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Economics of antibiotic usage on Dutch farms

The impact of antibiotic reduction on economic results of pig and broiler farms in the Netherlands

Summary

Reduction in antibiotic usage did not lead to a weaker competitive position of Dutch farmers.

- The reduction in antibiotic usage on broiler and pig farms in the Netherlands from 2009 to 2017 did not result in a deviation from the long-term trend in average production and economic results in these sectors.
- To improve animal health, which made a reduction in antibiotic usage possible, farmers used a variety of relatively easy and cheap measures, such as more attention to hygiene, use of pain killers and anti-inflammatory agents or more preventive vaccinations.
- International cost competitiveness of Dutch broiler and pig farms was not hampered by the reduction in antibiotic usage. The deterioration of the cost competitiveness in especially sow farms was caused by other factors, e.g. an increase of environmental costs.

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Antimicrobial resistance (AMR) is one of the most serious public health crises today, as governments, leading medical and public health organisations around the world agree.[1] Therefore, worldwide initiatives are taken and action plans are developed to reduce AMR both at national and international level.[2]

In the Netherlands usage of antibiotics in livestock production has already been substantially reduced in the past decade.[3] A further reduction of the usage is an important pathway to limit the further development of AMR.

When livestock farms reduce antibiotic usage, in most cases they need to implement measures to enhance animal health and change their animal health management. Stakeholders feared that this would have a negative impact on productivity and economic farm performance.

The usage of antibiotics is substantially reduced in the Netherlands

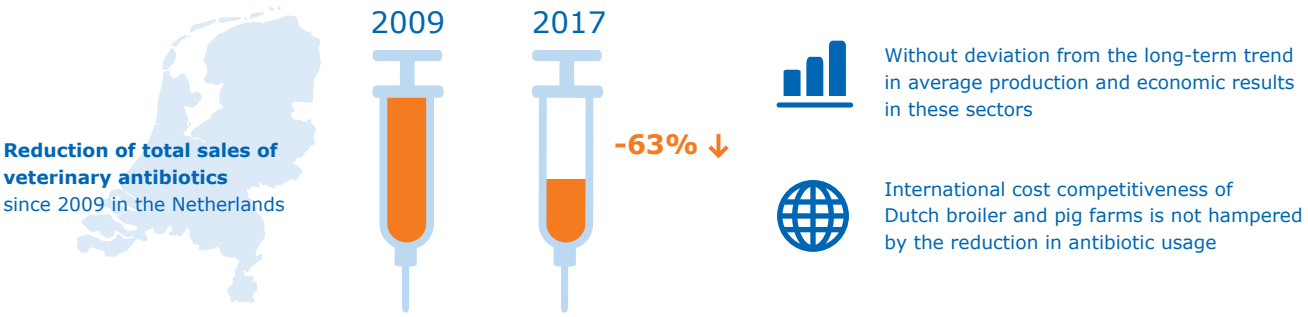
A lack of data and studies on the impact on productivity and economic performance may hamper farmers to reduce antibiotic usage. That's why the World Health Organisation (WHO), Food and Agriculture Organisation (FAO) and the World Organisation for Animal Health (OIE) call for studies to analyse the cost and benefits of actions to reduce antimicrobial usage.[4] This paper contributes to this international discussion by analysing the economic impact of the reduced antibiotic usage in the Netherlands.

The **objective** of this paper is:

- to show the development of antibiotic usage in the livestock industry in the Netherlands from 1999 to 2017,
- to evaluate the measures that farmers took to improve the health of their animal or the health status of their farms, also to prevent any negative side effects when reducing antibiotic usage, and
- to assess the impact of the reduced antibiotic usage on economic farm performance and on international competitiveness of the broiler and pig sector in the Netherlands.

The first section of this paper describes the veterinary antibiotic policy of the Netherlands and describes the development of antibiotic usage from 1999 to 2017. The next section elaborates on the measures that farmers took to improve the health of their animals, to make a reduction of antibiotic usage possible. The third section presents the attitude of the sow and broiler farmers towards antibiotic usage reduction. Sections four and five present the impact of the reduction of antibiotic usage on economic farm performance and on the international competitiveness of livestock farmers in the Netherlands. The paper ends with policy implications.

The study is limited to the pig and broiler sector in the Netherlands. These important sectors used to have a high usage of antibiotics and showed a large decrease in antibiotic usage.



