, but there are no aggregated objective data on this topic or on animal welfare and other factors (including risk factors). It is therefore not possible at present to establish an unambiguous relationship between reduction in antibiotic use on the one hand and animal health and welfare on the other. There are also as yet no reliable, objective indicators that can be used to monitor animal welfare.

All four sectors of animal husbandry investigated show an impressive reduction in antibiotic use. There has been close, effective cooperation within the farming community to respond to the changing demands made by society.

The RDA has found that both livestock farmers and veterinarians display greater awareness of the need for responsible, restricted antibiotic use. The rules required for this have been laid down in quality systems, professional guidelines, lists of approved antibiotics and the treatment plan drawn up for individual farms. More attention is now paid to the need for preventive animal healthcare, where the health plan drawn up jointly by the farmer and the vet for each farm plays an important role. Close, effective cooperation in the various sectors of animal husbandry has helped to bring these advances about. The benchmarking of antibiotic use for farmers and veterinarians contributes to transparency of use and permits internal comparison. There are, however, large differences between sectors, and there are still farmers who use too much antibiotics, and veterinarians who prescribe too much, in each sector.

When disease occurs, treatment that is neither timely (due to fear of sanctions and the wish to maintain restrictions on antibiotic use) nor effective (due to bacterial resistance to the agent initially chosen) can have an adverse effect on the incidence of disease and the mortality, and hence on animal welfare, on some farms.

[1] Antibiotic resistance working groups were set up in 2008 for four sectors – cattle, pigs, calves and poultry – within the framework of the Agreement on Antibiotic Resistance in Animal Husbandry (*Convenant antibioticaresistentie dierhouderij*). These working groups comprise mainly farmers, veterinarians and representatives of various professional associations and interest groups.

The activity and safety of new therapeutic and preventive drugs have not yet been adequately verified in practice. It is expected that a wider range of usable agents will be available in the near future.

Biosecurity and promotion of animal resistance to infection both make a major contribution in their own way to preventive animal healthcare and combating the adverse effects of the antibiotic policy. The motivation, knowledge and expertise of farmers and veterinarians, and the advisory skills of the latter group, play a major role in preventive animal healthcare. The entrepreneurial skills of the farmers, and their ability to make the necessary investments, are also extremely important. Field observations indicate that major differences exist between farms on all these points. Poor financial results in some sectors, potentially conflicting requirements, prolonged application procedures for permits for modifications to animal housing and the lack of a level playing field in Europe are some of the main factors delaying progress in this field.

Completely antibiotic-free animal husbandry is impossible without sacrifices in animal welfare. Animal diseases occur in all forms of animal husbandry. The RDA approves the responsible and selective use of antibiotics in animal husbandry, where sick animals receive quick, effective treatment.

Recommendations

- Integrated data on disease incidence, mortality, welfare, antibiotic use and other factors (including risk factors) should be made available to all parties concerned, such as farmers and researchers, as possible benchmarks for animal health and welfare, and as a basis for research into optimum treatment methods. Reliable, objective animal welfare indicators are also needed in this connection.
- Steps should be taken to ensure responsible, selective antibiotic use in animal husbandry, including rapid, effective treatment of animals where necessary. The wish to achieve a major reduction in antibiotic use should never lead to the attitude that higher disease incidence and mortality are acceptable.
- Control measures for antibiotic use should be focused on those using or prescribing large amounts of these agents, and should include close monitoring of the effects on animal health and welfare.
- Minimum antibiotic use demands system innovation, which in its turn requires further research and time for implementation. Stakeholder research and validation of best practices should be encouraged and facilitated. The implementation of successful innovation should be stimulated by financial measures and robust market concepts.
- An integrated sector- and production-chain-oriented approach should be taken to the reduction of antibiotic use: this will facilitate horizontal and vertical coordination and cooperation. Closer cooperation and exchange of information between farms and suppliers of young animals (hatcheries, dairy farmers, and breeders) should be encouraged. Good communication between farmers, veterinarians and others who visit the farms on business should be facilitated.
- Steps should be taken to create a level playing field in Europe concerning antibiotic use, animal health and welfare, and new approaches to prevention and treatment.
- The dissemination of existing knowledge in this field should be improved by education and other means such as life-long learning and study groups for farmers, veterinarians and others who visit farms on business. Steps should also be taken to ensure that the mind-set of stakeholders is aimed at a better balance between the reduction of antibiotic use and awareness of the need for animal health and welfare.

In this advisory report, the RDA makes detailed recommendations for continued cooperation, more measurement, more research, more knowledge transfer and more encouragement. The RDA is convinced that these recommendations can make a big contribution to increasing the motivation and ability of those involved in Dutch animal husbandry to take further steps to reduce antibiotic use without prejudice to animal health and welfare.

1. Introduction

1.1 Reason for this study

Antibiotic use entails the risk that micro-organisms may become resistant to the agents used to control them, which in turn leads to a risk to human and animal health. The Dutch government has adopted a policy of encouraging prudent, restricted use of antibiotics in animal husbandry and human healthcare in an attempt to limit the development and spread of such antibiotic resistance. Preventive use of antibiotics has been forbidden since 2012, and use as growth promoters in animal husbandry since 2006. Determined attempts have been made in recent years, with full assistance from veterinarians, to restrict the use of antibiotics for therapeutic purposes in the four main sectors of animal husbandry: cattle, pigs, calves and poultry. The present advisory report deals with the possible consequences for animal health and welfare of this reduction in antibiotic use.

The Dutch Ministry of Economic Affairs is updating its policy concerning the use of antibiotics in animal husbandry. Voices have been raised in the world of animal husbandry and veterinary medicine suggesting that the current policy may have adverse effects on animal health and hence on animal welfare. On the other hand, there is evidence that individual farms with a low level of antibiotic use may actually do very well in terms of animal health and welfare. Before the government takes any further steps, it is important to know the effect of the current policy on animal welfare.

In order to provide a basis for this further approach, the Cabinet asked:

- the Health Council of the Netherlands (*Gezondheidsraad*) for an update of its advisory report from 2011 on the risks to human health due to antibiotic use in animal husbandry. The requested advisory letter has been published (Gezondheidsraad.nl). Its recommendations are aimed in particular at farmers and veterinarians who still use relatively large amounts of antibiotics, and at the extension of the policy to animal species that are not yet monitored, including pets. The Health Council of the Netherlands also recommends international cooperation in this field, and further research into mechanisms leading to the creation of antibiotic resistance, and farming systems involving relatively low antibiotic use;
- the Netherlands Veterinary Medicines Authority (SDa) for an advisory report on a benchmarking system related to resistance levels, and the possibility of adopting a more animal-specific approach here rather than the generic approach adopted so far. The report requested has already been published (Autoriteitdiergeneesmiddelen.nl);
- the Council on Animal Affairs (RDA) for its view on the consequences for animal health and welfare of the policy of reducing antibiotic use, and the possibilities of adopting prudent, restricted use of antibiotics in animal husbandry without prejudice to animal health and welfare.

The advisory report of the RDA on the consequences for animal health and welfare of the policy of reducing antibiotic use is presented in the document before you.

1.2 Background

The Dutch government lays down the legal framework of antibiotic policy in the Netherlands, while the Netherlands Veterinary Medicines Authority (SDa) sets benchmarks for farms and veterinarians, and reports on the progress made in implementing the policy in each sector of Dutch animal husbandry. Use of these benchmarks, together with the defined daily dose per animal (the amount of antibiotic for a given farm or in a given sector, converted into the number of administrations per average number of kg of animal per year) as read-out parameter, provides a basis for gaining an insight into antibiotic consumption per farm, per sector or per veterinarian, and for comparing farms and veterinarians within the various sectors. The quality systems for the various animal husbandry sectors and for the veterinary services monitor the performance of individual farms and veterinarians and lay down improvement pathways. The Netherlands Food and Consumer Product Safety Authority (NVWA) regulates individual farms on behalf of the government (Rijksoverheid.nl). The Netherlands is a leader in antibiotic policy within the European Union.

Antibiotic use in Dutch animal husbandry dropped by 58.1% between 2009 and 2014 (SDa, 2015), a result that was by and large observed in all monitored sectors: cattle farming, pig farming, poultry farming and calf rearing. At the same time, there has been a sharp drop in the veterinary use of third-choice antibacterials[2] (3rd and 4th generation cephalosporins and fluoroquinolones), which are critical for human health. The reduction in antibiotic use was associated with a drop in the percentage of antibiotic-resistant bacteria in farm animals (MARAN, 2015). The target set by the Dutch government together with the various sectors of animal husbandry in 2009, of achieving a 50% reduction by 2013, was thus more than reached. At the time of writing it was not yet known whether the following target set by the Ministries of Economic Affairs and Health, Welfare and Sport, of reducing antibiotic use in animal husbandry by 70% in 2015 compared with 2009, had been met.

All parties involved agree that the point of departure both for current regulations and for future policies must be that sick animals should receive adequate treatment. The aim of reducing antibiotic use should not be allowed to conflict with this principle. Possible ways of reducing the use of antibiotics still further should be sought firstly in disease prevention, and secondly in prudent antibiotic use when treating sick animals. The Health Council of the Netherlands (Gezondheidsraad.nl) is moreover of the opinion that ways of reducing antibiotic use should also be sought in sectors of veterinary care that have not yet been monitored, such as the use of antibiotics on pets and animals kept as a hobby. The RDA regards this advice as logical and defensible.

1.3 Request for advisory report

The Minister for Agriculture has asked the RDA for an advisory report on how present and future Dutch antibiotic policy can ensure that animal health and welfare are preserved and improved as much as possible.

The main questions the Minister for Agriculture put to the Council in a letter dated 12 May 2015 were as follows:

- *What beneficial and adverse effects on animal health and welfare may be seen from the present policy of reducing antibiotic use?*
- *What is needed and what should be taken into account in order to be able to take further steps to develop government policy on antibiotic use in future so as to guarantee or improve intrinsic animal health and animal welfare?*

The State Secretary also asked the following secondary questions:

1. *What beneficial and adverse effects does the present antibiotic policy have on animal health and welfare in the four sectors of Dutch animal husbandry involved? Wherever possible, your answer should be based on current research and monitoring data.*

2. *Are these consequences in the above-mentioned sectors incidental or more structural in nature? Are the developments in these sectors specific or more generic in nature? If some developments are more specific, please name them.*

3. *Are there specific examples (and possibly best practices) of known cases in these sectors where possible adverse effects on animal health and welfare have been 'overcome'? And what factors led to the improvements in these cases?*

[2]Antibiotics for therapeutic use in animals are divided into first-choice, second-choice and third-choice antibacterials. Use of first-choice antibiotics gives the least risk of the development of resistance, and they may be used as part of a farm treatment plan whenever there is an indication for this. Use of second-choice antibiotics must be justified by a veterinarian. Third-choice antibiotics are of critical importance in human healthcare, and may only be used on animals under strictly controlled conditions.

4. *What are the possible underlying factors (such as nutrition, climate, hygiene or financial resources) and/or agents (such as the knowledge and skills of farmers and/or veterinarians, available financial resources or banking requirements) that can influence or limit not only further reduction in antibiotic use but also the taking of measures in the interests of animal health and welfare?*

5. *Is enough known about the effects of the reduction of antibiotic use on animal health and welfare and about the causal links in this field, and if not, where in particular is knowledge lacking? Is further research into the effects of the reduction of antibiotic use on animal health and welfare possible and necessary, and if so, what should the focus and direction of such research be? Can existing monitoring systems contribute to this research, and to what extent do they need to be modified and/or improved to be able to make such a contribution?*

6. *What are the critical success factors in each sector for ensuring continued animal health and welfare under future antibiotic policy aimed at preventing the development and spread of antibiotic resistance in the short, medium and long term, and what factors would tend to limit or encourage success in this connection?*

7. *What are the perspectives for future action by the various actors in this field aimed at ensuring, controlling or improving animal health and welfare, and how can such perspectives be taken into account in future policy?*

1.4 Scope of the study

The RDA considers a comprehensive approach to issues concerning animal health and welfare important. The Council has recently explained how this approach can be translated into relevant values and interests relating to animal health, human health and the ecosystem in the publication *One Health* (RDA, 2015). In view of the questions posed by the Minister for Agriculture, the RDA will limit its considerations to the effects of Dutch government policy on animal health and welfare. Antibiotic residues in products, which basically do not occur in practice due to the relevant waiting periods and the stringent checks on these products, will not be considered in this advisory report. Neither will the question of whether a further reduction in antibiotic use in animal husbandry is desirable. Moreover, the report restricts itself to the four sectors covered by government policy so far: cattle farming, pig farming, poultry farming and veal farming.

1.5 How to read this report

Factual advice is given in the main body of the text, while the results of the literature survey, the collection of information from field practitioners and other sources are given separately for each sector in the appendices. The interpretation of the data collected and the RDA's own view on these topics may also be found in the main body of the text.
Chapter 2 of the main body of the text describes the approach taken by the Council to produce this advisory report. Chapter 3 shows the considerations that the Council took into account, and gives the answers to the questions posed by the Minister for Agriculture, while Chapter 4 presents the conclusions and recommendations.
In order to keep the text as compact and accessible as possible, the answers to the Minister's questions in Chapter 3 are not given in the same order as that in which they were asked. Questions 1 and 2, about the effects of the antibiotic policy, are answered together in section 3.1. Questions 4 and 5, about underlying factors and missing knowledge, are dealt with in sections 3.2 and 3.3. Question 3, about examples of successful attempts to overcome adverse effects and about best practices, is dealt with in section 3.4. Finally, section 3.5 gives a survey of answers to questions 6 (about critical success factors) and 7 (about the perspectives for future activities). This last-mentioned topic is also dealt with in the recommendations. All sources consulted in the preparation of the appendices, together with those consulted in the preparation of the main body of the text, are listed after the main body of the text.

2. Approach

The work done by the RDA in its preparation of this advisory report involved not only a literature survey but also analysis of the knowledge of field practitioners as elicited by interviews and the collection of information from other sources that were considered to be relevant in the context of the main and secondary questions posed by the Minister for Agriculture.

2.1 Literature survey

First of all, an inventory was made of research from the Netherlands and abroad about the effects of reducing antibiotic use on the health and welfare of farm animals. Since the experience of policies aimed specifically at reducing antibiotic use, both in the Netherlands and abroad, is still quite recent, the literature survey yielded little information that could be used to answer the main question. Results from abroad may not be applicable to the Dutch situation, and moreover much of the research done concerned the reduction or termination of the use of antibiotics as growth promoters or the preventive use of antibiotics, not their therapeutic use. However, some sources were found that were relevant (at least in part) to some of the secondary questions asked, for example those dealing with new substances that might be used to replace antibiotics, preventive measures for promoting animal health, and the attitude and behaviour of veterinarians and farmers. Use was made of these sources where appropriate.

2.2 Analysis of knowledge and experience of field operatives

Since the literature survey proved to be of limited use for the purposes of this study, the next step was to try to find out more about the knowledge and experience of people working in practice in the above-mentioned four sectors of animal husbandry. The focus here was mainly on farmers, veterinarians and members of professional associations and interest groups. Representatives of all these groups may be found in the antibiotic resistance working groups set up in 2008 for four sectors of Dutch animal husbandry: cattle farming, veal farming, poultry farming and pig farming, within the framework of the Agreement on Antibiotic Resistance in Animal Husbandry (*Convenant antibioticaresistentie dierhouderij*). These working groups mainly consist of farmers, veterinarians and members of professional associations and interest groups. In order to collect information about the knowledge and experience of these field workers in a structured, transparent way, the RDA held four knowledge transfer sessions led by the consultancy firm The Bridge, in which members of the antibiotic resistance working groups were questioned with the aid of the 'Group Decision Making Software' (*Versnellingskamer*; Versnellingskamer.nl). The questions posed were first answered by individual participants and then discussed in a group session. Each participant was sent a questionnaire, which had to be completed and returned before the knowledge transfer sessions. The answers to this questionnaire were presented during the sessions. Members of the RDA and of the support team were also present during the sessions. The participants in these information collection sessions are referred to as 'interviewees' in the rest of this advisory report.

2.3 Expert committee

All the information collected was discussed, assessed and weighted by an expert committee set up by the RDA for the purposes of preparation of this advisory report. Apart from the sessions devoted to these activities, the expert committee also collected information from other relevant parties and organisations. It finally presented a draft advisory report to the Council.

3. Considerations

3.1 Beneficial and adverse effects of the reduction policy

3.1.1 Beneficial effects

- Attitude of farmers and veterinarians towards responsible antibiotic use

One important and widely observed beneficial effect of the policy is the greater awareness of the need for responsible antibiotic use throughout the field of animal husbandry. Both farmers and veterinarians speak of 'a new mind-set': responsible antibiotic use has become an implicit part of the way people look at animal health and welfare.

- Encouragement of a sence of responsibility

All Dutch animal husbandry sectors and veterinarians have assumed responsibility for reducing antibiotic use in animal husbandry, and have successfully achieved this target. The RDA believes that experience so far has shown that all sectors, together with all other stakeholders involved, have worked well together to achieve good results quickly. It is advisable to continue to appeal strongly to the sense of responsibility of the various sectors, individual farmers and veterinarians in future, as long as this is backed up by an appropriate legal framework and support from the other main stakeholders (the signatories to the Agreement on Antibiotic Resistance in Animal Husbandry).

- Prevention

Farmers are showing more readiness to consult their veterinarian and greater awareness of the need for prevention on the basis of a farm health plan and a farm treatment plan drawn up jointly by farmer and veterinarian. The farm health plan lays down requirements for such things as the quality of fodder, housing, ventilation, temperature controls, breeding and health checks. It also promotes good preventive animal healthcare, since infection risks, hygiene, measures aimed at breaking infection chains and facilitation of the vaccination of farm animals in situ are among the factors assessed during the making of a farm health plan. The farm treatment plan includes specification by the veterinarian responsible (on a one-to-one basis) for the farm in question of the preferred antibiotic for treatment of bacterial infections. The choice of such antibiotics is based on the guidelines drawn up by the Royal Dutch College of Veterinary Medicine (KNMvD), lists of approved antibiotics and the history of the farm. Both plans form part of the quality systems for the various sectors of animal husbandry and for the 'Guaranteed veterinarian' (Geborgde dierenarts)[3], and have as a result become an integral part of Dutch farm management. Examples of preventive measures include wider use of vaccination, biosecurity, hygiene, creation of an optimal interior climate, housing and sound nutrition for all animals. Apart from preventive measures, conditions for antibiotic use are described and implemented better. A good example of a preventive measure is the guideline for 'selective dry cow therapy' (*selectief droogzetten*), which has in a short time changed the systematic preventive use of antibiotic treatment at dry-off on all dairy cattle (blanket dry cow therapy) to a system where only cows with an indication are dried off with antibiotics.

- Research

The policy of reducing antibiotic use in the Netherlands has led to an increase in research on ways in which farmers can run their farms with as little use of antibiotics as possible. A great deal of research, jointly funded by the government and by the farming community, has been initiated in the Agri & Food sector (defined by the Dutch government as one of the 'top' sectors of the Dutch economy) with the aim of making animals more resilient, promoting intestinal health, greater use of vaccination and other measures facilitating the prevention of bacterial infections. Further research is also being carried out on preventive measures and therapies, though additional stimuli for this work would be welcome. It is expected that this research will lead to the availability of a wider range of preventive measures and therapies. The RDA considers the availability of a wide range of preventive measures and therapies to be highly desirable, since too undifferentiated or too narrow a range is likely to lead rapidly to the development of resistance that cannot be tackled by any available means.

[3] For quality control of the services provided by veterinarians in the Netherlands (Geborgdedierenarts.nl).

The RDA concludes that greater awareness of the need for responsible antibiotic use is displayed throughout the four sectors of animal husbandry in question. The rules required for this have been laid down in professional guidelines, lists of approved antibiotics and the treatment plan drawn up for individual farms. More attention is now paid to the need for preventive animal healthcare, where the farm health plan plays an important role. The results of the use of new substances reported so far have not yet been adequately validated. A wider range of preventive measures and therapies is expected to become available in the near future.

3.1.2 Adverse effects

- Not enough objective information to allow well-based conclusions to be drawn

The current antibiotic policy will lead to more sickness among animals and hence poorer animal welfare if the reduction in antibiotic use is not compensated by preventive measures. In fact, the need for subsequent treatment on a farm could cause the overall level of antibiotic use there to rise. Initial treatment with a first-choice antibacterial[2] in cases where the infective agent is resistant to this medication can also lead to a reduction in animal welfare, since it may take longer to cure the animals in question.

One circumstance that makes it very difficult to determine whether animal health and welfare are reduced in both of the above-mentioned cases is the very limited availability of objective data on animal health and welfare, aggregated with data on antibiotic use and risk factors related to animals and farms. While many farmers do record deaths and diseases in their farm management systems, these data are rarely or never aggregated to sector level.

Dorado-García et al. (2015) found a significant rise in mortality in a group of Dutch veal calf farms between 2009 and 2012. This rise was greatest in the farms where the doses of antibiotics the animals received had dropped most, but the relationship between rising mortality and falling antibiotic use was not statistically significant in this study. Data from farms show an upward trend in veal calf mortality in the 2007-2013 period, followed by a slight fall starting in 2014 (Figure B9 in Appendix 5). Antibiotic use in veal calves dropped in this period, but it is not known whether there was a causal relationship between this and the mortality. The Cattle Monitoring Programme (*Monitoring Diergezondheid Rundvee*) of the Dutch Animal Health Service (*Gezondheidsdienst voor Dieren*, GD) (GD, 2015) showed that calves aged between 3 months and one year that were raised on dairy farms have exhibited a slight rise in the mortality trend in recent years (0.66% in the first quarter of 2015 as compared with 0.61% in the first quarter of 2014; see Figure B2 in Appendix 2). Once again, there is no information about the possible existence of a causal link.

The mortality among broiler chickens raised on farms contributing to the farm information network (*Bedrijveninformatienet*) maintained by the LEI Research Institute in Wageningen was found to drop starting in 2009 and to stabilise at an average value of 3.3% in 2014 (data available from 2008; Agrimatie.nl[b]; see also Figure B7 in Appendix 4 of the present report). Data available from 2001 also show that the average mortality in piglets before weaning and the number of live births in piglets have risen in recent years (mortality 12.8% in 2009 and 13.3% in 2014, and live births 13.1 and 14.2 respectively in the same years; the mortality showed a dip in 2010) and mortality stabilised in 2014 (Agrimatie.nl[a]; Figure B5, Appendix 3 of the present report).

Once again, a causal relationship between mortality and reduced antibiotic use cannot be established here with certainty, due to the lack of aggregated data among other things. Moreover, the lack of a practically feasible method of monitoring animal welfare in a valid, structured and guaranteed way means that a causal relationship between reduced antibiotic use and animal welfare cannot be established with certainty.

According to research by Scherpenzeel et al. (2014), dry-off of cows with a low somatic cell count without use of antibiotics leads to nearly twice as many cases of mastitis during the next lactation compared with the dry-off of comparable cows with antibiotics. The guideline for 'selective dry cow therapy' in the Netherlands is however less restrictive as regards the use of dry cow therapy than the selection strategy adopted by Scherpenzeel et al. (2014). The average cell count of tank milk in the Netherlands has dropped in recent years (see Figure B3, Appendix 2), but the percentage of farms where at least 25% of the cows have a high cell count after calving shows a rising trend (Figure B4, Appendix 2; GD, 2015). These figures indicate that the risk of mastitis during and after the dry period has risen, while the falling cell count in tank milk during lactation shows that farmers are taking more care to ensure that fewer cows develop a high cell count during lactation. However, the data collected so far are not enough to establish with certainty whether there is a

causal relationship between reduction in antibiotic use and the incidence of disease or mortality. Further research is needed before this can be determined.
To sum up, no aggregated data on the reduction in antibiotic use, the incidence of disease, mortality and the risk factors associated with the various types of animals and farms are available for any of the sectors of Dutch animal husbandry in question.

- Interviewees indicate that animal welfare is under pressure

Interviewees mention the risk that animal welfare may decline if animals do not receive the proper treatment and may thus be sick for longer as the main adverse effect of the policy restricting antibiotic use. They also believe that overall antibiotic use regularly rises in cases where farmers or veterinarians are initially inappropriately reluctant to give antibiotics at an early stage of the disease. The following reasons why antibiotics may not be appropriately administered were mentioned: compliance with guidelines may cause the right antibiotic to be administered too late, while departure from the guidelines gives rise to a great deal of extra paperwork and is often avoided for fear of sanctions. Furthermore, a change in the mind-set towards lower antibiotic use based on reliance on the defined daily dose per animal as laid down in the benchmarks can lead to too much focus on reducing antibiotic use at the expense of animal health and welfare.
In the field of calf rearing, interviewees mentioned *Salmonella* infections that were difficult to deal with and raised mortality rates, which they believed were linked to the policy of restricting antibiotic use.
Interviewees further observed that restrictions on the use of effective antibiotics tended to lead to the use of new substances whose effectiveness and waiting period were unknown. They were also worried that antibiotics might be brought in from other countries where no policy restricting the use of antibiotics is yet in place. This finding reinforces the importance of a level playing field in Europe.
When animals are sick, more frequent visits from the veterinarian are required under a policy that restricts antibiotic use. This leads to higher costs, as do the investments needed for improved animal housing and climate systems, among other things. Applying for the permits required for such improvements also costs money, and is moreover often very time-consuming. These higher costs weaken farmers' competitive position on the international market, where they usually operate.

To sum up, the RDA concludes that the scientific literature and the available objective data from other sources on the effects of the current antibiotic policy are too limited to allow general conclusions to be drawn about the effect of this policy on animal health and welfare. The available data seem to indicate a rise in veal calf mortality and in the incidence of mastitis after calving, but more detailed research is required before it can be decided whether there is a causal relationship here. The lack of timely, effective treatment for sick animals may lead to a rise in the incidence of disease and in mortality, and hence to a decline in animal welfare.

3.2 Factors influencing antibiotic use

3.2.1 Farming skills

Interviewees with practical experience of the field noticed a wide variation in the amount of antibiotics required in comparable farms to achieve a given level of animal health and welfare. They ascribe much of this variation to differences in farming and entrepreneurial skills between farmers, to differences in the scope for investment and differences in the ability to communicate with the veterinarian and with other people visiting the farm on business. According to the interviewees, these differences indicate that there is room for improvement on many farms.

3.2.2 Financial position

Interviewees state that the poor financial results in large parts of Dutch animal husbandry in recent years mean that many farmers cannot afford to invest much in the farm improvements needed for disease prevention purposes. Moreover, the extensive legislation and regulations in this field together with the expense and time-consuming nature of the application procedure for the permits required for such improvements make farmers reluctant to embark on this undertaking. This reluctance is reinforced by the fact that the requirements imposed may be contradictory or difficult to reconcile with other (e.g. social) requirements. For example, free-range housing for poultry and pigs is good for animal welfare but may lead to a higher risk of infection.

3.3 Knowledge of the field

The RDA believes that a great deal of additional research is needed to support a further reduction in antibiotic use in animal husbandry. This would include research into the quality and effectiveness of lists of approved antibiotics and research into fast, accurate diagnostic methods (for the determination of bacterial sensitivity to antibiotics). We also need to know more about the various diseases caused by bacteria and the possibility of preventing infection by various measures, including vaccination. Further identification and quantification of animal- and farm-related factors (including risk factors) that have an impact on animal health and welfare is also required, as a basis for the practical measures that could be taken and for policy development. For example, why do some 'normal' farms have relatively low antibiotic use and still manage to keep their animals healthy, while other farms cannot manage this?

Best practices in this field have been identified (see section 3.4). However, it is not always specifically stated that these best practices do indeed serve to maintain animal health and welfare, and to reduce the need for antibiotics. This assurance can only be achieved with the aid of objective data. Any future decision to minimise antibiotic use in animal husbandry must involve validation of best practices and of system innovations developed in the past, and should also be accompanied by research into new system innovations. It is not simply a question of listing single solutions here, but of considering system innovations based on an integrated approach that allows each animal and flock or herd to live a healthy life in interaction with other animals, flocks or herds, its environment and micro-organisms (see also the One Health policy assessment framework; RDA, 2015). Investigation of and implementation of system innovations will take time.
Existing knowledge needs to be better disseminated through education and other means such as refresher courses and study groups designed for veterinarians, farmers and others who visit farms on business. This will help to change the mind-set of all stakeholders and raise their motivation to transform acquired knowledge into practical measures on the farm, which is of crucial importance as the basis for any policy. The advisory skills of veterinarians and others who visit farms on business can also play a key role in bringing any advances about.

Welfare plays an important role in all considerations concerning animal health. The Council believes that there is a need for the development of measurable animal welfare indicators suitable for use in practice that would permit the mapping of the effects of reduction in antibiotic use on animal welfare. In fact, a system for monitoring animal welfare known as the Welfare Quality Monitor is already in operation. According to interviewees, however, this system is too extensive and too time-consuming in use to be really practical. An alternative approach that is better suited for use in practice is needed. A number of projects set up with the backing of the Dutch government and the farming community to develop an animal welfare monitor (with initial coverage including dairy cattle, veal calves and broiler chickens) that is more suitable for use under Dutch conditions have been giving good results so far (Verantwoordeveehouderij.nl). Inclusion of such monitors in private quality systems and aggregation of the data collected in this way should make it possible in future not only to measure the effects of policy changes but also to present animal welfare issues to the public in a clearly understandable way. This approach would also help policy-makers to recognise and tackle the practical results of excessive reluctance to use antibiotics. Apart from an animal welfare monitor, there is also a need for automatic recording methods for animal health parameters, which would permit continuous monitoring of animal health without excessive effort.
Research into new ways of preventing and treating bacterial infections is growing, but is still limited. The results are not yet unambiguous enough to provide a basis for recommendation of the application of specific methods. Further research on this point therefore needs to be encouraged.

3.4 Best practices

A best practice is a way of working that can be used by several organisations, farms et cetera and that has been proven to yield benefits in operation. Individual farmers often develop their own ideas on how antibiotic use can be reduced in practice, for example by modifying animal housing or farm management so as to limit or prevent the spread of infection, through the preventive use of new substances such as probiotics to promote animal health or through changes in animal fodder. Such individual initiatives whose effectiveness has not been subjected to systematic third-party testing are not referred to as best practices. In this section we will restrict ourselves to the discussion of initiatives whose applicability has already been confirmed on a fairly wide scale.

Many ways of reducing antibiotic use and of achieving 'antibiotic-free' production have been introduced in the four sectors of Dutch animal husbandry considered here. For example, Agro and Nature Innovation (InnovatieNetwerk, 2011) has been commissioned by the Ministry of Economic Affairs to develop 'antibiotic-free' production methods for pig farming and broiler chicken farming. A successful product of their efforts is the antibiotic reduction programme of the Sustainable Pork Chain (*Keten Duurzaam Varkensvlees*). The wish to achieve a major reduction in antibiotic use should never lead to the attitude that higher disease incidence and mortality are acceptable. This would be highly undesirable in the interests of animal health and welfare. In the Sustainable Dairy Chain (*Duurzame Zuivelketen*), reductions in antibiotic use form part of a wider package including climate-neutral applications, continual improvement of animal welfare, maintained access to pasture grazing and maintenance of biodiversity and the environment (Duurzamezuivelketen.nl[c]). Research in the poultry sector focuses for example on ways of hatching eggs in the coop and concepts for slow-growing broiler chicken strains, some of which have already been put into practice. Successful raising of broiler chickens awarded one star by the *Beter Leven* (Better Life) quality label (Beterleven.dierenbescherming.nl) demonstrates that marked reduction of antibiotic use is possible in practice. A project has been set up to use financial incentives to encourage dairy farmers to give calves optimum amounts of high-quality colostrum before delivery to veal calf rearers. Optimum colostrum intake protects calves against disease later on in life. Ensuring optimum comfort for calves during transport results in better health during and after transport.

3.5 Can the adverse effects be overcome?

This section deals with various factors that can help to overcome the adverse effects on animal welfare of a reduction in antibiotic use. Figures 1 and 2 give schematic representations of the variation in antibiotic use and in the incidence of disease, suffering and mortality among animals as viewed by the RDA. The overall conclusion is that there is a clear reduction both in mean antibiotic use and in the variation in such use (Figure 1), while at the same time the variation in animal health and welfare has actually increased (Figure 2).

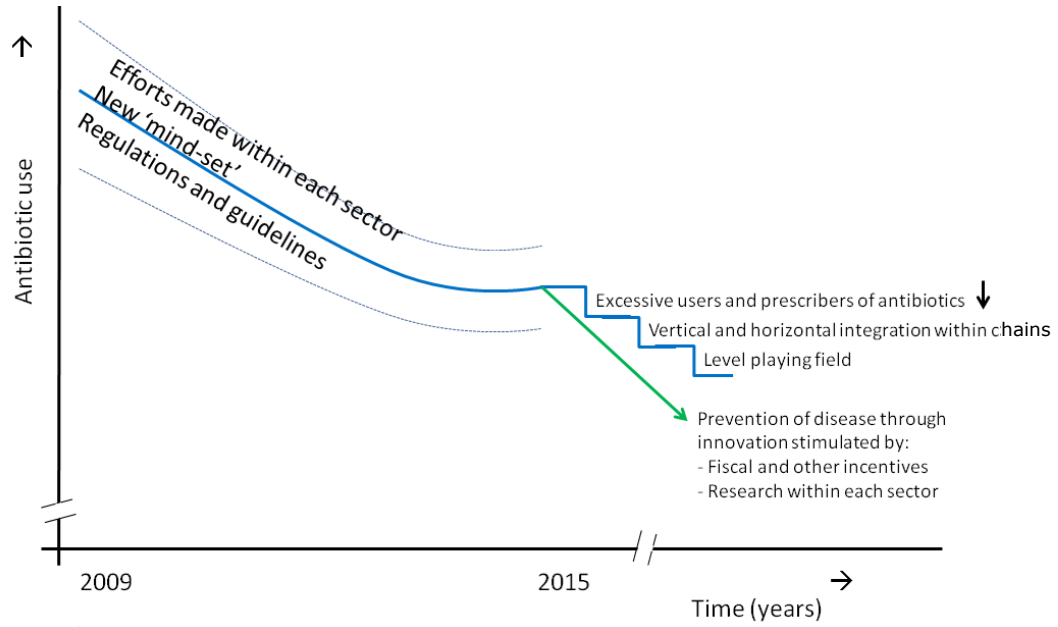

Figure 1. Schematic representation of drop in antibiotic use and the factors influencing this. While the curve shown is not based on hard data, the fact that antibiotic use is in general subject to a falling trend is based on hard data (Maran 2015). The blue dotted lines represent the confidence interval.

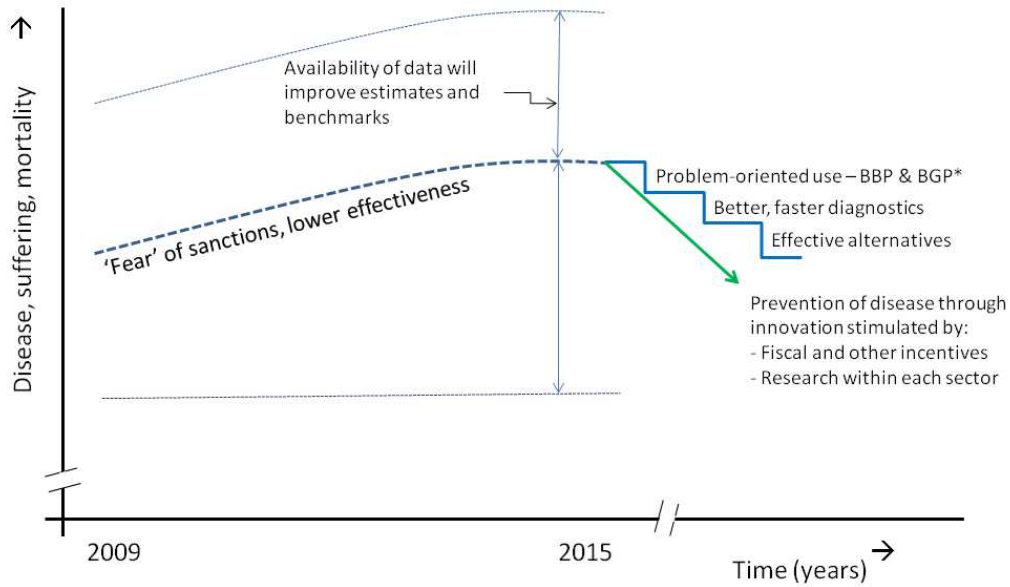

Figure 2. Schematic representation of suffering, incidence of disease, mortality and the factors influencing these variables. This figure represents an interpretation of the views of interviewees, and is not based on hard data (*BBP = farm treatment plan; BGP = farm health plan). The much wider confidence interval compared with Figure 1 indicates the importance of collecting much more data in future in order to refine the estimates of suffering, incidence of disease and mortality. The light-blue dotted lines give a schematic representation of the confidence interval.

3.5.1 Farm health plans

Research on organic dairy farmers in Denmark has shown that when farmers undergo suitable training, reduction in antibiotic use need not be associated with lower milk production or poorer animal health (Bennedsgaard et al. 2010). Grave et al. (2006) reported that after the use of antibiotics as growth promoters was terminated, therapeutic use of antibiotics showed a temporary rise in Denmark and Sweden, but fell in Norway. This drop coincided with a publicity campaign in that country on preventive measures and prudent antibiotic use, and may be at least in part explained by the effect of this campaign. Aarestrup (2012) reported that reduction in antibiotic use in Denmark was not followed by deterioration in the health of pigs. As Wielinga et al. (2014) pointed out, however, conditions in Denmark or other countries may differ from those in the Netherlands, so that the results obtained there need not necessarily apply in the Netherlands. Speksnijder et al. (2015) reported on the other hand that reduction in antibiotic use need not lead to higher production costs. According to Rajala-Schultz et al. (2011), adverse effects on udder health can be avoided if dry cow management is optimised on each farm and if cows are thoroughly screened for udder infections before dry-off. They do state in this connection that further research is needed before the optimum strategy can be determined.

The effectiveness with which adverse effects can be combated appears to depend to a great extent on the approach taken on each individual farm. In the opinion of the RDA, the farm health plan plays a critical role in limiting the animal welfare risks associated with a restrictive antibiotic policy. Each farmer should work together with the responsible veterinarian to draw up a strategic approach forming part of the farm's quality system to ensure the best possible animal health levels on the farm. The jointly formulated farm health plan includes all recommended preventive measures. Interviewees agree on the importance of the farm health plan in bringing about the reduction in antibiotic use achieved so far, but point out that the results obtained can vary from farm to farm and from veterinarian to veterinarian. In addition to the motivation of the farmer, the motivation and advisory skills of the veterinarian play a crucial role here. In this connection, the RDA applauds the initiative of the association of registered dairy cattle veterinarians for peer review of farm health plans as a step towards improved quality of these plans and hence of recommendations for prevention of infectious diseases. Keeping visitors to the farm (such as fodder suppliers, transport companies and parties coming to pick up animals or other farm products) informed about the content of the farm health plan, and even involving them in the formulation of the plan where possible or necessary, can make a further contribution to preventive animal healthcare.