1 Expert Commission on Addressing the Contribution of Livestock to the Antibiotic Resistance Crisis. COMBATING ANTIBIOTIC RESISTANCE A Policy Roadmap to Reduce Use of Medically Important Antibiotics in Livestock, 2017. Washington, D.C, http://battlesuperbugs.com/sites/battlesuperbugs.com/files/Expert%20Commission%20Report%2001.02.18.pdf#page=9

2 WHO, 2015, Global Action Plan on Antimicrobial Resistance https://apps.who.int/iris/bitstream/handle/10665/193736/9789241509763_eng.pdf?sequence=1&isAllowed=y

3 https://onlinelibrary.wiley.com/doi/full/10.1111/zph.12167

4 https://www.who.int/antimicrobial-resistance/global-action-plan/UpdatedRoadmap-Global-Framework-for-Development-Stewardship-to-combatAMR_2017_11_03.pdf

Antibiotic usage policy in the Netherlands

In 1999, the Dutch government started the monitoring of antibiotic usage in Dutch livestock production by recording the total sales of veterinary antibiotics. In 2004, this was extended to include antibiotic usage per animal species.[5]

In 2008, the Dutch government implemented a new policy on the reduction and the responsible use of antibiotics in livestock. The policy was set up as a public-private partnership with private stakeholders from the major livestock production sectors in the Netherlands and the

Private sector is responsible for reduction

Royal Netherlands Veterinary Association. The private stakeholders were responsible for reducing the antibiotic usage, while the Dutch government facilitated and supervised developments. Key elements in the approach were:

- Antibiotic reduction targets: Compared to the antibiotic usage in 2009, a reduction of 20% in 2011 and of 50% in 2013 for all livestock production sectors combined.
- Transparency and benchmarking of antibiotic usage per herd and per veterinarian (since 2011).
- Implementation of mandatory animal health plans, one contracted veterinarian per herd and mandatory periodical veterinary herd inspections, all aimed at improving herd health and clarifying health management responsibilities.

Already in 2012, the objective of a 50% reduction of total sales, as compared to 2009, was realised (see Figure 1). By 2017 the sales of veterinary antibiotics had dropped by more than 63%, from 495 tonnes of active substance in 2009 to 181 tonnes in 2017. Moreover, Figure 1 also shows that since 2013 critically important antibiotics[6] are hardly used anymore in the Dutch livestock sectors. The reduction in use of antibiotics resulted in lower levels of antibiotic resistance in the major livestock species.[7]

The reduction in antibiotic usage differed between livestock sectors. Figure 2 shows that antibiotic usage in broilers in 2017 was 74% lower compared to 2009, in pigs 58% lower, in dairy 47% lower and in veal calves 40% lower.