Research confirms the importance of cooperation with those who visit farms on business as well as with veterinarians. Speksnijder et al. (2015) regard behavioural change and the implementation of new measures as key factors, which can be promoted by internal and external motivating factors such as social pressure, remuneration and subsidies. Wessels et al. (2013) list regulations, education, social pressure, economic stimuli and tools or technical facilities as motivating factors. Speksnijder et al. (2015) and Wessels et al. (2013) agree that the attitude and advisory skills of veterinarians can play an important role in this connection.

3.5.2 Biosecurity

According to Dar et al. (2015), preventive measures can minimise the spread of bacteria and hence reduce the risk of infection and the need for antibiotics. The RDA regards the prevention of infection as one of the most important means of preventing adverse effects of reduction in antibiotic use. Moreover, restricting antibiotic use is probably not enough in itself to combat the above-mentioned spread of antibiotic resistance. The use of biosecurity measures to break or prevent infection chains can probably make a further contribution to this end. Contact between animals from different farms plays a key role here. Closed farm management, where no animals are brought in from other farms, is probably the best from a biosecurity perspective. Where that is not possible, attempts should be made only to bring in animals from farms stocking animals of as similar an origin as possible, to avoid interim mixing up of animals and to adopt an 'all-in, all-out' approach, preferably at the farm level but in any case at the department or shed level. Keeping the housing clean and disinfected between rounds is essential, and each shed must remain empty for at least a week between rounds. Biosecurity also involves the prevention as far as possible of indirect contact between farms that can allow infection to be transmitted by people, vehicles, pets, vermin and the like (Moore, 1992).

The above comments refer to external biosecurity, where the aim is to avoid introducing infection from outside. Internal biosecurity is also important on farms. This includes effective means of

separating different groups of animals and hygienic measures aimed at preventing transmission of infection between various groups.

3.5.3 Improving animal resistance

Antibiotic use on young animals is mainly associated with stressful periods such as the weaning of piglets and starting broiler chicks and calves on dry feed. Optimum nutrition, an optimum interior climate and avoiding stress as much as possible are important factors in making animals more resistant (Griebel et al. 2014) and can help to reduce the levels of antibiotic use that are needed. An integrated approach and good coordination of the various activities on the farm and in the production chain also play a role here.

Current research aimed at making animals more resilient was mentioned in section 3.4. It may be expected that new initiatives in addition to from the broiler chickens with the *Beter Leven* (Better Life) quality label mentioned in section 3.4 will enrich Dutch animal husbandry in future. One way of raising animal resistance that already attracts great interest is vaccination. Since bacterial infections are often combined with other infections in intensive animal husbandry (such as a virus infection followed by a bacterial infection), anti-virus vaccinations for example can give wider protection against disease than just against the specific disease for which they were designed. It should be noted that this is another field where further research is required to elucidate the underlying mechanisms. Research on alternatives to antibiotics for drying-off of dairy cattle has already been published; these alternatives may be expected on the market in the foreseeable future (Ollier et al., 2015). Immunostimulants that could help to reduce the incidence of disease are currently undergoing active investigation (Hassfurther et al., 2015); this may lead to the availability of products that Dutch farmers could put to good use in the medium term.

3.5.4 Therapy and early diagnosis

Fast diagnostic methods combined with techniques for determination of bacterial sensitivity to antibiotics are urgently needed so that appropriate treatment approaches can be worked out without delay as a basis for adequate therapy of infectious diseases in animal husbandry. One problem that needs to be dealt with quickly, according to interviewees, is that the product information included with veterinary products such as antibiotics is sometimes incorrect (for example, the recommended dose may be too low), which forces veterinarians to use such products off-label.

3.5.5 Incentives

Incentives in the production chain are an important factor in achieving further reduction in antibiotic use. For example, dairy farmers can be rewarded for delivering healthy, vital calves to veal calf rearers. Another possibility is to make investments made by farmers to improve the interior climate, give animals more space in the barns or other measures aimed at improving animal health and welfare tax-deductible. The Environmental Investment Tax allowance (*Milieu-investeringsaftrek*, MIA) and the Arbitrary Write-off of Environmental Investments (*Willekeurige afschrijving milieu-investeringen*, Vamil) scheme are examples of such an arrangement, which Dutch farmers can make use of when they build cattle sheds that comply with the Sustainable Cattle Farming Yardstick (*Maatlat Duurzame Veehouderij*) (RVO.nl).

The development and promotion of market concepts such as the existing *Beter Leven* quality label will generate market-based incentives aimed at better animal health and welfare, and lower antibiotic use. Greater flexibility in granting permits for such investments will also encourage developments in the desired direction.

3.5.6 Horizontal and vertical coordination

The RDA believes that an integrated approach, coordination and communication, both in the production chain and in the relationship between the farmer, the veterinarian and others who visit farms on business are vitally important factors for ensuring further progress in this field. Agreement between the three above-mentioned parties is needed to ensure that they are all equally involved and share the same aims, and that they all work together to achieve the objectives set for the farm. Research by Derks et al. (2013) shows that this approach works.

The RDA furthermore attaches great importance to coordination in the vertical chain, for example in the form of the exchange of information between the suppliers of young animals and the farmers for whom they are intended, so that for example appropriate decisions can be made concerning the housing and management of the young animals. Such information may refer for example to the health status of calves sent by a dairy farmer to a veal calf rearer, or to the information

accompanying piglets or chicks from one stage in the production chain to the next. One farm may also take measures, such as feeding colostrum and vaccination, which may yield benefits further down the chain. Veal calf rearers want calves with good long-term immune competence, which is promoted by proper feeding of colostrum to the young calves. What is important here is that information is provided and activities are undertaken – and hence expenses are incurred – at one stage in the chain, while the benefits are reaped at a later stage. The financial equivalent of part of these benefits should be used to stimulate the desired behaviour earlier in the chain.
Intra-chain or intra-sector coordination is also important for the combating of animal diseases that lead to higher antibiotic use and for which means and knowhow are available to combat them at the sector or chain level. This consideration applies for example to bovine virus diarrhoea (BVD) in dairy farming and to *Mycoplasma synoviae* in poultry farming.

3.5.7 Role of the government and a level playing field

Antibiotic policy needs to be formulated at the European level; after all, antibiotic resistance does not stop at national boundaries. Farmers and other entrepreneurs benefit from the predictability and consistency of regulations at national level. According to the interviewees, regular modification of quantitative targets that have not yet been adequately tested in practice confronts farmers with problems when it comes to the planning and financing of investments. It is furthermore bad for their motivation to have to follow constantly changing requirements. Similar considerations apply to compliance checks. Harmonisation of the findings of private quality systems and the Netherlands Food and Consumer Product Safety Authority (NVWA) is desirable in this connection (in other words, the NVWA should focus mainly on cases where the level of antibiotic use and prescription is high, and on farms that are not covered by private quality systems).
According to this view, excessively strict interpretation of regulations and legislation severely hinders the introduction of the necessary changes at the private level. Conversely, it would be advisable to provide more leeway in the rules for farms that make demonstrable progress in promoting animal health and reducing antibiotic use.
Finally, the government has an important contribution to make in connection with the need for a level playing field in Europe and where applicable further abroad. This is confirmed by Speksnijder et al. (2015). According to these authors, the international nature of animal husbandry demands international measures to prevent that national animal husbandry is penalised by antibiotic reduction measures taken in that country, and potential illegal imports of antibiotics from neighbouring countries that have not taken such measures are stimulated. In the Dutch case, this means on the one hand the formulation of demands on Dutch animal husbandry that take into account the corresponding demands made in other countries (especially within Europe) that compete with the Netherlands in this market. On the other hand, the Dutch government must do its best to ensure that animal health and welfare requirements set in the Netherlands should also be recognised at the European level – and even further abroad where applicable. Such steps to promote and protect a level playing field will do a lot to improve the motivation, activities and ability of Dutch farmers to do more to reduce antibiotic use. In addition the RDA considers that there should be a single policy within the European Union and that research should be encouraged on new treatment methods for sick animals, including 'natural' approaches and the use of chemical drugs whose effects, waiting periods and maximum permitted residue limits have not yet been adequately investigated.

4. Conclusions and recommendations

4.1 Conclusions

The RDA has drawn the following conclusions on the basis of its literature survey, analysis of the available data and information obtained from interviewees with practical experience of the field.

- The available information is too limited to permit an unambiguous answer to the question of what effects antibiotic policy has on animal health and welfare.
  - The available scientific literature is limited in scope, and does not allow an unambiguous conclusion to be drawn concerning the relationship between reduction in antibiotic use and animal health and welfare.
  - The lack of common databases leads to a shortage of objective data on the incidence of diseases, mortality rates and risk factors, certainly in relation to antibiotic use. As a result, it is not possible to define an evidence-based relationship between reduced antibiotic use and animal health and welfare.

- There is as yet no generally accepted system, validated and ready for use in practice, for the objective, structural and uniform determination and aggregation of welfare indicators related to animal health.

- The data available indicate in certain sectors of Dutch animal husbandry a rise in mortality (for example in the veal calf sector) or disease (such as mastitis after calving), simultaneously with a drop in antibiotic use; it is not clear, however, whether there is a causal link here.

- All four sectors of animal husbandry reviewed show a marked drop in antibiotic use. There has been close, effective cooperation within the farming community to respond to the changing demands made by society. Differences have however been observed between sectors and between farms. There are still farmers who use too much antibiotics, and veterinarians who prescribe too much, though the frequency of such practices varies from one sector to another.

- The antibiotic policy followed has led to increased focus on the prevention of infectious diseases on farms and on the research needed to support this; the farm health plan provides strong support for preventive measures at the farm level. It is important to maintain, and where necessary to improve, the quality of the farm health plan on individual farms. Other parties who visit farms on business could also make a contribution to the necessary preventive measures.

- Greater attention is being paid to the use of new therapeutic and preventive approaches as alternatives to the use of antibiotics. However, the results reported so far have not yet been adequately validated, and maximum permissible residue limits have not yet been determined for all the new drugs. As a result, they cannot in general be approved yet for general therapeutic or preventive use as replacements for antibiotics since their efficacy and safety have not yet been adequately established. Further research has been initiated, which may be expected to yield a wider range of curative and preventive agents in the short to medium term.

- The current antibiotic policy can place animal health and welfare under pressure at certain farms, in particular due to the failure to initiate prompt, adequate therapy when called for. Observations in the field indicate that there are marked differences between farms as well as between farming systems in this respect.

- Further reduction in antibiotic use in future could be stimulated by incentives in the production chain and the creation of a level playing field at the European level (and further abroad where necessary) as regards antibiotic use and animal health and welfare requirements.

- The RDA regards integrated horizontal and vertical coordination and cooperation within chains and sectors together with a market-oriented approach as critical success factors for an antibiotic policy. Sharing health information throughout the production chain and good communication between farmer, veterinarian and others who visit farms on business are of great importance, together with initiatives (for example in the fields of biosecurity and hygiene) aimed at breaking the infection chain or measures (for example aimed at improving the resilience of animals or giving them more space) to control the infection chain. Here again, the motivation, mind-set, professional skills and knowledge of farmers, veterinarians and others who visit farms on business play a key role, as do the advisory skills of the veterinarian and other visitors to the farm.

- Research is a necessary condition for further reduction in antibiotic use. Short-term research objectives are for example the identification and quantification of the factors (including risk factors) that can influence antibiotic use and animal health and welfare, in order to gain an insight into practical measures that can be taken and to validate best practices. Research into the quality and effectiveness of lists of approved antibiotics, optimum biosecurity, quick and reliable diagnosis and more and better vaccines is also important. Research objectives in the longer term include study of innovative methods of enhancing the resilience of animals and integrated sustainable production systems that allow each animal and flock or herd to live a healthy life in interaction with other animals, flocks or herds, its environment and micro-organisms.

- Existing knowledge is not always shared optimally with farmers, veterinarians and others who visit farms on business.

- The motivation and professional skills of farmers, and the knowledge and advisory skills of veterinarians and other visitors, are of crucial importance in enabling antibiotic use to be reduced without adverse effects on animal welfare. The entrepreneurial skills of the farmers, and their ability to make the necessary investments, are also extremely important. Poor financial results in the sectors under review and administrative pressures associated with the application for permits for modification and improvement of animal housing are among the main factors that limit progress in this field.

- Important instruments that are already available for overcoming adverse effects of the antibiotic policy include biosecurity and hygiene, vaccination and the creation of an optimum interior climate, together with good animal housing and nutrition. Other tools that may be expected to become available in the medium term are quicker diagnosis, effective ways of increasing the resilience of animals and better housing and nutrition concepts.

- Existing benchmarks for antibiotic use, together with new benchmarks for animal health and welfare that may become available in the foreseeable future, are highly desirable tools for further reduction in antibiotic use, especially in view of the large differences that still exist between farms in this field. It should be stressed that this only applies if restrictions on antibiotic use are not taken so far as to limit antibiotic use when it is really needed, which would have adverse effects on animal health and welfare.

- Completely antibiotic-free animal husbandry is impossible without sacrifices in animal welfare. Animal diseases occur in all forms of animal husbandry. The RDA approves the responsible and selective use of antibiotics in animal husbandry, where sick animals receive quick, effective treatment.

- When preparing decisions that concern the One Health domain, it is important to take all relevant data into account. The RDA has drawn up the One Health policy assessment framework (RDA, 2015) to this end.

4.2 Recommendations

- Integrated data on welfare, disease incidence, mortality, antibiotic use and other factors (including risk factors) should be made available to all parties concerned, such as farmers and researchers, as possible benchmarks for animal health and welfare, and for research that can be used as a basis for policy formation and disease prevention.

- The introduction of valid, objective, uniform animal welfare indicators that are usable in practice should be encouraged, as a basis for reliable, structured monitoring of animal welfare. This can help in the assessment of the consequences of health measures and of diseases that cannot be controlled adequately when antibiotic use is reduced.

- Policies aimed at further reduction of antibiotic use should be supported by research. To this end, research promoting responsible antibiotic use that is compatible with good animal health and welfare in the short and long term should be encouraged. Short-term research objectives include the identification of the factors (including risk factors) that can influence antibiotic use and animal health and welfare, in order to validate best practices, to gain an insight into the quality and effectiveness of lists of approved antibiotics and to achieve optimum biosecurity, quick and reliable diagnosis and more and better vaccines. Research objectives in the long term include study of innovative methods of enhancing the resilience of animals and integrated sustainable production systems that allow each animal of a flock or herd to live a healthy life in interaction with its environment and micro-organisms.

- The dissemination of existing knowledge in this field should be improved by education and other means such as life-long learning and study groups for farmers, veterinarians and others who visit farms on business. Steps should also be taken to change the mind-set of stakeholders, where necessary, towards a better balance between attempts to reduce antibiotic use and care for animal health and welfare.

- Steps should be taken to improve the quality of farm health plans to ensure continuous awareness of the need for improvement of preventive animal healthcare on farms and promotion of the motivation and advisory skills of veterinarians, who play an important role in this process.

- Stricter measures for reduction in antibiotic use and enforcement should be focused on those using or prescribing large amounts of these agents, and should include close monitoring of the effects of reducing antibiotic use on animal health and welfare. If the antibiotic policy is extended to include Dutch animal husbandry sectors that are not yet monitored, pets and/or animals kept as a hobby, the effects of reducing antibiotic use on animal health and welfare should also be taken into account here.

- Steps should be taken to create a level playing field in Europe, and further abroad if necessary, in relation to antibiotic policy and animal health and welfare requirements.

- An integrated sector, production-chain and market-oriented approach should be taken to the reduction of antibiotic use; this will greatly enhance the effectiveness of the measures taken. In particular, exchange of information between farms and suppliers of young animals (hatcheries, dairy farmers, and breeders) should be encouraged to this end. Good communication between animal husbandry, veterinary services and others who visit the farms on business should also be facilitated. The market-oriented approach can facilitate the use of market profits to cover some of the extra costs incurred by the farming community.

- Steps should be taken to promote incentives, subsidies and other rewards for farmers, for the extra efforts they have to make to comply with animal health and welfare standards. For example, farmers could receive a payment for delivery of healthy young animals with sufficient immune competence to the next stage in the production chain. The government could for example provide more leeway in the rules for farms that make demonstrable progress or make investment in animal health and welfare measures on farms tax-deductible.

- The government should create the conditions needed to enable the various Dutch animal husbandry sectors and veterinarians to make an optimum contribution to reducing antibiotic use while safeguarding animal health and welfare through use of private quality systems, sectoral programmes for combating animal diseases and financing of the necessary research.

- Future attempts to minimise antibiotic use in animal husbandry should be supported by research into system innovation, and time should be allowed for the implementation of such

innovation. Steps should be taken to ensure that any innovations to be introduced permit adequate treatment of animals when they need it.

- When preparing decisions that concern the One Health domain, all relevant considerations and values – such as human and animal welfare and health – must be made clear. The RDA's proposal for this in the One Health policy assessment framework (RDA, 2015) can provide a useful guideline here.

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Appendices

Effects of the reduction in antibiotic use in cattle farming, pig farming, poultry farming and calf rearing

1. Introduction

The following four appendices give the results for each sector of Dutch animal husbandry reviewed of the information collection sessions and the associated questionnaire-based survey, the literature survey, the search for best practices and the consultation of other sources. The RDA used this information to compile the main body of the text of this report. Each appendix presents the answers to the questions posed in the main body of the text for a sector of animal husbandry.

The main questions the State Secretary put to the Council in the letter of 12 May 2015 were as follows:

- *What beneficial and adverse effects on animal health and welfare may be seen from the present policy of reducing antibiotic use?*
- *What is needed and what should be taken into account in order to be able to take further steps to develop government policy on antibiotic use in future so as to guarantee or improve intrinsic animal health and animal welfare?*

The State Secretary also asked the following secondary questions:

1. *What beneficial and adverse effects does the present antibiotic policy have on animal health and welfare in the four sectors of Dutch animal husbandry involved? Wherever possible, your answer should be based on current research and monitoring data.*

2. *Are these consequences in the above-mentioned sectors incidental or more structural in nature? Are the developments in these sectors specific or more generic in nature? If some developments are more specific, please name them.*

3. *Are there specific examples (and possibly best practices) of known cases in these sectors where possible adverse effects on animal health and welfare have been 'overcome'? And what factors have led to the improvements in these cases?*

4. *What are the possible underlying factors (such as nutrition, climate, hygiene or financial resources) and/or agents (such as the knowledge and skills or farmers and/or veterinarians, available financial resources or banking requirements) that can influence or limit not only further reduction in antibiotic use but also the taking of measures in the interests of animal health and welfare?*

5. *Is enough known about the effects of the reduction of antibiotic use on animal health and welfare and about the causal links in this field, and if not, where in particular is knowledge lacking? Is further research into the effects of the reduction of antibiotic use on animal health and welfare possible and necessary, and if so, what should the focus and direction of such research be? Can existing monitoring systems contribute to this research, and to what extent do they need to be modified and/or improved to be able to make such a contribution?*

6. *What are the critical success factors in each sector for ensuring continued animal health and welfare under future antibiotic policy aimed at preventing the development and spread of antibiotic resistance in the short, medium and long term, and what factors would tend to limit or encourage success in this connection?*

7. *What are the perspectives for future action by the various actors in this field aimed at ensuring, controlling or improving animal health and welfare, and how can such perspectives be taken into account in future policy?*

2. Effects of the reduction in antibiotic use in cattle farming

2.1 Beneficial and adverse effects of reduction in antibiotic use

2.1.1 Beneficial effects

Interviewees stated that the greater involvement and knowledge of farmers and veterinarians had a marked beneficial effect. More effort is now devoted on and around the farm to preventive animal healthcare through vaccination and appropriate management and animal housing in such forms as larger boxes or separate calving stalls. More is now known about the right choice of antibiotics, new medication or appropriate dry-off management.