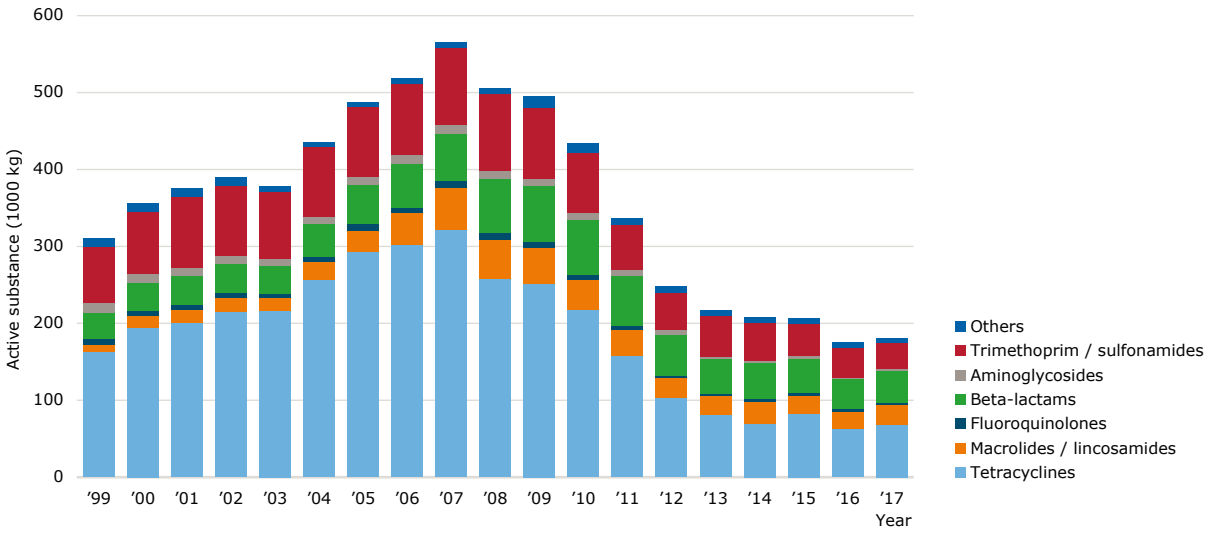


Figure 1 Antimicrobial veterinary medicinal product sales from 1999-2017 in kg (thousands; excluding use of Antibiotic Growth Promoters in the years 1999-2005).
Source: Netherlands Veterinary Medicines Authority (SDa)

5 The monitoring was based on the registration of national antibiotic sales or antibiotic purchases on farms, assuming that all sold or purchased antibiotics were actually used.

6 Critically important antibiotics are antibiotics that are of high importance in human health for the treatment of infection (3rd and 4th generation cephalosporins and fluoroquinolones). The use of these antibiotics is ideally limited to restricted use in the human population and restricted in livestock.