Interviewees further stated that the role of the veterinarian had already been shifting for many years towards a greater emphasis on the provision of information about preventive animal healthcare and the supervision of such measures. This has now been speeded up by the introduction of farm health plans and farm treatment plans drawn up jointly by farmers and veterinarians. Involvement in this process gives the veterinarian a clearer insight into the management of the farm in question, and helps him to give better advice about preventive measures.

Third-choice antibacterials are hardly ever used any more, and one benefit of this for farmers is lower expenditure on antibiotics. On the other hand, the fact that current regulations allow farmers to hold limited stocks of antibiotics to treat animals if necessary (in particular second-choice antibacterials for the treatment of mastitis) is beneficial for animal health and welfare, since it makes it possible to initiate treatment early when the chance of a cure is higher. Mastitis is painful for dairy cows, and reduces their welfare.

A slight drop in the antibiotic resistance of bacteria in dairy cattle has recently been observed (MARAN, 2015), which may perhaps be ascribed to the policy of reducing antibiotic use. The dairy farming sector is currently trying to introduce measures to make cattle more resilient, and to give them better immune competence (better resistance to disease).

2.1.2 Adverse effects

Interviewees also observed that the policy of reducing antibiotic use can have adverse consequences for animal health and welfare. It is more difficult to treat some complaints, because fewer different types of antibiotics are available. They stated that farmers and veterinarians now tend to be more reluctant to use antibiotics even when they are needed. Since the introduction of the 'Only to be administered by Veterinarians' (*Uitsluitend door Dierenarts*, UDD[4]) regulation for antibiotics, farmers are increasingly careful not to exceed the defined daily dose per animal (DDD[5]), and try to avoid the costs of mandatory use of the veterinarian's services. They tend to use a lower dose than the DDD to avoid possible sanctions, and wait longer before treating animals; this may cause diseases to persist for longer, or even make it necessary to slaughter animals that could have been cured if they had been treated in time.

Figure B1 shows a rise in the mortality trend for calves aged between three days and a year from the second half of 2007 (no data breakdown by age available within this range). Figure B2 shows that the percentage mortality trend for calves on dairy farms aged between three days and three months and for calves aged between three months and a year rose slightly in recent years – levelling off in 2012 – though the percentages involved were very low (0.61% in the first quarter of 2014 and 0.66% in the first quarter of 2015).

[4] This regulation came into force on 1 March 2014. Its full official name is: *Regeling van de Staatssecretaris van Economische Zaken van 15 augustus 2013, nr. WJZ/13031524, houdende wijziging van de Regeling diergeneesmiddelen in verband met het toepassen van antibiotica door houders van dieren* (Regulation enacted by the Minister for Agriculture on 15 August 2013, No. WJZ/13031524, concerning amendments to the Veterinary Medicines Regulation relating to the use of antibiotics by livestock owners) (Officielebekendmakingen.nl).

[5] DDD: daily dose per animal measured at the farm level. The official abbreviation is $DDDA_F$ where F stands for farm.

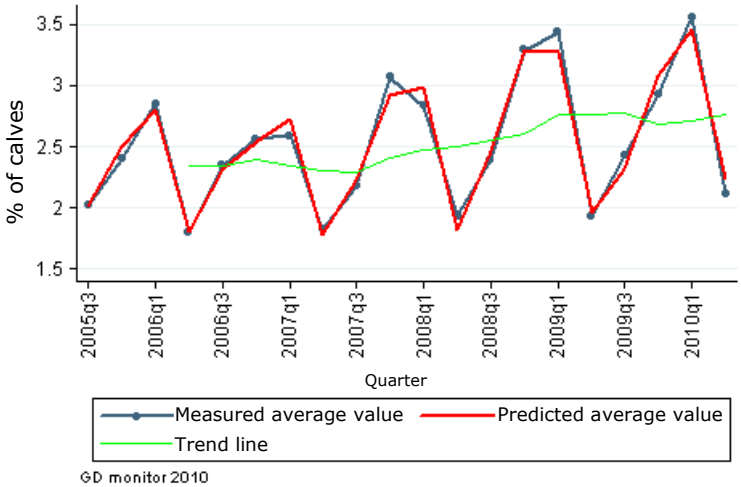


Figure B1. Percentage quarterly mortality of ear-tagged calves aged three days to a year (no further breakdown of data available) on Dutch dairy farms in the period 1 October 2005 – 30 June 2010 (Source: GD Data analysis on basis of data from I&R, Rendac and GD: GD, 2015).

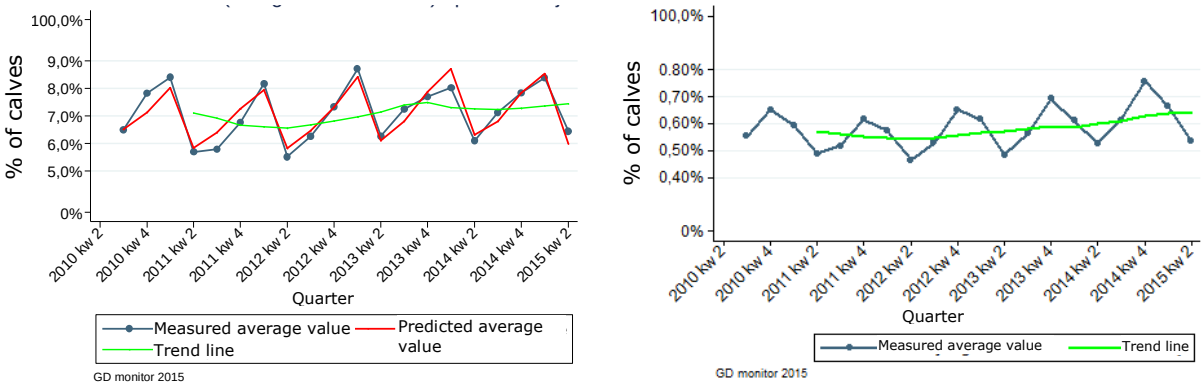


Figure B2. Percentage quarterly mortality of ear-tagged calves aged three days to three months (left-hand figure) and calves aged three months to a year (right-hand figure) on Dutch dairy farms in the period 1 July 2010 to 30 June 2015 (Source: GD Data analysis on basis of data from I&R, Rendac and GD; GD, 2015).

According to those directly involved, animal diseases were often initially treated with a first-choice antibacterial which proved not to be effective, so that a second-choice antibacterial had to be used; this procedure delayed the start of effective treatment.

Both first-choice and second-choice antibacterials often proved to be ineffective in the treatment of mastitis caused by *E. coli* bacteria (FIDIN, personal communication). Since this complaint often makes affected cows very ill, there is insufficient time for bacteriological testing with sensitivity determination before starting treatment. In such cases, veterinarians often do not dare to use third-choice antibacterials such as fluoroquinolones (Cbip-vet.be), which probably would be effective, unless the disease is life-threatening. This is because the use of third-choice antibacterials is in principle only permitted after bacteriological testing with sensitivity determination, for which there is no time in urgent cases.

Scherpenzeel et al. (2014) found a 1.7-fold increase in clinical mastitis and a significantly higher cell count (an indicator of subclinical mastitis) in the first period after calving in the udder quarters of cows with a low cell count (<150,000 cells/ml for primiparous cows and <250,000 cells/ml for multiparous cows) which had not been treated with antibiotic during dry-off. Despite the higher incidence of clinical mastitis, the quarters that had not been treated with antibiotic during dry-off showed 85% lower total antibiotic use for treatment of udder complaints than quarters that had been treated with antibiotic during dry-off.

Cows with a low cell count (less than 200,000 and no clinical mastitis in the last three months) that have been dried off with antibiotics have on average a lower cell count than cows that have not been dried off with antibiotics, though the results vary widely from one farm to another (Rajala-Schultz et al., 2011). When cows with a low cell count (<200,000 cells/ml) were selectively dried off with or without antibiotics on the basis of the results of a bacterial culture, the absence of treatment has no adverse effect on clinical mastitis (Cameron et al., 2014), cell count or milk production (Cameron et al., 2015). When cows are thoroughly screened for the presence of

mastitis, selective drying off need not have any adverse effect on udder health (Rajala-Schultz et al., 2011). The current dry-off guidelines (*Richtlijn droogzetten*) for the Netherlands states that cows with a cell count <50,000 and heifers with a cell count <150,000 must be dried off without antibiotic. These guidelines thus leave the option of treating cows with a cell count between 50,000 and 250,000 with antibiotic during dry-off, which may help to counter the increased risk of mastitis and high cell counts mentioned by Scherpenzeel et al. (2014). It is further important to ensure optimum cow management around the dry-off period, and to check what measures are possible and desirable on each farm (Mons, 2012; Rajala-Schultz et al., 2011). For example, it is important to ensure that cows are producing less than 12 litres of milk a day when they are dried off. The immune competence of the cows and the risk of infection on the farm are also relevant factors here (Mons, 2012). To sum up, it may be concluded from the above-mentioned studies and the statements by interviewees that excessively strict interpretation of the restrictions on antibiotic use during dry-off and less than optimum management of the dry-off process contribute to the adverse effects of selective dry-off with reference to the incidence of mastitis after calving.

It may be mentioned, by the way, that statistical data (Figure B3) show a slight falling trend for the mean cell count in tank milk in the Netherlands since 2008 (GD, 2015). The percentage of cows with a high cell count, and the percentage of farms where at least 25% of the cows with a high cell count before dry-off still have a high cell count after dry-off, have also been falling since 2008 (GD, 2015). This drop in the lack of recovery probably indicates that when cows are dried off with antibiotics, the curative process is retained or even slightly strengthened during the dry period. The percentage of farms with >25% new cases of mastitis in the initial phase of lactation was constant during the 2005-2013 period, but has risen since the end of 2013 (Figure B4; GD, 2015). It may be cautiously concluded from these data that the risk of infection during the dry period has risen, but that overall udder health has not deteriorated since the introduction of the policy of selective dry-off with antibiotics. However, the available data do not provide a basis for determining with any certainty whether there is a causal link between the reduction in antibiotic use and disease incidence or mortality.

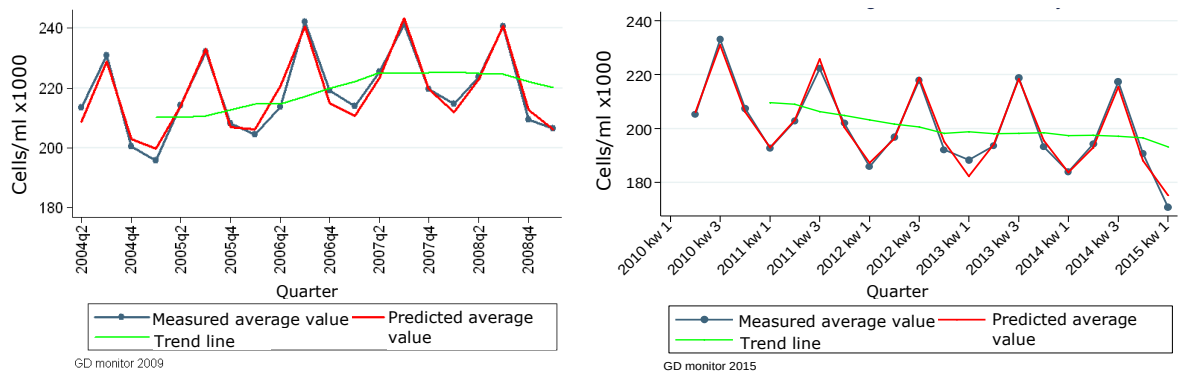


Figure B3. Mean quarterly cell count in tank milk on Dutch dairy farms in the period 1 April 2004 – 31 March 2009 (left-hand figure) and in the period 1 April 2010 – 31 March 2015 (right-hand figure) (Source: GD Data analysis on basis of data from Qlip; GD, 2015).

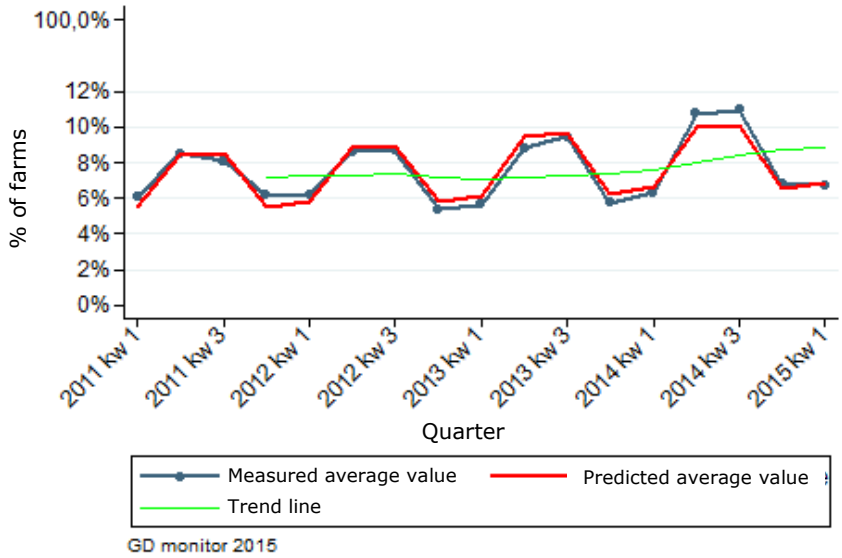


Figure B4. Percentage of farms where more than 25% of cows have mastitis again after dry-off in each quarter of the period 1 April 2010 – 31 March 2015 (kw= quarter; Source: GD Data analysis on basis of data from CRV; GD, 2015).

Dutch regulations demand that evidence of the need for second- and third-choice antibacterials must be provided before they are administered. This can take time. According to the testimony of interviewees, veterinarians consider it a challenging task to provide evidence of the urgent necessity to treat animals without delay when this is called for. It is sometimes necessary to depart from the instructions given in the product information, but this off-label use leads to an extra administrative burden and the fear of sanctions. The fact that both farmers and veterinarians may fear sanctions from the Netherlands Food and Consumer Product Safety Authority (NVWA) or quality systems can sometimes have an adverse impact on animal health and welfare. There is a risk that antibiotics or other medication may be given too late, or may not be given at all, as a result of which the animals may be ill for longer – and longer than if they received adequate treatment immediately.
Interviewees stated that veterinarians may find it difficult to collect all the farm or animal health data needed to draw up the farm health plan, for example because the farmer is reluctant to provide all the necessary information. Moreover, the veterinarian's advice is not always followed in full. This may be because the advice is difficult to put into practice, because the farmer is not completely convinced of its validity or because he regards other matters as more important. This is a point where the veterinarian needs to exercise his advisory skills to the full.

2.2 Factors influencing antibiotic use

2.2.1 Antibiotic use already low, motivation, farming skills

According to interviewees, both farmers and veterinarians may be quite sceptical about the chances of reducing antibiotic use any further. After all, antibiotic use is already low in dairy farming. The use of antibiotics on lactating cows has been associated with economic drawbacks for many years now: milk from these cows may not be delivered to dairy companies. Most of the low-hanging fruit in this field has already been picked. Further reduction in antibiotic use will demand relatively great sacrifices in other areas and will entail risks to animal health, welfare and longevity. These factors tend to weaken the motivation of stakeholders to put much effort into reducing antibiotic use further. In addition, not all farmers have the farming skills needed for this, and there are doubts as to whether further reduction in antibiotic use will actually lower antibiotic resistance on the farm.
Some farmers don't see any problem, and state that their colleagues have the same attitude. The fact that antibiotic use is already regarded as low, and that convincing evidence for the efficacy of new alternatives to antibiotics tends to be lacking, does not help either.
Interviewees further commented that the ease with which animals and animal products can be imported from abroad hinders further reduction of antibiotic use.

2.2.2 Financial position

The low price of milk at the time of writing (early 2016) makes farmers even keener to eliminate unnecessary expenses. This has an impact on measures to improve animal health and welfare: there is currently not enough scope for investment in structural measures, for example in the area of animal housing. In individual cases, farmers may prefer to have sick animals destroyed rather than devoting time and money to treating them.

2.3 Knowledge of effects of antibiotic reduction

There are still large gaps in our knowledge of the effects – both beneficial and adverse – on animal welfare of reducing antibiotic use in dairy farming. Any improvement in this situation due to monitoring and research will be good for the success of the antibiotic policy by providing extra evidence of the merits of the policy and helping to distinguish between effective and less effective measures.

For example, farmers do not yet know enough about the strength of the association between reduction in antibiotic use and lower antibiotic resistance. On the other hand, there is a lack of knowledge about the relationship between reduced antibiotic use, which can be measured in terms of the daily dose per animal, and the prevention of various animal diseases. As mentioned above, there is also still plenty of uncertainty about the mode of operation and safety of new alternatives to antibiotics and about the effects of such substances on animal health and welfare.

Animal welfare is a concept that is still difficult to measure. As a result, it is difficult to know with any certainty what effect changes in a number of key variables related to antibiotic use may have. What are the effects on animal welfare of failure to provide proper, timely treatment for pulmonary or intestinal complaints, or disorders of the claws or hooves? What are the consequences for animal health and welfare of giving antibiotics in too small quantities, for too short a time, or too late? Knowledge of the structural and incidental distribution of antibiotic use over dairy farms, and of whether heavy use of antibiotics is in response to outbreaks of disease or for some other reason, should help to answer these questions. It should be noted that much knowledge that could be used in practice is already available, but still does not reach farmers to a degree that will give them the desired higher motivation, to change their mind-set or simply to lead to more effective farm management. One example of such knowledge is the fact that completion of a course of antibiotics greatly enhances the effects on health and reduces the need for further treatment later. The role of the veterinarian as a provider of information and advice remains important.

2.4 Best practices

The 'Sustainable Dairy Chain' (*Duurzame Zuivelketen*) in the Netherlands arose from an initiative by the Dutch Dairy Organisation NZO and LTO Nederland (Land- en Tuinbouw Organisatie), the Dutch Federation of Agriculture and Horticulture, an entrepreneurial and employers' organisation. The Sustainable Dairy Chainis part of ZuivelNL (DairyNL) the organisation of the Dutch dairy supply chain. This is one example of attempts to introduce future-proof, responsible practices in the Dutch dairy sector, based on greater awareness of the need for continuous improvement of animal welfare and responsible use of antibiotics (Duurzamezuivelketen.nl[a]). Reduction in antibiotic use is one of the main aims of the Sustainable Dairy Chain, which has defined its own objectives in this field. The goal is to reduce antibiotic resistance by responsible use of antibiotics, in line with the targets of the SDa. The indicator employed here is the percentage of farms that have reached the SDa targets for antibiotic use: Sustainable Dairy Chain aimed to achieve a percentage of more than 90% here. In fact, 99% of Dutch dairy farms had reached SDa targets by 2014 (Duurzamezuivelketen.nl[b]). In addition, it is aimed at minimising the proportion of third-choice antibiotics in the entire amount of antibiotics administered (Verantwoordeveehouderij.nl). A number of projects are being developed and research is being performed to this end. One example of such a project is 'Tailor-made dry off' (*Droogstand op Maat*), a continuation of the previous WHY DRY project, which aimed to optimise dry-off strategies (in particular with reference to antibiotic use) and to make them applicable to the entire Dutch dairy farming sector (Duurzamezuivelketen.nl[c]; Verantwoordeveehouderij.nl).