7 NethMap-MARAN 2017; Monitoring of Antimicrobial Resistance and Antibiotic Usage in Animals in the Netherlands in 2016.

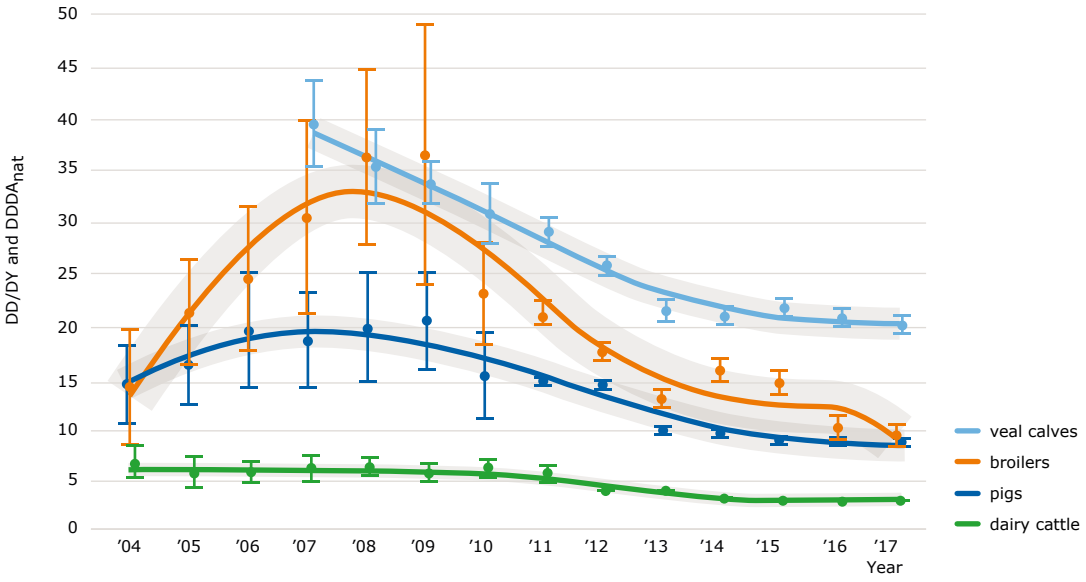


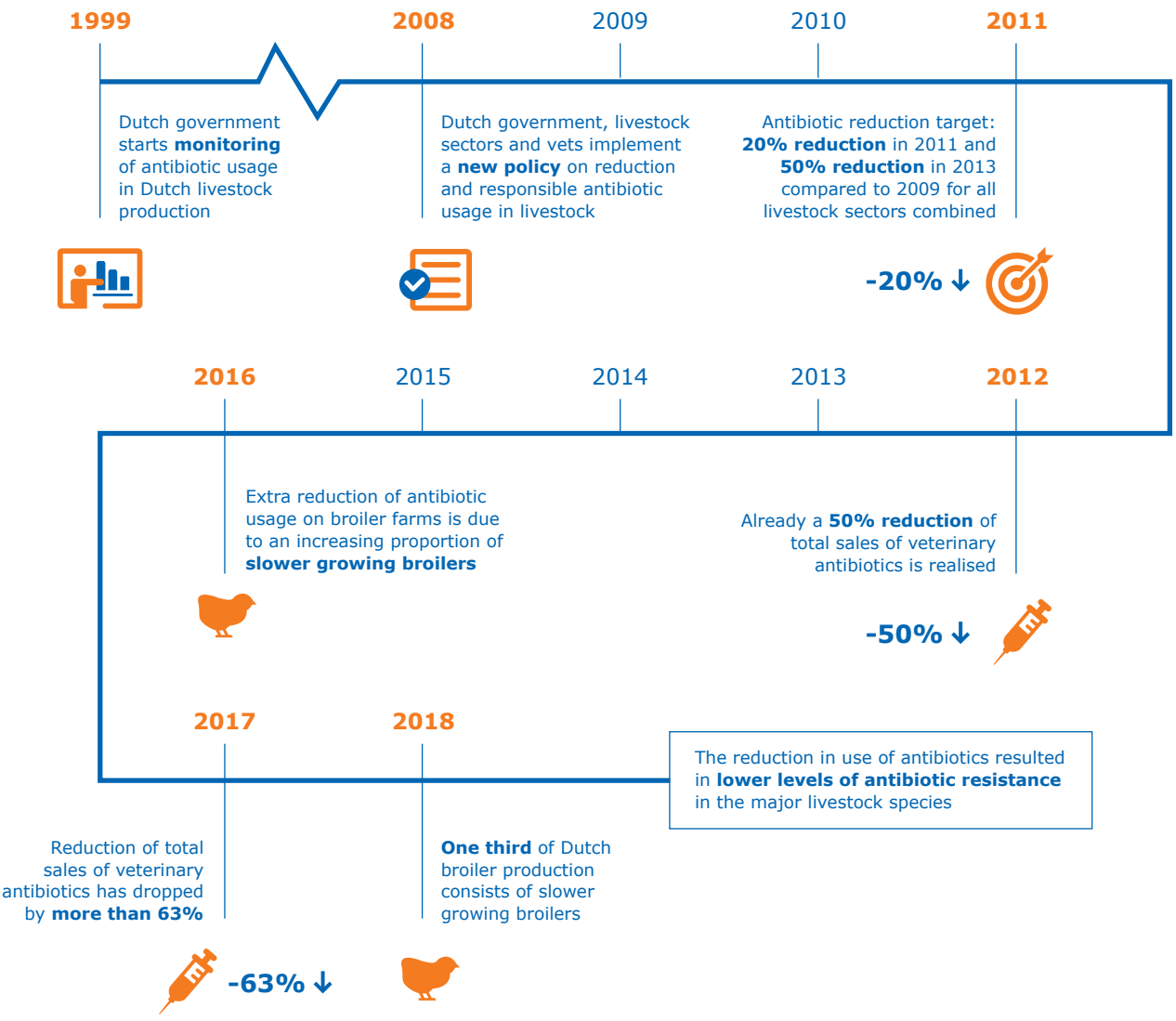
Figure 2 Trends in antibiotic usage per species.
Source: Wageningen Economic Research (2004-2010), SDa (2011-2017)

A substantial part of the decrease in antibiotic usage on broiler farms since 2016 is due to an increasing proportion of slower growing broilers. These slower growing broilers have been introduced as a response to animal welfare concerns of Dutch consumers and retailers. In 2018, about one third of Dutch broiler production consisted of slower growing broilers. Table 1 shows that, although the production parameters substantially differ between conventional and slower growing broilers, gross margin is about the same, as a result of a higher price paid by Dutch retail for meat of slower growing broilers. However, average antibiotic usage in animal daily dose (ADD) in the production of the slower growing broilers is one third of that of conventional broilers.

Table 1 Production parameters, gross margins and antibiotic usage of conventional (fast growing) and slower growing broilers

	2016		2017	
	fast	slower	fast	slower
Growth daily (gram)	62	47	61	47
Feed conversion ratio	1.62	1.96	1.61	1.95
Gross margin/broiler (eurocent)	30	55	33	68
Gross margin/m²/day (eurocent)	13	12	15	16
Antibiotic usage (ADD)	13	4	13	4.5

Source: Wageningen Economic Research calculations



Measures taken by farmers

The highest initial antibiotic usage and largest reduction was observed in the pig, broiler and veal calf sectors. The remaining part of this paper focuses on pig- and broiler farmers. Production practises in these sectors in the Netherlands are very similar to those in a large part of the EU and the world. The veal calf sector is not included in the analysis, because production and economic data are not publically available.[8] To get insight into the measures farmers took to improve the health of their animals and to minimise the impact on technical and economic performance when reducing the usage of antibiotics, broiler and pig farmers participating in the Farm Accountancy Data Network (FADN) of Wageningen Economic Research were approached for a survey with structured questions. In total, 79 sow farmers were approached of which 56 participated in the survey, and 30 broiler farmers were approached of which 22 participated in the survey. The farmers were interviewed in the summer of 2018.

Measures taken by sow farmers

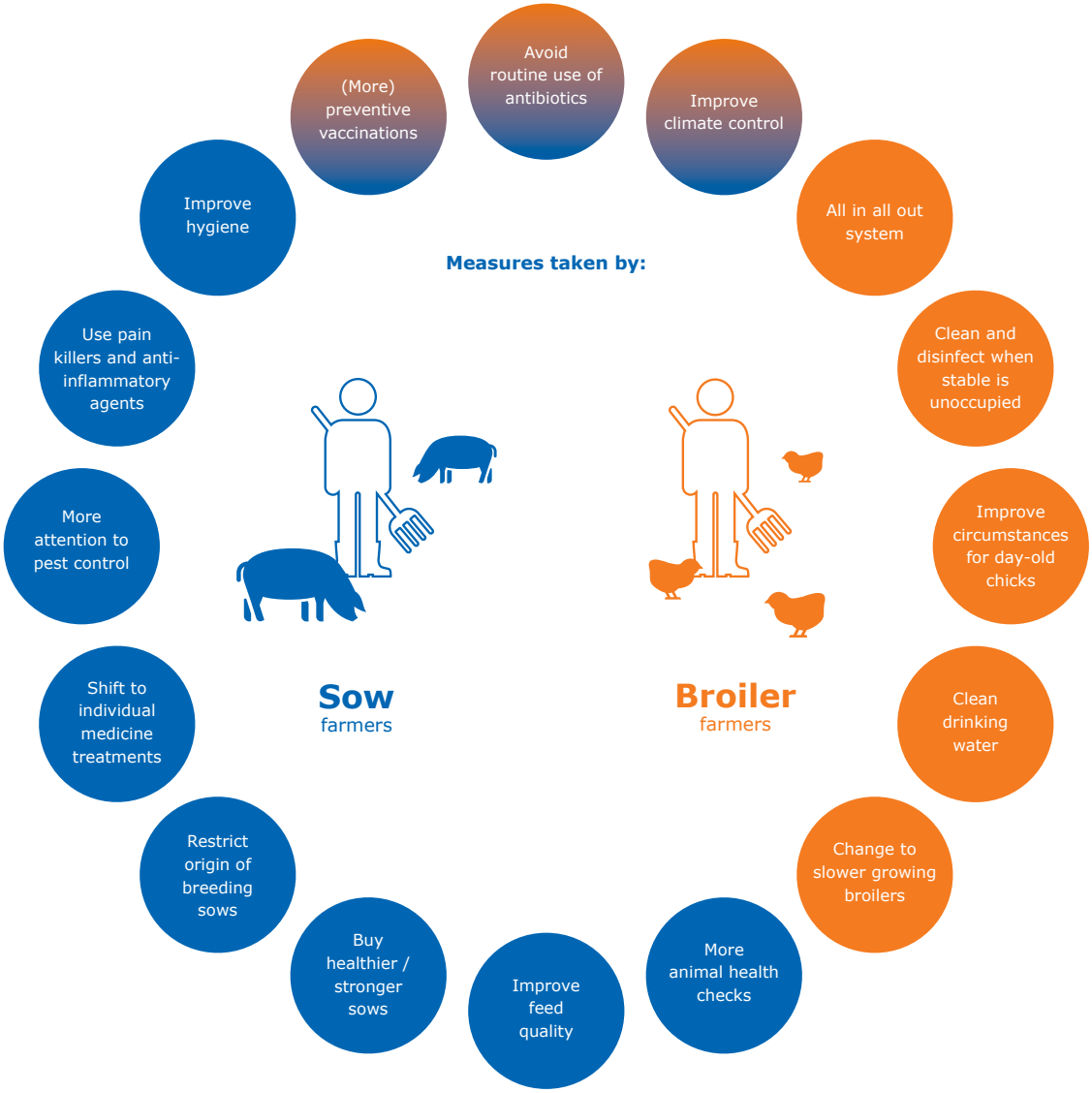
Table 2 shows a summary of the measures interviewed sow farmers took to improve the health of their animals or the health status of their farms. Measures focused mainly on animal health management, such as improving biosecurity, use of anti-inflammatory agents or preventive vaccinations. The majority of the famers indicated in the interviews that they implemented the measures generally in consultation with their vet and more than three years ago. Once implemented, most farmers continued taking these measures (Table 2).