The Netherlands Udder Health Centre (*Uiergezondheidscentrum Nederland*, UGCN), a project financed by the former Dairy Product Board (*Productschap Zuivel*), produced an Udder Health Handbook containing practical advice. It also set up study groups, such as the one on 'Reducing the risk of infections', where improved animal health and reduction in antibiotic use were key

themes (UGCN.nl). The UGCN developed a variety of methods that farmers could use to improve the udder health of their animals, together with various tools for critical inspection of cows, milking machines and animal housing in search of risk factors for mastitis. This project has already been terminated, and its brand label has been taken over by the Dutch Animal Health Service (*Gezondheidsdienst voor Dieren*, GD) and renamed UGA (*uiergezondheidsaanpak*, udder health approach). The UGA maintains the materials developed by the UGCN, and offers various services to Dutch farmers to improve udder health on farms (GDdiergezondheid.nl).

2.5 Can the adverse effects be overcome?

2.5.1 Management, farming skills and intervention at the farm level

Most of the measures that can be used to overcome the adverse effects of the policy of restricting antibiotic use will have to be taken at the farm level. Management and farming skills are key to success here: making more conscious choices about how to treat animals, performing the selected treatment more correctly and – once again – paying more attention to prevention. Appropriate measures here will include providing better housing and comfort for animals, and more vaccinations, and will thus tend to enhance animal welfare. Dry-off management can be optimised to limit the adverse effects of selective dry-off as much as possible (Mons, 2012; Rajala-Schultz et al., 2011). In addition, it seems likely that new alternatives for drying off cows will be appearing on the market in the near future. Such substances may for example lead to a substantial drop in milk production during dry-off, thus reducing the risk of new infection (Bach et al., 2015).

According to researchers, there are various possible ways of limiting the effects of reducing antibiotic use – or, to put it another way, of making antibiotic use less necessary (Trevisi et al., 2014). This review article indicates that antibiotic use on dairy farms can be reduced by a combination of early diagnosis of infections, diagnosis of high-risk animals and improvement of the immune competence of animals. The proposed strategy is not yet ready for implementation in practice.

2.5.2 Biosecurity

Disease prevention in animals must play a key role in any policy aimed at reducing antibiotic use and in any effective health promotion policy. Biosecurity and hygiene are extremely important in this connection. Measures in this field may include keeping unnecessary visitors and pets off farms, and providing visitors and farm workers with information on the risks of the accidental introduction of infection and ways of preventing it.

2.5.3 Measuring animal welfare

A well-defined and widely accepted method of measuring animal welfare is not so much a way of combating the adverse effects of an antibiotic policy, but rather a way of monitoring the effects of such a policy. According to interviewees, the availability of such a method is of vital importance for ensuring animal welfare. If animal welfare can be quantified and visualised through monitoring and the production of performance indicators, it can play a meaningful role in farm management and quality systems. The animal welfare monitor (*Welzijnsmonitor*), commissioned by the Ministry of Economic Affairs and developed by the faculty of Veterinary Medicine and DLV Rundvee, is now very nearly ready for use in practice, and could be employed for this purpose.

2.5.4 Incentives

Regular incentives that would motivate stakeholders are important to ensure further progress in the field of animal health and welfare, according to interviewees. Wessels et al. (2013) list regulations, education, social pressure, economic incentives and tools or technical facilities as motivating factors, which they encapsulate in the acronym RESET. Of these factors, the economic incentives deserve particular attention. This is confirmed by interviewees, who regarded the lack of such incentives as a barrier to progress in this field. This is understandable, in view of the extra attention, skills and investment needed to maintain or improve animal welfare when antibiotic use is reduced.

2.5.5 Horizontal and vertical cooperation and coordination

Cooperation within the production chain is an important factor for further reduction of antibiotic use in animal husbandry. It may be noted that such cooperation is already at quite a high level in the

dairy farming sector (unlike the case in beef farming), due to the strong influence of the processing industry. According to interviewees, the structural changes needed to improve animal welfare are impeded by a number of factors. One is the absence of the old regulatory system imposed on the various sectors of Dutch agriculture and animal husbandry due to the dissolution of the Product Boards (*Productschappen*): as a result, there is now no way of making proposed measures generally binding. This is important not only in the interests of effectiveness, but also to avoid problems due to competition at the national level. It would moreover be justified, because factors such as health and welfare undeniably represent interests of importance to the sector as a whole. The availability of ways of making proposed measures generally binding would also support the financing of research on animal health and methods of reducing antibiotic use. This applies to the beef farming sector even more than to dairy farming, where the dairy organisation ZuivelNL enjoys wide support throughout the production chain.

Animal health and welfare in the Netherlands are already at a high level compared with other countries. Farmers are quite well informed about these matters, there is an effective animal health service (*Gezondheidsdienst voor Dieren*, GD), and the quality of veterinary services is guaranteed by the *Geborgde Dierenarts* programme. The obligatory one-to-one relationship between farmer and veterinarian ensures regular exchange of information and provision of advice by the latter. The tank milk delivered by dairy farms is already subject to measurement of many health-related parameters, such as the cell count and the antibody level against various diseases, though such measurements do not cover all variables it would be useful or necessary to know about.
New knowledge at sectoral level has been developed concerning udder health (UGCN.nl) and the use of antibiotics on young calves. Newly developed instruments such as Medi-Rund, the farm treatment plan and the farm health plan support the dissemination and use of this knowledge. The drawing up of these plans are the joint responsibility of the veterinarian and the farmer who, as mentioned above, are in a one-to-one relationship, so these processes help to intensify the communication between them on health matters.
The development of awareness, preceded by the provision of good information and advice throughout the sector, are important factors in overcoming the adverse effects of the policy of restricting antibiotic use. Interviewees stressed the critical need for cooperation between the farmer, the veterinarian and others who visit farms on business as a basis for progress in the appropriate use of antibiotics, and this view was confirmed by research results. For example, Barkema et al. (2013) listed a number of activities that are needed to bring an excessive cell count under control: definition of the problem in terms of primary udder health parameters; identification of the cows giving rise to the problem; setting of short- and long-term objectives; formulation and implementation of a farm management plan, and evaluation of the results. These authors went on to state that findings and plans should always be documented so that they could be discussed during subsequent visits as a basis for evaluation and if necessary modification of the plans. Actual reduction of the cell count (if that is the objective) can only be achieved if the farmer is sufficiently motivated, the farming consultants know their job, and both parties work together on the basis of a jointly formulated plan that they both stick to. Research by Derks et al. (2013) has shown that more attention needs to be focused on the joint formulation of health objectives by the farmer and the veterinarian. Awareness of the objectives and the priorities was found to be important for communication and the following of advice. Ivemeyer et al. (2008) showed that antibiotic use on dairy farms for the treatment of mastitis fell by 32% after these farms had participated in a two-year farm health programme focusing on udder health, while cows on these farms lived longer (0.2 lactation per cow). Furthermore, udder health at farm level was significantly improved due to the motivation of the farmers and their veterinarians, and the dedication they both showed to the programme.

The results of practical trials, for example of dry-off management, and stimuli from the dairy industry (some of which may be included in the conditions for delivery of milk), all work together in the right direction, adding to awareness of the need for better animal health and welfare. Finally, the wide-ranging cooperation within the framework of the Agreement on Antibiotic Resistance in Animal Husbandry, which fostered clear communication with farmers, helped to overcome fear and ignorance of the antibiotic policy.

3. Effects of the reduction in antibiotic use in pig farming

3.1 Beneficial and adverse effects

3.1.1 Beneficial effects

According to the information received from interviewees, Dutch pig farmers are now more aware of the need for prevention, know more about it and devote more time to it. Important sources of this knowledge are the farm health plan and the farm treatment plan, in combination with the reports on the monthly visit to the farm by the veterinarian and on any investigations performed, which are to be found in the farm dossier. The available knowledge about the causes of diseases and how to prevent them is applied more. This leads to better health and vitality for the animals in question, while the farmers are more receptive to advice from the veterinarian and others who visit farms on business.

The availability of data on daily doses per animal (DDD) on individual farms increases farmers' interest in comparing their farms with others, and motivates them to think about the utility of and the need for antibiotic use and to investigate alternatives to antibiotic use.

According to interviewees, the introduction of the 'Only to be administered by Veterinarians' (*Uitsluitend door Dierenarts*, UDD) regulation has encouraged veterinarians to perform bacteriological tests more often than in the past, in order to determine the causative agents responsible for the various diseases diagnosed. This permits more effective treatment, and provides a basis for preventive measures.

The limits on the amount of antibiotics that may be kept in reserve on the farm in accordance with the terms of the above-mentioned regulation discourage unnecessary stockpiling of these substances. In addition, according to interviewees, they lead both farmers and veterinarians to think seriously about the utility of and the need for antibiotic use and about possible alternative approaches. Dutch pig farmers have also become more aware of their own health and possible health risks they may be exposed to, which represents another motive for doing their best to reduce antibiotic use.

The rules about antibiotic use stimulate communication between veterinarian and pig farmers, and hence, according to interviewees, lead to greater readiness to think about the general health situation on the farm and possible ways of improving it. The overall result is healthier livestock, lower mortality and incidence of disease, greater productivity, more job satisfaction for the farmer and farm workers and – last but not least – higher profits.

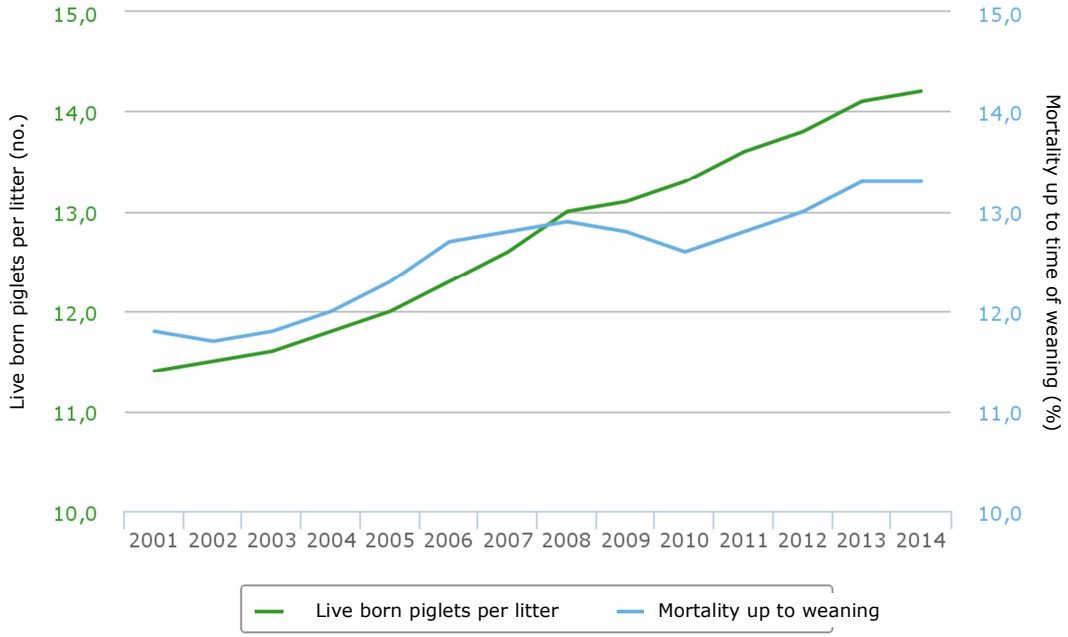
3.1.2 Adverse effects

Again according to interviewees, one of the main drawbacks of the policy of reducing antibiotic use, in this sector of Dutch animal husbandry as in others, is that both farmers and veterinarians are more reluctant to use second-choice antibiotics (third-choice antibiotics are no longer used at all in this sector) than is good for the health of the animals. They report that this often leads to delay in initiation of the proper treatment. These delays may be due to the obligation to perform bacteriological tests or to provide other evidence of the need for treatment, and/or to the need for the veterinarian to be physically present when the decision whether to treat the animals is made. This is time-consuming and expensive, and may make the pig farmer reluctant to proceed. The veterinarian, on the other hand, may be reluctant due to the weight of the responsibility for providing evidence for the use of second-choice (and third-choice) antibiotics, together with the fear of sanctions by the NVWA.

Farmers can also be too keen to reduce antibiotic use. When they withhold antibiotics from their animals for fear of raising the DDD too much, this can lead to exacerbation or further spread of the disease, which is bad for animal welfare and may actually lead to increased antibiotic use in the long run. A similar effect may be found on farms where outbreaks of disease are not adequately controlled by preventive measures such as good farm management, vaccination or early use of the right medication: the results then are higher mortality, more sick animals and more animals with chronic complaints, stunted growth and an unfavourable feed conversion ratio.

Data available since 2001 show that mean piglet mortality up to the time of weaning and the number of live born piglets per litter have been rising in recent years (12.8% and 13.3% mortality, and 13.1 and 14.2 live born piglets per litter in 2009 and 2014 respectively, with a dip in mortality in 2010) and that piglet mortality seemed to have stabilised in 2014 (Figure B5; Agrimatie.nl[a]). No association can however be established between mortality and antibiotic use here.

Apart from structural effects, interviewees also reported incidental effects of the policy restricting antibiotic use – but only during the transition between the old regime and the new, more restrictive regime. For example, pig farmers who had been used to using antibiotics as a management tool and who now had to look for alternatives by a process of trial and error might find that some of their animals were more seriously ill, because the underlying causes were not always recognised; this could have adverse consequences for animal health and welfare. Moreover, when different limiting values of the DDD were set for certain groups of animals, there was an incidental risk that a particular type of medication might be used for the wrong category of animals. However, this can only happen on farms where several categories of animals are held, and according interviewees the risk of this occurring is not substantial.
One problem that does need to be tackled urgently, according to interviewees, is that product information may be incorrect; for example, the maximum permitted dose given in the product information may be too low. In such cases, veterinarians may be forced to use the medication in question off-label.



Source: Agrovision performance indicator monitor, processed by LEI Wageningen UR

Figure B5. Number of live born piglets per litter and percentage mortality of piglets up to the time of weaning from 2001 to 2014 (Agrimatie.nl[a]).

3.2 Underlying factors influencing antibiotic use

3.2.1 Financial position and scope for investment

Management limitations, due for example to inadequate scope for investment in changes to the farms, may represent a barrier to improvements in animal health. In some cases, inadequate ventilation or overcrowded pens can increase the risk of infection and thus lead to a structural rise in antibiotic use, but the farmer cannot afford to take the necessary measures to deal effectively with the situation. In other cases, there may be practical or technical reasons that make it impossible to take the appropriate steps, independent of the farmer's management ability.
According to interviewees, the main barriers to further progress in reducing antibiotic use are economic in nature. Income and expenditure have to be kept in balance at all times on all farms, and that means that a farmer will be reluctant to spend money on something that does not yield any income, which applies to all efforts devoted to reducing antibiotic use. At present, reduction in antibiotic use and improvements in animal health and welfare are not reflected in any increase – even a slight one – in the price the farmer receives for his animals and/or products. While lower antibiotic use does yield certain financial savings, these are in general less than the expenses that have to be incurred to bring this reduction about.

3.2.2 Farming system and buildings

Since sow farms often operate on a continuous system, where all pens are never simultaneously empty, the development of strategies to combat endemic infection under such circumstances is a complicated and expensive matter. Such cases, in which one or more infections are continuously present on the farm, are characterised by regular outbreaks of certain diseases. This situation occurs frequently in the Netherlands.

The structure of the farm buildings may make it difficult to cope with these problems. In particular, the space available in the pens for weaned piglets cannot keep pace with the piglet production on many farms. This leads to overcrowding, and hence to a higher risk of infection. It is often difficult to create extra space quickly.

3.2.3 Regulations and incentives

It appears on the one hand that the limitations arising from the UDD ('Only to be administered by veterinarians') policy can have a motivating effect, especially if the farmer manages to find more or less the right balance between animal health, antibiotic use and farm results. On the other hand, farmers can feel frustrated by the rigid regime, leaving little room for manoeuvre, which they see as being imposed on them. Time is a key factor in achieving results, according to interviewees. There is a feeling throughout the entire sector that there is not enough time to do the job properly. The inflexible regime also contributes to this effect. Many farms have already reduced antibiotic use as much as they can, while the policy expects further reduction. Any attempts to go below the lower limit of what is possible in practice are sure to lead to animal welfare problems.

The absence of any rewards or recognition for farms that do well in implementing the policy does not make it any easier to achieve the reduction targets.

3.2.4 Mind-set, knowledge and information supply

It may finally be noted that a sound supply of information and knowledge is a necessary condition for effective policy implementation that is not always met. Advice from the various parties involved with the farm may be contradictory, or may in any case not always point in the same direction. It also seems that not enough knowledge generated by research reaches the parties who are influential in determining the course of events on the farm. Knowledge of the composition of the feed is often inadequate and suppliers do not seem keen to change this situation, even though this knowledge is important for promoting the health, vitality and immune competence of the animals.

According to interviewees, the mind-set, awareness and knowledge of farmers are crucial factors for achieving the desired reduction in antibiotic use and the animal health and welfare targets. It follows that farms where it is found to be difficult or impossible to bring about the necessary changes in these factors face huge challenges in attaining the results aimed at. Cooperation, together with the communication and advisory skills of the veterinarian and others who visit farms on business, can help to improve the situation.

3.3 Knowledge of effects of reduction

Since welfare is such an important issue in relation to any attempt to improve animal health and to combat disease in animals, there is a need for a clear method of measuring this quantity. Such methods will make it possible to map the consequences – both beneficial and adverse – of reducing antibiotic use on animal welfare. It is worth while making the necessary efforts to achieve the proper balance between antibiotic reduction and animal welfare.

More generally, it is desirable that as much as possible, preferably quantifiable information is made available about the consequences of the policy of reducing antibiotic use. Such information may concern, for example, the effect of reducing antibiotic use on the antibiotic resistance of bacteria in pigs, humans and the environment, or the effect of such reduction on the number of piglets of less marketable quality. There is also a need for knowledge about the transfer of antibiotic resistance genes to humans, and about the routes and vectors involved in such transfer.

In-depth knowledge is also required concerning the dynamics of certain pathogens and any zoonotic bacteria that may be present on the farm, and possible ways of combating them. The development of new vaccines and approval of their use would make a big contribution here.

Interviewees commented frequently on the effectiveness of the lists of approved antibiotics, which has a profound effect on the speed and effectiveness of the initial veterinary response to any observed infection. It would be desirable for more knowledge to be made available on the effectiveness of these lists, and in particular for action to be taken on this basis to improve the lists and make them more suitable for use in practice. The availability of quick, reliable diagnostic

methods is also important in this connection. Many unnecessary decisions to use second-choice antibiotics, with all the waste of time and frequent adverse effects on animal health they involve, could be avoided if such methods were available.
Knowledge is furthermore needed on the effects of the measures proposed within the framework of the antibiotic policy to deal with the farms that show up 'red' in the SDa's information system (the farms where antibiotic use remains above the target level and where much progress is to be made). It would also be useful to know more about the success factors that helped the farms that show up 'green' in the SDa's information system to meet their targets, about the measures they used that proved to be effective and those that did not.
In addition, more needs to be known about new substances or measures that could be used as alternatives to antibiotics, and about the effects of the composition of the mixed feed used on animal health and on the reduction in antibiotic use. This knowledge should be made available to those who use antibiotics on the farm, i.e. not only the farm manager but the other farm workers involved as well. The available literature mentions various substances that could be used as alternatives to antibiotics, but gives no clear picture of their effectiveness and safety.
Finally, it would be desirable to know more about the economic benefits and drawbacks of the antibiotic policy for the production chain as a whole. Such knowledge will motivate stakeholders, and will help to provide the basis for the implementation of the detailed approach considered necessary for further reduction of antibiotic use in future.

3.4 Best practices

The Sustainable Pork Chain (*Keten Duurzaam Varkensvlees*, KDV) foundation was created as an alliance of pig farmers, butchers, meat product manufacturers and retail companies (Duurzaamvarkensvlees.nl[a]). Its main objectives are to improve animal health and welfare and to protect the environment. The foundation has been working together with the *InnovatieNetwerk* (an agency commissioned by the Dutch Ministry of Economic Affairs to develop methods for antibiotic-free intensive animal husbandry) to reduce antibiotic use. Their ultimate joint aim is to eliminate antibiotic use entirely in this sector, with the intermediate target of achieving a mean antibiotic use of less than 1 DDD per annum by 2016 (Innovatienetwerk.org[a]). It is not stated whether this is feasible, and no details are given of how it is proposed to deal with any higher mortality and adverse effects on animal health and welfare caused by the reduction in antibiotic use. The Council would like to warn against the acceptance of higher disease incidence or mortality resulting from attempts to eliminate or achieve very low levels of antibiotic use. This would be highly undesirable in the interests of animal health and welfare. It should be noted that the Sustainable Pork Chain expects pig farmers who are members of the alliance to adhere to strict rules concerning housing, animal health, living environment and environmental care (Duurzaamvarkensvlees.nl[a]). The KDV has had an online tool since 2014 that allows pig farmers to gain an impression of how well their own farm is doing by comparing performance indicators for their farm with those of other pig farmers who belong to the KDV. A clearly designed dashboard presents readings of the farm's current performance compared with its own objectives and certain standards (Boerderij.nl[a]; Boerderij.nl[b]).
The KDV's annual report for 2014 presented the performance of its members as regards antibiotic use in terms of the daily dose per animal per annum, as shown in Figure B6.

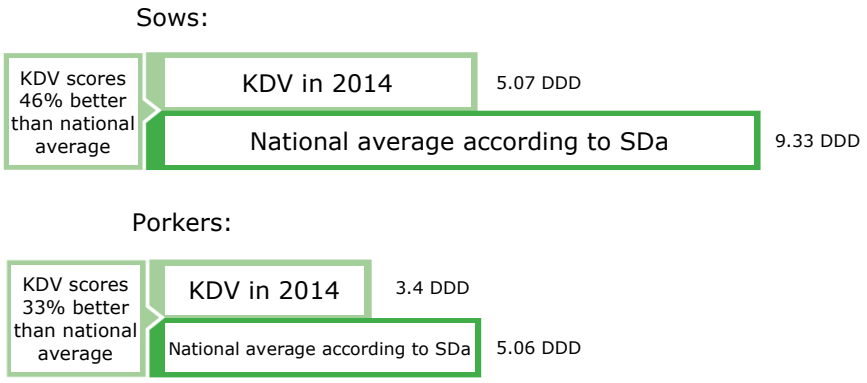


Figure B6. Results of pig farmers belonging to the KDV compared with the national average for the Netherlands as a whole in terms of the defined daily dose animal (DDD).

According to the annual report, the performance of KDV farmers in reducing antibiotic use was achieved through dissemination of knowledge gained during the joint innovation programme with the InnovatieNetwerk, individual supervision of farms and a project aimed at tackling risk factors associated with the interior climate in pig pens on individual farms (Duurzaamvarkensvlees.nl[b]). Cooperation between the *InnovatieNetwerk* and KDV has now come to an end, and the KDV is independently implementing the programme they had developed (Innovatienetwerk.org[b]).

3.5 Can the adverse effects be overcome?

3.5.1 Mind-set, management, skills and intervention at the farm level

According to interviewees, a focus on antibiotics and the compulsory farm health and treatment plans has led to the development of a new mind-set characterised by greater attention to prevention and accurate diagnosis, which has done a lot to help to deal with the adverse effects of the antibiotic policy. Proper understanding of the way to use antibiotics, with special reference to the DDD and the related benchmarks, often leads to greater awareness of the issues involved and pride in the results obtained, which in itself has a motivating effect. This is of course reinforced if it proves possible to obtain the same or even better farm performance while reducing antibiotic use, and possibly even cutting operating costs too. These outcomes will enhance the pig farmer's willingness to use antibiotics sensibly (and less), and such willingness is the basis for progress. Good results may in general be expected from alert, focused farm management with prevention as one of its main aims, including a hygiene protocol and measures to ensure good feed and animal housing, regular animal suppliers and consultation on policy issues with the breeder. The entire team working on each farm should be involved in such measures. Good training of farm workers makes a big difference, as does a knowledge of diseases and the relationship between one's own actions and the health of the animals on the farm. Awareness of the ways animal diseases can be spread, support for the idea that antibiotic use can and should be reduced, and systematic, structured work on a daily and weekly basis – these are all parts of an approach that can be expected to yield good results in terms of animal health and use of antibiotics and similar substances.

Some interviewees reported a trend towards greater use of veterinarians specialising in the treatment of pigs, which may help to counter the possible adverse effects of the policy of reducing antibiotic use. In addition, interviewees stated that vaccination or appropriate management measures can help to deal with certain infections, thus enhancing the welfare of the piglets.

3.5.2 Prevention

An increasing amount of research is being performed on possible new alternatives to antibiotics, with special reference to the preventive use of such substances. The focus group EIP-AGRI (2014) distinguishes three interrelated main approaches to the reduction of antibiotic use on pig farms.

Firstly, general improvement of animal health and welfare may be expected to reduce the need for antibiotics. This may include elimination of disease, improvement of biosecurity, management, pig handling, facilities and the training of farmers, farm workers, veterinarians and others who visit farms on business, including agricultural consultants. Biosecurity measures are expected to make a huge contribution here, according to interviewees.

The second approach is the use of alternatives to antibiotics such as vaccination, special feed tailored to the needs of the animals and breeding measures. According to interviewees, use of *Actinobacillus pleuropneumonia* (APP) vaccine, particularly on porkers, can help to prevent outbreaks of this disease (which are more likely to occur when antibiotic use is reduced), thus leading to lower mortality, better growth and less pleurisy. Alternatives to antibiotics may also include certain enzymes, amino-acids or proteins, minerals, fermented liquid feed, probiotics, other substances that can influence the immune system and acidification of feed or water to promote growth and health (Adjiri-Awere and Van Lunen, 2005). A more recent study (Jacobs et al., 2015) showed that some of the above-mentioned factors can affect the temperature and quality of drinking water and hence the water intake and health of piglets. Probiotics appeared to reduce the thickness of the biofilm in water pipes and on the wall of the pen, when added to the mixture used to clean these structures. According to Rovers (2012), no single new substance can be used to achieve the desired reduction in antibiotic use: what is needed here is a combined approach. Nutrition is important for animal health. It is important that pigs should not have too much indigestible protein in their gut, as pathogenic bacteria could grow on this. The right balance of the intestinal flora and promotion of the action of the immune system are also important. Rovers

(2012) states that these three factors contribute to the intestinal health of pigs, and can thus reduce the need for antibiotics. It may be noted that research publications do not always give clear details of the mode of action of these new alternatives to antibiotics. In view of the potential importance of these substances as means of reducing antibiotic use, a great deal of further research on this topic would be desirable.

Vaccination and management measures also offer scope for promoting the growth of pigs and the action of the immune system, and for disease prevention. Such management measures could include ensuring that the pigs get feed of the right composition and quality, fresh, clean drinking water, fresh air and good ventilation, that their housing leaves enough space to avoid overcrowding, and that the knowledge and skills of the farmer and farm workers are at the right level (Adjiri-Awere and Van Lunen, 2005). Since many of these factors are interdependent, it is also important to take an integrated approach to farm management so that production and animal health and welfare can be maintained or even improved while reducing antibiotic use. A Korean study has shown that introduction of the quite comprehensive HACCP (Hazard Analysis and Critical Control Points) system on pig farms led to less antibiotic use and more piglets born and sold per sow per annum (Cho et al., 2010). A study by Van der Fels-Klerx et al. (2011) showed the influence of the farming system: these authors demonstrated clearly that more animal movements and mixing of animals increased the risk of infection.

The third factor identified as important by EIP-AGRI (2014) is changes in the attitude, customs and behaviour of farmers, veterinarians and others who visit farms on business (such as agricultural consultants) and improved information transfer. The effect of such changes has been discussed in the previous section.

3.5.3 Image and incentives

Messages from the wider world on such issues as Methicillin Resistant *Staphylococcus Aureus* (MRSA), or public opinion concerning such matters as pig farming and the use of medication, can stimulate pig farmers to activity in this field. According to interviewees, many pig farmers are keen to have a solidly based, convincing story about their work they can tell the general public. Image is very important for pig farming, and a credible, generally accepted story about antibiotic use is a key element here. However, public acceptance of pig farming is not very high – especially in the case of big farms or farms that want to expand. Small farms have a better reputation in certain sectors of society. Not everyone realises that large-scale operations actually facilitate the investment in knowledge and facilities that make for better animal health and welfare. Finally, if deliberate implementation of a responsible health and antibiotic policy gives the farm's products added value, this could encourage further reduction in antibiotic use.

It may be stated in conclusion that interviewees were of the opinion that there are no incentives of any kind – whether it be financial rewards, or public recognition of initiatives of pig farmers in response to social pressures – for efforts to reduce antibiotic use. The lack of such incentives does not make it any easier to make progress in this field. Similarly, few facilities or support are offered those who wish to leave the sector, for example because their farm is too small to justify the necessary investment. Farmers who do manage to achieve outstanding performance cannot expect much financial or other support either. The ability to finance the changes needed to ensure the desired improvement in animal health and welfare is certainly a bottleneck, especially with the profitability of pig farming at its current level.

3.5.4 Horizontal and vertical coordination and cooperation

Good cooperation between farmers, veterinarians and others who visit farms on business must also be mentioned as one of the main factors supporting implementation of the antibiotic policy. Communication between these three parties can help to avoid fragmentation of advice, or conflict between opposing recommendations.

A shared commitment to animal health by farmers, veterinarians and other visitors to the farm such as animal and feed suppliers, hauliers and people coming to pick up animals can be a significant factor, and is more likely to arise when there is strong production-chain management. Such a shared commitment makes a big contribution to a clear, unambiguous approach to animal health and welfare, and provides a strong frame of reference for pig farmers.

A number of factors can hinder implementation of the structural changes needed in this sector. While strong production-chain management has been mentioned as a success factor, it may be stated here that lack of such strong management makes it more difficult for the desired changes to be made. This issue is not unrelated to the mentality in this sector, which often still shows signs of individualism and isolationism. The fact that the products marketed by pig farmers are almost

always anonymous in nature, and the related inability of the producers to build up a strong market presence, are barriers to progress in this field. The resources and infrastructure needed for a joint approach to marketing, research and innovation, which until recently were provided by the old Product Boards (*Productschappen*), are no longer available. A ruling making decisions of the Association of Dutch Pig Farmers (*Producentenorganisatie Varkenshouderij*) generally binding would go some way towards filling this gap.

3.5.5 Practical and financial challenges

According to interviewees, getting the necessary financing and permits for updating their animal housing and filtration systems may be a problem for many pig farmers. Support from the bank will be needed in any case. Practical and financial barriers will have to be overcome to provide heating during transport, and where international transport is involved it would be desirable to make arrangements to provide good disinfection facilities at certain designated border crossings. This has already been done in Denmark.

3.5.6 Role of the government and a level playing field

Interviewees stated that the effective implementation of an antibiotic policy would be facilitated by the presence of a system of regulations that is perceived as predictable by pig farmers, veterinarians and other interested parties. A system of regulations offering more continuity and predictability would in the opinion of interviewees make it easier to make the necessary plans and to modify these plans where this is needed to optimise results. The current system of regulations is however often regarded as unpredictable and short-term. It changes so often that plans often have to be corrected and cannot be optimised for the long term. In addition, interviewees claimed that the large number of rules stifles the introduction of innovative farming methods, while the policy of the individual Dutch provinces and the complicated procedure required to obtain the necessary permits often makes it difficult to create the conditions needed for improvement. A level playing field at the European level is vital to allow Dutch pig farmers to compete effectively in the international market. This is lacking at present.

4. Effects of the reduction in antibiotic use in the poultry sector

4.1 Beneficial and adverse effects

4.1.1 Beneficial effects

Just as in other sectors, it is assumed here that a reduction in antibiotic use leads in the long term to a drop in the antibiotic resistance of the bird pathogens involved. This can help to ensure that the necessary antibacterials will remain available and effective in situations where they are really needed. Here again, better health of the birds improves poultry welfare. Attempts to breed stronger and more resilient birds, which according to interviewees are encouraged by the policy of restricting antibiotic use, will have a similar effect. Another important outcome of this policy is a reduction in the use of second- and third-choice antibacterials, which increase the risk of the development of antibiotic resistance.

The policy of restricting antibiotic use will encourage the search for new preventive techniques throughout the poultry sector and on individual farms. This policy leads to a different attitude among poultry farmers, which has a beneficial effect in various fields. Poultry farmers are encouraged to achieve the best possible conditions for optimum production, such as the quality of the feed and the drinking water, climate control and farm management in general. They will also make higher demands on suppliers, according to interviewees.

The absence of initial antibiotic treatment under the current regime also has a beneficial effect on bird management. It is no longer possible to use such treatment as a way of disguising management errors. Farmers now have to work out their own strategy for improving the initial conditions for the chicks.

The mortality among broiler chickens raised on farms contributing to the farm information network (*Bedrijveninformatienet*) maintained by the LEI Research Institute of Wageningen UR was in any case found to drop starting in 2009 and to stabilise at an average value of 3.3% in 2014 (see Figure B7; Agrimatie.nl[b]).

Another beneficial effect is the greater involvement of the veterinarian, who has a role to play whenever birds are treated with antibiotics. This should guarantee proper diagnosis, thus providing a basis for optimum treatment.

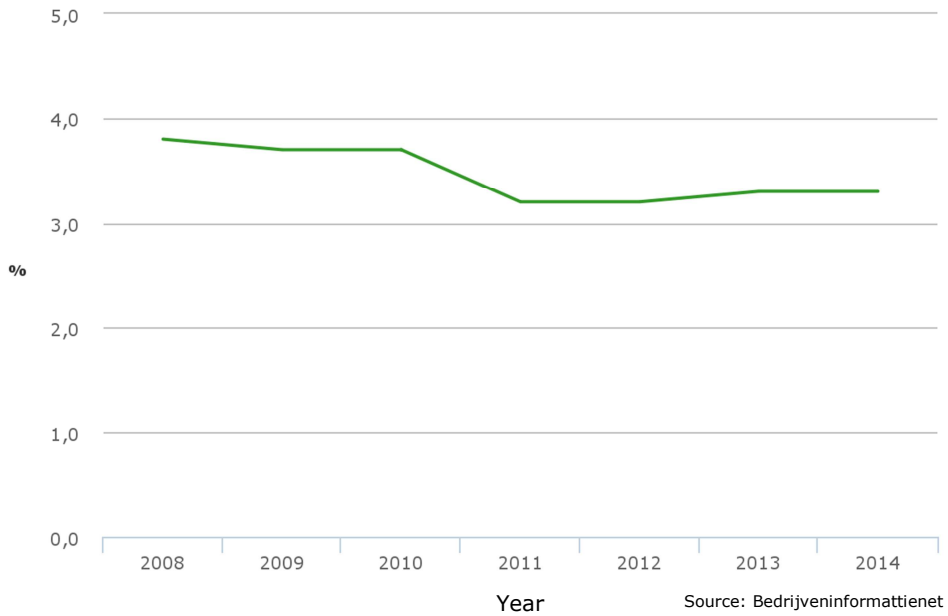


Figure B7. Percentage mortality of broiler chickens from 2008 to 2014 on farms contributing to the farm information network (*Bedrijveninformatienet*) maintained by the LEI Research Institute in Wageningen (Agrimatie.nl[b]).

4.1.2 Adverse effects

Interviewees were convinced that the current rules tend to make farmers reluctant to phone veterinarians for assistance, and that they tend to lead to initial treatment with a first-choice antibiotic, even when it is recognised that such medication is less effective than second- or third-choice antibiotics. The final result is then a slower and less adequate solution of health problems, more treatment and more time needed for the disease to clear up, and hence poorer bird welfare, more extensive spread of the disease, more antibiotic use and higher mortality. Some birds may not be treated at all in this situation, which is also bad for welfare. The adverse effects on bird health and welfare may lead to worse growth, farm efficiency and profitability. Possible consequences of delayed treatment or no treatment at all may include more leg problems, more *E. coli* infections, cellulitis, problems with digestion and poor condition of the sole of the foot.

Interviewees specifically mentioned that the inability to make preventive use of antibiotics, against Enterococci for example, may lead to mortality and higher antibiotic use, and that the absence or discontinuation of vaccinations can also increase antibiotic use in the long run. For example, Gaucher et al. (2015) found that the absence of preventive treatment with antibiotics and coccidiostats during a broiler chicken production run led to a significant rise in feed conversion, a drop in live weight at slaughter and daily weight gain, more outbreaks and subclinical cases of enteritis and an increase in litter moisture content at the end of the rearing period as a sign of gut problems. The drug-free programme was associated with higher *Clostridium perfringens* isolation rates. According to Cervantes (2015) and Paiva & McElroy (2014), antibiotics have a preventive effect against enteritis and systemic diseases in chickens. Prohibition of their use can lead to a rise in such complaints as enteritis, which has an adverse effect on bird welfare and production (growth, feed conversion and mortality) and a rise in the CO_2 footprint and production costs. Other measures such as vaccination (though completely effective, safe vaccines do not seem to be available yet), easily digestible feed, feed additives such as probiotics and phytogenics (for example essential oils from plants), reduction or avoidance of stress, and biosecurity then become more important (Cervantes, 2015; Paiva and McElroy, 2014).

It has been stated (GD, pers. comm.) that the first-choice drug against erysipelas is often ineffective. A second-choice drug may only be given after evidence of the need for treatment has been provided, which takes time; and before the evidence has been produced, the birds will suffer. This example has been documented, but there are other, more informal, reports of such problems (GD, pers. comm.). There are also fairly frequent reports of drug changes because the bacteriological test with antibiogram shows that the first-choice drug is ineffective. This may be due to antibiotic resistance, or to the fact that the antibiotic is not taken up by the tissue affected (GD, pers. comm.).

The factors reducing support for the antibiotic policy should also be included among the adverse effects. Policy measures are not adequately backed up by knowledge and practical experience, in the opinion of interviewees. Veterinarians should be given more scope for initiating antibiotic treatment quickly, on the basis of their experience and professional skills, when birds need it. Interviewees further expressed the view that current legislation cannot really ensure better animal health, especially when the feasibility of proposed measures within the framework of farm management is not taken into account.