8 The Dutch veal sector is characterised by a small number of highly integrated enterprises with a large influence on uniform production practices. Production is located mostly in the Netherlands, economic data are sparsely available and mostly confidential.

Table 2 Measures taken by 50% or more of the interviewed sow farmers to improve the health of their animals (% of farmers)[9]

		Measures taken or not and since when				
Measure	**Number of farmers**	**Yes**	**Yes, >9 years ago**	**Yes, 6-9 years ago**	**Yes, 3-6 years ago**	**Yes, <3 years ago**
Avoid routine use of antibiotics	55	81.8	20.0	12.7	41.8	7.3
More preventive vaccinations	54	81.5	9.3	11.1	38.9	22.2
Use pain killers and anti-inflammatory agents	55	76.4	12.7	14.6	36.4	12.7
More attention to pest control (flies, rats, mice)	55	74.5	34.6	14.6	12.7	12.7
Improve hygiene	55	67.3	38.2	7.3	14.6	7.3
Shift to individual medicine treatments	55	65.4	21.8	10.9	20.0	12.7
Improve feed quality*	54	63.0	18.5	7.4	20.4	16.7
Improve climate control	55	60.0	21.8	5.5	18.2	14.6
More animal health checks	54	59.3	27.8	3.7	24.1	3.7
Restrict origin of breeding sows	55	56.4	29.1	9.1	10.9	7.3
Buy healthier/ stronger sows	55	40.0	18.2	5.5	9.1	7.3

* By choosing better ingredients



9 Other measures taken by less than 50% of the interviewed sow farmers are the use of new needles for each litter of piglets (49.1% of the interviewed sow farmers), having a separate sickbay for piglets (45.4%), adapting the water pipe system (45.4%), only using own bred sows (44.2%), having a separate sickbay for sows (43.6%), buying healthier/stronger sows (40.0%), acidifying drinking water (35.2%), injecting without needles (32.7%), keeping breeding sows from outside in quarantine for a few weeks (32.1%), using new needles for each sow (29.6%), and having an SPF system (3.7%).

Measures taken by broiler farmers

Table 3 shows the measures interviewed broiler farmers took to improve the health of their animals or the health status of their farms. Like the interviewed sow farmers, interviewed broiler farmers mainly took animal health management measures, such as improving biosecurity and water and feed quality. The majority of them implemented the measures more than three years ago and continued taking these measures. Changing to slower growing broilers is a quite 'new' measure, taken less than three years ago, by 30% of the interviewed broiler farmers.

Table 3 Measures taken by 50% or more of the interviewed broiler farmers to improve the health of their animals (% of farmers)[10]

		Measure taken or not and since when				
Measure	**Number of farmers**	**Yes**	**Yes, >9 years ago**	**Yes, 6-9 years ago**	**Yes, 3-6 years ago**	**Yes, <3 years ago**
Clean and disinfect when stable is unoccupied	21	80.9	71.4		9.5	
Avoid routine use of antibiotics	21	76.2	28.6	14.3	28.6	4.8
All in all out system	21	67.7	42.9		14.3	9.5
Clean drinking water	21	61.9	33.3	14.3	4.8	9.5
Improve climate control	21	61.9	28.6	4.8	23.8	4.8
Improve circumstances for day-old chicks*	21	61.9	28.6	14.3	14.3	4.8
Change to slower growing broilers	20	55.0	10.0		15.0	30.0
Apply preventive vaccinations	21	52.4	38.1	4.8		9.5

* clean, well-organised, well-lit, and kept at the right temperature and oxygen levels.