4.2 Underlying factors influencing antibiotic use

4.2.1 Horizontal and vertical coordination and cooperation

Cooperation and integration play an important role in helping to deal with the limitations arising from reduced use of antibiotics. Key factors here are cooperation and communication between the various visitors to the farm, transparency and willingness to engage in knowledge transfer – for example, between the hatchery and the poultry farmer. Vertical integration (which, it may be mentioned, may have drawbacks as well as advantages) can also help to support the desired knowledge transfer and coordination.

4.2.2 The economy and a level playing field

The role of economic factors should not be underestimated here either, according to interviewees. It is difficult to innovate under economically challenging circumstances in the absence of a level international playing field, especially when the added value of the proposed changes is unknown or

absent. The current or expected difference between the cost price and the sales price, and hence the farmer's income, also plays a role here.

4.2.2 Availability of antibiotics and public opinion

The availability of effective first-, second- and third-choice antibiotics in a given situation may represent a bottleneck: sick animals need to be treated.

Public demands for good animal and bird welfare – as understood by society at large – and the impact these demands have on farming practices may not always lead to circumstances that are favourable for animal health. In particular, the measures that need to be taken to limit the spread of infection may sometimes conflict with the public perception of what is needed to promote livestock welfare, such as free-range housing. It is nevertheless possible to find certain measures that are good for the farmer's profits as well as livestock welfare, and also support reduced antibiotic use. The development of concepts such as 'Tomorrow's Chicken' (*Kip van Morgen*) and chickens with the *Beter Leven* (Better Life) quality label are good examples in this connection. It is often difficult, and sometimes impossible, to satisfy all the sometimes conflicting demands made by society concerning such matters as environmental care and animal welfare. An integrated approach to such issues is usually the best way to reconcile all wishes as far as possible.

4.2.3 Legislation and support

Legislation and regulations often make life difficult for farmers, especially when (as is often the case) they are not as predictable as they might be. The procedures to be gone through when applying for permits are barriers to regular modification of bird housing in the interests of optimum health and welfare. These factors weaken the support for an effective policy of reducing antibiotic use in the poultry sector, though such support is of crucial importance for ensuring further progress in this field.

4.3 Knowledge of effects of reduction

There is a lack of usable data, and the analyses and knowledge derived from such data, on the effects of reducing antibiotic use. Some of the data required do exist, but are not integrated into centrally accessible databases. There is a particular need for data that can be used to establish a causal link between reduction in antibiotic use on the one hand and livestock health and welfare on the other. Data are also needed to address concerns that the failure to initiate antibiotic treatment early, when required, may actually lead to an overall increase in antibiotic use. Further topics that need to be discussed with the aid of reliable quantitative data include the effect of the wrong choice of antibiotic to treat infections, or delay in the inception of such treatment, on the development of antibiotic resistance, and whether antibiotic use could be reduced further if the distinction between first-, second- and third-choice antibiotics was abolished.

An indicator of animal welfare that is measurable in practice would also be useful in the interests of future policy development. It could be used for example in research on the differences between individually reared animals and those reared in flocks, and those that have or have not been treated for enterococcal infections, among others, and the resulting leg afflictions.

More information, based on better evidence, is also needed about the effect of the composition of feed on bird health, and on the financial consequences of various measures aimed at promoting bird health and welfare on the farm. Further research is also required on the differences between regular antibiotic regimes and alternative systems, and on the hygienic status of litter and such devices as peck blocks, hung in poultry runs or houses to provide interest, occupation and distraction. The increased incidence of enterococcal and other infections under present conditions was mentioned above. Research into innovative ways of promoting bird health and welfare could make a big contribution to finding solutions for such bottlenecks.

Finally, further research into measures yielding economic benefits as well as promoting bird welfare and helping to reduce antibiotic use might encourage farmers to invest more in such schemes.

4.4 Best Practices

InnovatieNetwerk has investigated the possibility of developing antibiotic-free production methods for broiler chicken farming. This study included an inventory of bottlenecks on thirteen poultry farms (rearing and breeding units and broiler chicken farms) and of strategies for dealing with these problems. The following main themes were mentioned in connection with the bottlenecks:

Rearing units and broiler chicken farms
- Lameness (necrosis of the head of the femur)
- Mortality during first few days of life (yolk sac infection)
- Problems of digestion in older chicks (coccidiosis, enteritis)

Breeding units
- Bringing laying hens to peak production (peritonitis)
- Lameness (leg afflictions)
- Parasites (tapeworm infections and lice)

A plan was then drawn up for each farm, and various interventions were tested. Antibiotic use was monitored with reference to the daily dose per bird. Tests were performed on new alternatives to antibiotics such as probiotics, allicin, a special glucose-rich starter feed formulated to promote intestinal health, a modified REO virus vaccination scheme and a modified phototherapy scheme to treat leg problems. Unfortunately, few details of these tests are available and in some cases several strategies were applied at the same time, which makes it impossible to draw hard conclusions about any particular intervention (Innovatienetwerk.org[c]). A follow-up project revealed a direct relationship between antibiotic use and hygiene, the care of day-old chicks, water supply, litter and climate. Participating farmers could use the project's web portal to follow their own antibiotic use in comparison with the SDa standard and the amounts used by other groups of participating farmers. The portal also gives the top three antibiotics most used by the farmer himself and by the group, together with the indications for use (Pluimveeweb.nl).
The poultry sector has undertaken a number of initiatives to modify the housing of broiler chickens to facilitate the reduction in antibiotic use. On-farm hatching is one promising approach in this connection. This involves arranging the housing so that chickens can be hatched on the farm, and giving them an optimum start in life so that they grow up healthy and stress-free. X-Treck is a concept that permits on-farm hatching in traditional chicken houses. An alternative approach is the Patio system, which introduces a completely new accommodation lay-out (Vencomaticgroup.com). According to a study by Van de Ven (2012), on-farm hatching using this system ensured better average growth of the chicks than when they were hatched in the hatchery. These results were obtained by providing the young chicks with feed and water immediately after hatching; the actual design of the Patio system did not seem to contribute to the improvement. Vieira and Moran (1999) also found better growth in broiler chicks that were given feed and water immediately after hatching, as opposed to waiting 24 hours before feed and water is made available. Some farmers have also developed their own on-farm hatching systems.
Wageningen Livestock Research is currently investigating whether there is any difference in antibiotic use between broiler chickens that are hatched on-farm and those supplied to the farm by the hatchery (De Jong, pers. comm.).
According to data from the slaughterhouse, an average of 99.7% of broiler chickens with one star from the *Beter Leven* quality label (Beterleven.dierenbescherming.nl) currently come from flocks that are completely antibiotic-free. Figure B8 and Table B1 give details of the antibiotic use on these ('alternative') chicken farms and standard broiler chicken farms. Broiler chickens with one star from *Beter Leven* come from the Hubbard JA757 breed. They have an average growth rate of 42-45 gram a day, which is lower than standard breeds. These birds also enjoy a better living environment than conventional broiler chickens, with more space, daylight, fresh air and environmental enrichment (Welpelo, pers. comm.).
It may be noted that the wish to achieve a major reduction in antibiotic use, or even antibiotic-free operation, should never lead farmers to the attitude that higher disease incidence and mortality are acceptable. This would be highly undesirable in the interests of bird health and welfare.

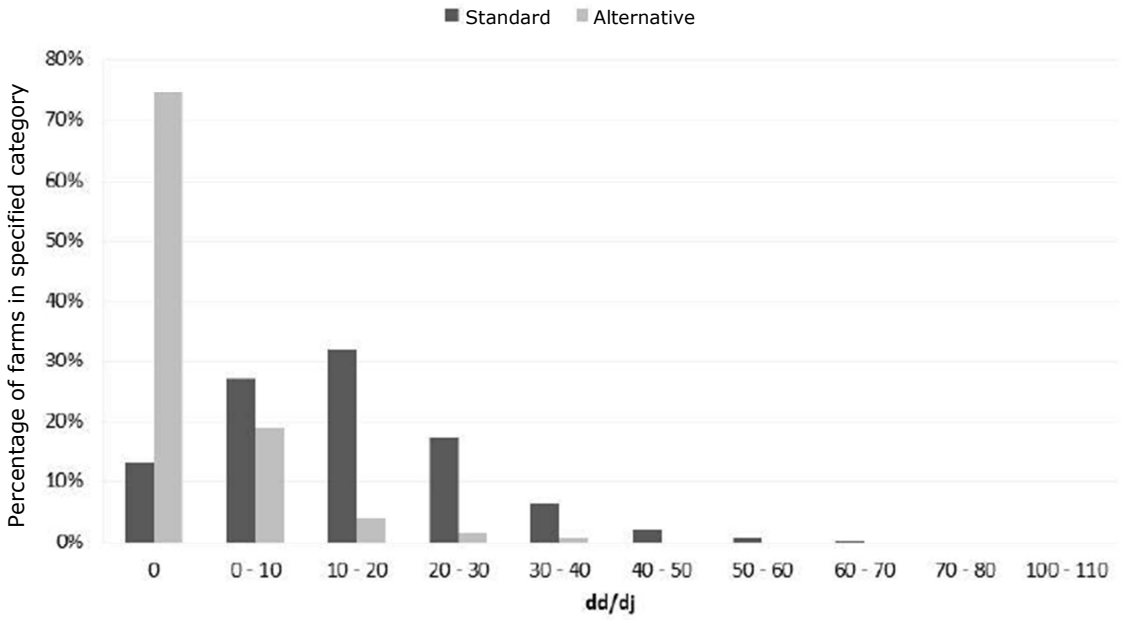


Figure B8. Defined daily dose per animal year (dd/dj) for the broiler chicken husbandry systems in 2014 (AVINED, 2015).

Table B1. Defined daily dose per animal year (dd/dj) for the broiler chicken husbandry systems in 2014 (AVINED, 2015).

Husbandry system	Dd/dj	% life days	% dd/dj = 0
Standard	15.9	95	13
Alternative	1.8	5	74

4.5 Can the adverse effects be overcome?

4.5.1 Mind-set, management skills and intervention at the farm level

The limitations arising from the current policy of restricting antibiotic use cause poultry farmers and others in their professional environment to pay more attention to other factors that can promote bird health, such as health management, improved farm management in general (including the choice of the right stocking density), better consultation with the veterinarian and hence greater accuracy in use of antibiotics, and registration of such use. The availability of benchmarks plays a role here. Breeding changes (such as selecting chickens with the right growth rate) may also be involved. Awareness among poultry farmers, veterinarians and others who visit farms on business of the vital importance of good farm management in order to ensure the right interior climate, water and feed quality and hatching system is also needed. The greater involvement of veterinarians demanded by the current system will make errors in the use of antibiotics, such as giving the wrong dose, less likely according to interviewees.

The possibility of infrared beak treatment on laying farms is crucial in the interests of hygiene and the prevention of infections – and hence also of bird welfare. The promotion and implementation of technical innovations, such as the new hatching systems with immediate availability of feed and water mentioned in section 4.4, is also of considerable value for the further improvement of bird health and welfare.

Various aspects of farm management need to be taken into account if further progress is to be made in reducing antibiotic use. These include compliance with the basic principles of broiler chicken management, the 'ABC approach' (Innovatienetwerk.org[d]), cleaning and preheating chicken sheds and care of day-old chicks. Poultry housing in general and feed quality also require attention.

Changes in the mentality and behaviour of poultry farmers can also do a lot to overcome the adverse effects of the antibiotic policy. Greater awareness of the importance of reducing antibiotic use and hence of health management, improved farm management in general, better communication with the veterinarian, better registration of drug use and the availability of benchmarks are factors that play a role here.

4.5.2 Prevention and treatment

Biosecurity measures help to reduce bacterial infection in livestock such as *Campylobacter* infection on poultry farms, though biosecurity measures alone are not enough (Pasquali et al., 2011). A study by Lin (2009) suggests that there are three main approaches to the prevention of infection by such organisms as *Campylobacter*. The first option is to reduce the risk of infection by generic biosecurity measures such as hygiene or physical barriers, and by specific measures such as only holding one species on a given farm and partial depopulation. It can however be to difficult to check whether these measures are effective, and it may be difficult to implement them in free-range farming. There is a need for study of the practical feasibility and costs of such methods. More attention needs to be paid to the reception of visitors on farms, for example, in the interests of hygiene. According to interviewees, there is a similar need for more measures to prevent the spread of infections from human healthcare, for example via wastewater from hospitals.

The second option is to raise the immune competence of poultry. One possible way of doing this is with the aid of probiotics, but it appears that success is not always guaranteed when this method is used to combat *Campylobacter* infections. Further research is needed in this field. Vaccination is a theoretical possibility, but no completely effective vaccine is available here (Lin, 2009). Genetic selection might also be used to this end, but more needs to be known about the interaction between *Campylobacter* and the chicken before this could be put into practice. It has been found to be useful to perform intake monitoring on broiler chicken farms, where tests are performed on individual incoming chicks, chosen at random, during the first few days of their life and the results used to improve the care of the chicks – for example by heating the chicken houses better and keeping the floors warmer. The provision of feed and water for day-old chicks while they are still in the hatchery has also been found to help.

The third option is the use of new alternatives to antibiotics for the treatment of diseases in birds. These may include bacteriophages (viruses that can infect and kill bacteria) and bacteriocins (antimicrobial peptides produced by bacteria). The former may still involve the risk of resistance; the latter, however, seem to be show great promise for clearing up *Campylobacter* infection in chickens (Lin, 2009; Pasquali et al., 2011).

4.5.3 Incentives

Some factors can influence the financial position of poultry farmers and the support for their activities on the market. Since farmers in this sector often have to operate on a very tight margin, they will in the opinion of interviewees pay close attention to measures that may have raise or lower their earning capacity. Any changes that have to be financed from the farmer's operating profits demanded by elements within society who do not wish to bear any financial burden in this connection will not be greeted warmly by farmers. If on the other hand funds are available for the study and development of the necessary innovations, or the farmers' efforts are supported by market incentives, this may speed up the renewal process.

Finally, farmers will be more motivated to work for reduction in antibiotic use if their efforts are rewarded financially and through public recognition – in other words, if the farmers get a better price for products that are perceived to be healthier.

4.5.4 Horizontal and vertical coordination and cooperation

Cooperation and transparency in the production chain represent a critical success factor in poultry farming. This includes coordination between the various visitors to the farm and the exchange of information, especially between the hatchery and the chicken farmer but also between other links in the chain. A relationship of trust between the veterinarian and the farmer is of critical importance here, since it is the interaction between these two that determines the main operating results in the first instance. Vertical transparency should also be aimed at. Some conflicts of interest may have to be overcome; for example, hatcheries may not always be keen to pass on all the information needed by the chicken farms that receive their chicks.

4.5.5 Role of the government and a level playing field

Factors that determine competition at the European level also have an important impact on the market orientation of Dutch poultry farmers. After all, antibiotic resistance is not a purely Dutch issue. It follows that measures to reduce antibiotic use deserve a Europe-wide approach. This would also help to ensure that the competitive position of Dutch poultry farmers is not unduly disadvantaged by Dutch government policy. Active and successful efforts to achieve such a level

playing field in Europe will make Dutch poultry farmers much more willing to support a policy of reducing antibiotic use.

Finally, interviewees pointed out that in their opinion the many barriers to innovation and change among poultry farmers thrown up by Dutch legislation and regulations hinder progress in improving poultry health and welfare. One example of this is the complex, time-consuming application procedure for the permits required for any modification or extension of the farm.

5 Effects of the reduction in antibiotic use in veal farming

5.1 Beneficial and adverse effects

5.1.1 Beneficial effects

A significant beneficial effect of the policy of restricting antibiotic use that may be observed in the calf rearing sector is increased attention to animal health in general, and prevention in particular. This applies not only to veal farmers but also to veterinarians and other stakeholders. There has been a major change in attitude, with much more stress being placed on preventive healthcare, where the farm health plan and the one-to-one relationship between the farmer and the veterinarian play an important role. There seems to be a tendency to avoid antibiotic use on all fronts, including the treatment of digestive problems, which can now be well controlled by other means. Salmonellosis can now also be detected more quickly and more reliably.

The increased attention to animal health among veal farmers is reflected for example in various aspects of farm management, animal housing (including ventilation) and nutrition. Structural investments are being made in preventive measures at farm level, as may be seen from the ten-point plan for the veal sector (*Tienpuntenplan Kalversector*) (Dekalverhouder.nl). A health protocol for the initial assessment of young calves has been introduced at reception centres to ensure that sick animals are no longer passed on to veal farmers. Furthermore, both farmers and veterinarians are definitely making better use of antibiotics, with greater awareness of the issues involved. In general, the gatekeeping role of the veterinarian is becoming more clearly defined and is gaining greater recognition; this has the additional advantage of ensuring greater insight into the health situation on veal farms.

Cooperation with the dairy farmers and cattle dealers who deliver the young calves to the veal farmers is also important. This is gradually leading to greater attention to the need to deliver healthy young calves that have had adequate colostrum intake. Projects aimed at 'optimum performance at the start of the production chain' such as *IBR-BVD-vrij* (aimed at eliminating infectious bovine rhinotracheitis – IBR – and bovine viral diarrhoea – BVD – from young calves) and *Gezond en Vitaal Kalf* (Healthy, vital calves) illustrate the good work being done in this field. The overall objective here is to ensure the delivery of high-quality calves to the veal farmer, by measures that include providing good conditions for the animals during transport and reception.

5.1.2 Adverse effects

It should also be noted that reducing antibiotic use can also have an adverse effect on calf health in a number of respects. For example, veterinarians and farmers may be reluctant to use antibiotics for fear of sanctions from the NVWA; this may cause the treatment of sick animals to be delayed or even omitted, and may ultimately lead to higher overall antibiotic use. In addition, some undesirable effects on animal health may be directly ascribed to the reduction in antibiotic use. For example, data relating to this sector for the period starting in 2012 indicate the recurrence of salmonella outbreaks on veal farms where such outbreaks seemed to have become a thing of the past. The percentage of salmonella outbreaks among calves raised by contract veal farmers in the Netherlands has risen from zero to about 10%, though no outbreaks were reported by their counterparts in Belgium, France and Italy. Data are available on this trend starting in 2013. These salmonella outbreaks were associated with higher calf mortality and greater overall antibiotic use. It is not yet possible to draw any conclusions about a possible causal link, but these data do indicate that the salmonella outbreaks may have caused a rise in mortality and in antibiotic use. The data indicate further that salmonella outbreaks occur more often in pens where most calves come from the Netherlands, and less often in pens where most calves come from other countries.

The data on salmonella outbreaks relate to a large number of Dutch veal pens, where calves were raised on a contract basis, nearly always operating on an 'all-in, all-out' principle. The age of the calves at the time when the outbreaks occurred was variable. The percentage of all contract pens where confirmed salmonella outbreaks were reported was 9.5% in 2013, 9.7 % in 2014 and 7.2% in 2015.

Figures from one of the big Dutch veterinary practices specialising in calves confirm that salmonella outbreaks occurred more often in pens where most of the calves came from the Netherlands than in pens where most of the calves came from other countries (DAP Thewi, pers. comm.). The number of outbreaks reported here peaked in the autumn. Similar reports were made by another veterinary practice specialising in calves (DAP VUG, pers. comm.), which found salmonella

outbreaks in newborn calves; these outbreaks were less intense half-way through the rearing period, and most intense towards the end of this period.
The recurrence of salmonella outbreaks is probably not due to failure to control flies and other pests or to keep birds away. The veal farming sector is dealing with such issues with increasing thoroughness, professionalism and attendance to protocol, which should lead to fewer outbreaks, not more. It seems likely that changes in the antibiotic policy were to blame for the increase. Three factors seem to be particularly relevant here: 1) the usual practice was to start calves on colistin for ten days; 2) Baytril was used freely for the treatment of individual young calves suffering from diarrhoea, and 3) marbofloxacin was used quite often to treat older calves, in view of the waiting period and the single-dose administration. The first two factors may have had a preventive effect. The third allowed farmers to treat sick calves quickly and effectively near the end of the rearing period, and may thus have had the incidental effect of avoiding an extensive outbreak. There are however well-based reasons not to use these drugs thoughtlessly, so alternative ways of dealing with this problem will have to be found. In any case, the recurrence of these salmonella infections is very worrying.

According to interviewees, data also show that the number of calves in the Netherlands with marked (15% - 30% below target) and severe (> 30% below target) growth retardation rose in the 2009 – 2015 period. There was also a structural rise in the lung scores and the incidence of pleurisy. Dorado-García et al. (2015) found a significant rise in mortality in a group of Dutch veal farms in the period 2009-2012. This rise was greatest on the farms where the doses of antibiotics administered fell most, but the relationship between rising mortality and falling antibiotic use was not statistically significant in this study. Data from the farming community indicate an upward trend in veal calf mortality in the 2007-2013 period, followed by a slight drop starting in 2014 (see Figure B9). This figure also shows a drop in antibiotic use in the same period. This does not mean, however, that there is necessarily a causal link between these two trends.

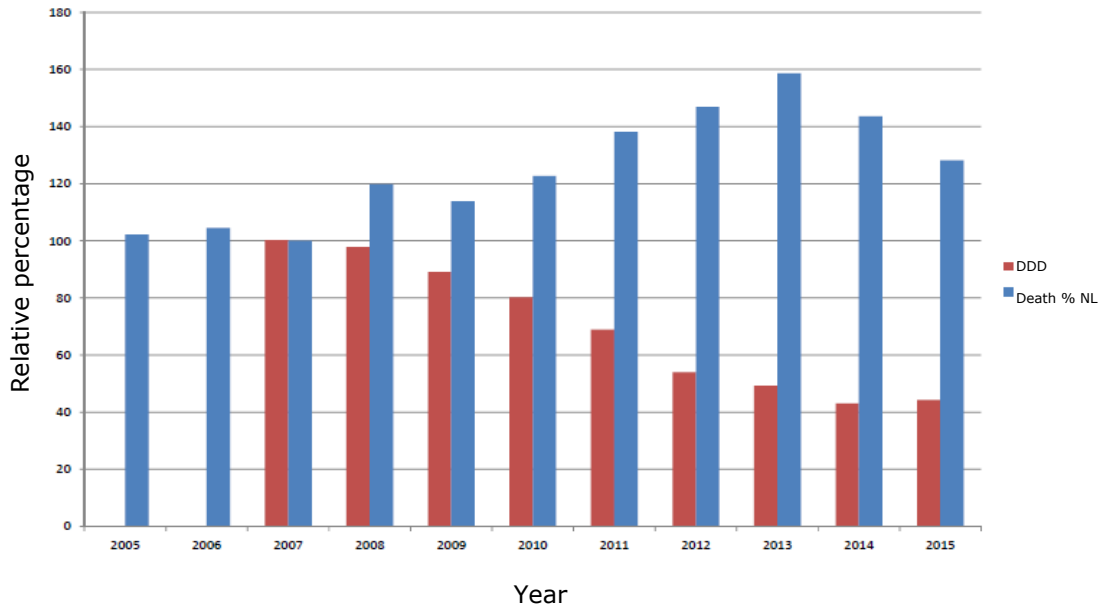


Figure B9. Annual index (for isolated herds, 2007 = 100) based on data from the farming community on daily dose (DDD, red bars) and mortality in the pen (Death % NL, blue bars) of calves suffering from bloat.

The current antibiotic policy also has other adverse effects. For example, the rules for use of first-choice, second-choice and third-choice antibiotics (the last-mentioned being hardly ever used in practice) are regarded as too rigid, especially in combination with the enforcement measures undertaken by the NVWA. This may cause the appropriate treatment to be delayed, as a result of which the infection can spread further and animals that are already infected may not recover as well – or may succumb to the disease – which has an adverse effect on animal welfare. Treatment of an entire herd is often delayed until all animals in the herd are sick. The disease may then be so far advanced in some animals that treatment is less effective and more animals are left with chronic complaints or remain stunted in growth.

Veterinarians are regularly torn between the reluctance to use antibiotics – especially second-choice ones – and the knowledge that these second-choice antibiotics are exactly what is needed because there are no first-choice antibiotics that will do the job. Another problem in this connection is the large amount of paperwork needed to provide the written justification of the use of the second-choice antibiotics required by the NVWA.
It would seem that the above-mentioned increase in mortality is due to the abruptness with which the policy of restricting antibiotic use was introduced. Veal farmers, veterinarians and other persons involved were given no time and no room for manoeuvre to adjust to the new, rigid protocol and to find an appropriate way to use antibiotics effectively within the new regulatory framework. This put everyone involved under a certain amount of stress, and tended to lead to use of drugs that were less than ideal for the intended purpose. This effect seems to have worn off slightly during the past two years, and the mortality rate has dropped again towards the value found in 2007 when the policy was first introduced. It may be forcefully suggested on the basis of the above facts that veal farmers and the other members of the production chain should be given more time in future to come to terms with proposed changes in the antibiotic policy.

5.2 Underlying factors influencing antibiotic use

5.2.1 Horizontal and vertical coordination and cooperation

Veal farmers will have to cooperate closely with dairy farmers and cattle dealers to make further reduction in antibiotic use possible. While some advances in this direction had been made under the current policy, there is still a long way to go. For example, much more has to be done to ensure that all calves delivered to the veal farmer have been given enough high-quality colostrum, and that they are accompanied by timely, complete information. It is further known that vaccination of cows before they calve leads to better health of their offspring; but this involves asking dairy farmers to incur expenses from which they themselves do not reap the benefits, which makes such a scheme difficult to promote. The fact that consultation is already underway between the dairy industry, dairy farmers and veal farmers to determine the points where cooperation is required and ways of bringing it about is to be welcomed.

5.2.2 Rising burden of disease, timely diagnosis and treatment

Further reduction of antibiotic use is hampered by the rising burden of disease, including a higher incidence of chronic lung problems due to *Pasteurella multocida*, mycoplasma and more salmonella outbreaks, and the lack of scope for real-time diagnosis of pulmonary complaints. Failure to make the initial diagnosis in time may mean that any treatment given to individual calves is too late, and hence ineffective. This can cause the infection to spread through the whole herd, making it necessary for the farmer and the veterinarian to treat at least part the herd for the infection in question.

5.2.3 Prevention

The lack of enough effective, affordable vaccines is a crucial problem in the field of infection control. If such vaccines were available, much infection could be avoided and there would then be no need to use antibiotics or other means to deal with it.
In the final analysis, the need to learn how to adopt a new management style focusing more on health and prevention is a barrier to progress in the desired further reduction of antibiotic use. The various visitors to the farm often know a lot about the necessary farm management, but this knowledge is not always passed on sufficiently.

5.2.4 Financial position and incentives

Measures aimed at maintaining or improving calf health and welfare may be hampered by the same kind of factors as those encountered in other sectors of Dutch animal husbandry. Such measures are sometimes regarded as too expensive, while the cost price of the calves has to remain as low as possible in order to allow Dutch farmers to compete at an international level. Moreover, in many cases farmers simply cannot afford to make the necessary investments. The measures in question often require extra work, but adequate human resources may not be available to get the job done or it may be impossible to pay for the labour demanded. Besides, there are no incentives or rewards to compensate farmers for the financial burdens they are asked to shoulder. This reduces their motivation to undertake the measures, even if they realise how useful and necessary they may be.

5.2.5 Differences between farms

There are big differences between the animal health and welfare measures taken on different veal farms – so much so that it could be said that there are 2,000 different farm situations in the Netherlands. This makes it difficult to give any general or widely applicable advice.

5.2.6 Regulations

The rate at which antibiotic use has had to be reduced so far is seen by many in, and associated with, the veal farming sector as bad for confidence in the government and the aims of the antibiotic reduction policy. It is also regarded as increasing the workload of those concerned (in particular because of all the paperwork required to justify the use of second-choice antibiotics) and as being bad for animal welfare (because delay in the use of second-choice antibiotics may lead not only to higher antibiotic use in the long run but also to animals being ill for longer).

5.3 Knowledge of effects of reduction

It may be noted that there is a lack of knowledge about the effects of reducing antibiotic use in many areas, including animal health and welfare, the effects on antibiotic resistance in humans and animals, and the effect on concrete infectious diseases such as salmonellosis. For example, the knowledge available at present does not allow conclusions to be drawn about the relationship between the reduction in antibiotic use in calf rearing and a drop in antibiotic resistance in calves. The ability to make such a pronouncement would enhance farmers' motivation to reduce antibiotic use even more. The introduction of a central database containing the results of bacteriological and sensitivity tests would help in this connection, as it would facilitate the comparison of different bacteria and the antibiotics to which they are or are not sensitive and thus provide a basis for deciding which treatment to use in specific situations.
There is also a lack of quantitative data on management styles on different veal farms and their impact on animal health. Such information might permit the development of an early warning system using digital techniques to alert farmers in advance to the possibility of impending infections. It could also serve to permit comparison of individual and herd-based treatment for various complaints.

The lack of effective vaccines and vaccination protocols, for example against salmonella infections, also hampers further reduction in antibiotic use. Development of the knowledge needed to produce such vaccines should therefore be given a high priority. There is also a need for fast, reliable diagnostic methods to minimise incorrect prescription of first- or second-choice antibiotics, and for methods providing quantifiable information on the relationship between reduced antibiotic use and animal welfare. Both farmers and those visiting the farm on business need to have a basic knowledge of physiology, together with a good insight into when to use first-choice and when to use second-choice antibiotics. They should also have a good understanding of the relationship between reduced antibiotic use and the recurrence of salmonella infections.

5.4 Best practices

One case where a best practice is needed in the veal calf sector is for the delivery of calves that are as healthy as possible by dairy farmers to veal farmers. To encourage this, a supplier of nutritional supplements for calves set up the *4 better V* scheme in 2013, where 'V' stands for *vaak, vlug, veel* and *vers* in Dutch (or frequent, fast, plentiful and fresh in English) – four desired characteristics of an optimum colostrum intake for young calves. About a hundred farms took part in this scheme in 2014. Dairy farmers were rewarded financially to motivate them to look after their calves better, in the hope that this would avoid health problems and make it unnecessary to use antibiotics further down the production chain. The calves delivered to veal farmers were monitored in cooperation with a veal producer, and the mortality among the calves was recorded. Participating farmers were given a bonus for each calf as long as the mortality among their calves remained lower than 3% (Vandriegroup.nl). The scheme was a success, according to the supplier of nutritional supplements: the mortality rate has fallen slowly. The scheme was continued in 2015.
Transport can be a challenge to calf health and welfare. A number of trials of 'comfort class' calf trucks have been performed in an attempt to improve the situation. The interior climate of these trucks is fully controllable (Vandriegroup.nl). The calves can stand or lie on straw, and feed and drink is provided throughout the trip. A closed-circuit camera system is used to monitor the calves in the truck. These trials have shown that calves arrive at the veal farm in better physical condition

after 'comfort class' transport, and mortality during the next 56 days is lower than with conventional transport. It may be noted in this connection that a tendency has been observed for Dutch veal farmers to source their calves from the Netherlands or nearby countries such as Germany, Denmark, Belgium and Luxembourg rather than from more distant countries in Eastern Europe. This has the double advantage of reducing the transport distance (which is good for calf welfare) and reducing the risk of introducing infectious or other diseases.
The guaranteed tracing system set up by the Quality Guarantee Foundation of the Dutch Veal Calf Sector (*Garantiesysteem tracering van de Stichting Kwaliteitsgarantie Vleeskalversector*, GTSKV), which covers about 95% of all Dutch veal farmers, plays an important role in preventing disease and ensuring the welfare of imported newborn calves. This system, which has the primary objective of making it possible to trace all animals that might be involved in outbreaks of disease, also permits monitoring of compliance with various important transport requirements, such as quarantine requirements, prior reporting of transport movements and the requirement that all calves in a single truck must have come from the same country, and are not allowed to be unloaded or selected en route. The participating farms can be fined if they fail to meet these requirements. Animal health in the various EU Member States is continuously monitored in cooperation with other organisations such as the Dutch Animal Health Service (*Gezondheidsdienst voor Dieren*), the Dutch Dairy Organisation (*Nederlandse Zuivelorganisatie*) and the Dutch Federation of Agriculture and Horticulture (*Land- en Tuinbouworganisatie (LTO) Nederland*). A 'traffic-light' model based on inventory of the relevant risks allows calf transport to be regulated with the aid of various restrictive measures, such as changes in the regulations governing which veterinary drugs may be used to treat specific diseases (used for example in connection with an outbreak of BVD in Germany) and import bans (used for example in connection with an outbreak of TB in England and an outbreak of bluetongue in Romania). Such restrictive measures are applied throughout the production chain.

5.5 Can the adverse effects be overcome?

5.5.1 Mind-set, management skills and intervention at the farm level

As in other sectors, changes in the mind-set of farmers and their motivation to build up knowledge and practical experience of prevention play an important role in overcoming the adverse effects of the policy of reducing antibiotic use. The new regime has set in motion a learning process that, as may be judged from the results presented in the Cattle Monitor (*Rundermonitor*; GD, 2015), gradually led to the slight drop in mortality already mentioned in the previous section.
Greater attention is now being paid to antibiotic use, which is no longer seen as quite so self-evident.
Another decisive factor is the dairy farmer's attitude to the care of newborn calves. Prevention of lung problems is one of the matters that should start at the farm delivering the young calves, and in general this is the place where the conditions for immune competence and the health of the calf to be delivered can be created. More awareness of the need for good hygiene is also desirable. The rate at which a farm and its various divisions are filled with animals and the quality of feed and housing are factors that play a role here.
A further condition for success is adequate, sensible use of veterinary drugs. The farming skills of the veal farmer, and his willingness to accept advice from the veterinarian, also play an important role.
However, in the opinion of interviewees the undue haste with which new, rigid regulations were implemented tended to slow down rather than to speed up the introduction of the structural changes required on various farms. It should be noted in this connection that not all veal farmers welcomed the changes to be made, and they are not alone in this attitude: switching to a new, unknown regime, especially when such changes are made compulsory, can often meet with resistance. Even though changes are being made, as noted above, there is still definitely a need to pay attention to the behaviour, attitude and motivation of veal farmers.
Trying to make antibiotic use as low as possible, as reflected in a minimum DDD – an approach that is encouraged to a certain extent by the current policy – can sometimes be counterproductive. Delay in providing the right treatment causes animals to remain ill for longer and increases the risk that they may infect other animals. Conversely, quick diagnosis and adequate treatment help to limit the duration of the disease and the infection level as much as possible.

5.5.2 Prevention

Among all possible measures that could be taken, prevention makes the biggest contribution to further reduction in antibiotic use. One important preventive measure is the check on incoming animals by the farm's regular veterinarian. The farm health plan and the farm treatment plan are drawn up jointly by the farmer and the veterinarian on the basis of the condition of the new batch of calves and the experience gained during the previous cycle. Benchmarking with the aid of data provided by InfoKalf (Infokalf.portaal.skv.info) has led to greater awareness of the issues involved, thus laying a basis for greater readiness to undertake preventive measures.

Wider adoption of the 'all-in, all-out' system of animal management and keeping pens empty for at least a week between occupation rounds can help to enhance prevention. It would also be good for prevention, and for calf welfare in general, if the number of starter farms, where calves are kept for about twelve weeks before being passed on to regular veal farms, were to be limited or if such starter farms were to be completely abolished.

Farms rearing calves for the production of rose veal seem to be increasingly motivated to use vaccination, which appears to make a slight contribution to reducing antibiotic use on most veal farms. These farms are also increasingly adopting the approach of grouping younger calves together on the farm and stricter separation of different age groups.

According to Mohler et al. (2009), comprehensive preventive strategies (aimed at optimising immunity by a good supply of colostrum, or provision of good feed containing milk and roughage and a comfortable environment) can be used to avoid salmonella outbreaks. These authors state further that vaccination can boost immunity against specific diseases, but few vaccines are available in the Netherlands that are suitable for use on young calves. There is a risk of infection from infected colostrum, milk, materials, personnel and fertiliser. This risk can be minimised by biosecurity measures as part of environmental management, leading to fewer cases of salmonellosis, lower mortality, less drug use, lower labour costs and better growth of the calves.

5.5.3 Horizontal and vertical coordination and cooperation

Cooperation with the dairy farmers supplying young calves is essential if antibiotic use is to be reduced further. The same may be said of measures aimed at protecting animal health and welfare. Better animal health in dairy farming, for example by effective measures against BVD, salmonellosis and IBR, and adequate, timely provision of high-quality colostrum to calves makes a direct contribution to better animal health in veal farming. However, not all dairy farmers and cattle dealers are keen to cooperate. Dairy farmers tend to focus their management plans on achieving optimum milk yield; the health of the young calves they produce is a secondary issue, since this makes no visible contribution to their earnings. Cattle dealers set no great price on transparency in the production chain, which is of such great important for health purposes.

Knowledge transfer, both between farmers, veterinarians and others who visit farms on business and between dairy farmers and veal farmers, also plays an important role. The information involved in the latter case concerns mainly the health of the calves and their mothers, together with details of the bull selected for breeding (in order to ensure more resilient, stronger calves), nutrition, feed deliveries etc. Cattle dealers should also be involved in the attempts to achieve greater transparency.

Knowledge transfer on matters such as the rations allotted to calves, ventilation and other aspects of animal management, together with more structured supervision of preventive measures, are also important.

5.5.4 Economics, incentives and a level playing field

Considerations relating to the economics and continuity of farming activities, which are naturally of great concern to farmers, must not be forgotten when the factors limiting the reduction of antibiotic use are listed.

It costs dairy farmers money to deliver a strong, healthy calf. Investments in better pens and good ventilation represent costs for the veal farmer, as do earlier and more frequent consultations with the veterinarian. All these extra operational costs, which it is hoped will lead to better health for the calves though there is not always scientific evidence to back this up, influence the cost price of the product and hence the international competitiveness of the veal farmers, and may make it harder to achieve the level playing field that is so important for all of them.

5.5.5 Role of the government

It is also important in order to limit the adverse effects of the policy of reducing antibiotic use that experience should be gained with alternative management methods that might prove useful to farmers, and that a new balance is established that will be compatible with the antibiotic policy. In the opinion of the interviewees, farmers must be given enough time to adjust to the new rules and prohibitions, and to adapt their management methods to them.

Hasty introduction of new, rigid objectives that have not yet been tested in practice can easily lead farmers to make decisions that turn out in the long run to be counter to the real interests of the policy. This effect is reinforced by the natural resistance often evoked among farmers when policy objectives are imposed on them.

Colophon

Members of the expert committee charged with preparing this advisory report

This document represents the view of the entire Council on Animal Affairs. It was prepared by an expert committee chaired by Prof. J.A. Stegeman, with Dr F.L.B. Meijboom, Prof. F. van Knapen, Prof. L.J. Hellebrekers, Prof. M.C.M. de Jong, P.J. Vingerling, H.W.A. Swinkels and A.J.M. van Hoof as the other members. Prof. D.J. Mevius and Prof. Y.H. Schukken were added to the expert committee at the request of the RDA. Dr T.C.W. Ploegaert acted as secretary of the expert committee.

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