Attitude and behaviour of farmers in relation to the reduction of antibiotic usage

To help farmers to change their daily practise, tailor-made interventions are required which fit their decision-making environment. However, often uptake and upscaling of promising interventions is disappointing. A reason for this may be that it is often assumed that farmers and other agents are rational, self-interested economic agents. However, new insights have made it increasingly clear that psychological and sociological elements should also be taken into account, with consideration of intrinsic motivations, moral convictions, social preferences, reciprocity and the impact of peer groups.[11]

To be able to help farmers to change their behaviour, insight is needed on their willingness and motivation to change, on their capability and ability to change, on factors that influence this capability and ability, e.g. knowledge and education, and on the opportunity to change, e.g. possible constraints regarding time, money or a suitable housing system. Therefore questions regarding these topics were included in the survey among the sow and broiler farmers in the FADN.

Uptake and upscaling of promising interventions is often disappointing

10 Other measures taken by less than 50% of the interviewed broiler farmers were: improving food composition (47.6% of the interviewed broiler farmers), applying more and better health checks (42.9%), stopping thinning (38.1%), using probiotics (38.1%), and using preventive and supporting treatments (painkillers and anti-inflammatory agents) (14.3%)

11 see for example: Edwards-Jones, G., 2006. Modelling farmer decision making: concepts, progress and challenges. Animal Science 82, 783-790. Herzfeld, T., Jongeneel, R.A. (2012) Why do farmers behave as they do? Understanding compliance with rural, agricultural, and food attribute standards Land Use Policy 29 (1). - p. 250 - 260.
Garforth, C., 2014. Livestock keepers' reasons for doing and not doing things which governments, vets and scientist would like them to do. Zoonoses and public health 62 (suppl. 1), 29-38.

Behavioural differences between sow farmers

The survey results indicate that sow farmers who use **less** antibiotics compared to sow farmers that use more antibiotics:[12]

In this survey, sow farmers who use **more** antibiotics are more concerned that low antibiotic usage is bad for their farm results, perceive more risk and uncertainty, and think to a lesser extent that they have enough knowledge and time. These results indicate that providing these farmers with knowledge and information on management practices to reduce the usage of antibiotics may be helpful. The survey also indicates that policymakers, when thinking about ways to provide such knowledge and information to sow farmers, should keep in mind that:

- sow farmers who use more antibiotics are more sceptical about policy makers than farmers who use less antibiotics;
- the veterinarian is the most important source of information for sow farmers, followed by the feed supplier;
- sow farmers comply the most to the opinion of their veterinarian, followed by the feed supplier and the consumer;
- individual advice is the preferred way to get information, followed by study groups, internet and research reports.

Veterinarian important stakeholder to change behaviour of farmer

For that reason, it would be useful to focus on continuous involvement of the veterinarian and possibly the feed supplier in providing knowledge about reduction of antibiotic usage to sow farmers, preferably by means of individual advice.

12 Only significant associations are presented ($p<0.05$); The results are based on univariate linear regression analyses with intention, attitude, perceived risk and uncertainty, relative risk perception, intergroup perception and separate items of positive and negative behavioural beliefs, normative beliefs and perceived behaviour control – capability as predictors for the average no. of ADD/year from 2014-2017.

Behavioural differences between broiler farmers

In the survey on broiler farmers no significant relations were found between the average use of antibiotics from 2014-2017 and behavioural factors like perceptions, beliefs, attitude and intention. This is probably due to the low number of participants and the diversity of farm types of the farms participating in the survey: 9 conventional farmers, 12 farmers with slower growing broilers and 1 farmer with 2 stars of the Better Life Logo.[13] In this small group of broiler farmers no relation between antibiotic usage and farm type was found. However, in another study[14] concerning the influence of behavioural factors on broiler farmers' decision making with regard to reduction of antibiotic usage in the Netherlands, similar results were found as found for sow farmers in the underlying study. That study showed that broiler farmers with structurally low use of antibiotics, in comparison with broiler farmers with a structurally high use of antibiotics: 1) had a more positive attitude towards keeping or getting the usage of antibiotics under the target value, 2) had higher scores for positive and lower scores for negative behavioural beliefs about getting or keeping the use of antibiotics under the target value, 3) perceived themselves to be more capable to get or keep their use of antibiotics under the target value and 4) perceived less risk and uncertainty and more control over their decisions concerning antibiotic usage.

Economic impact of use reduction

The number of sow and broiler farms has been decreasing steadily over time (Figure 3). This trend is also present in other Dutch agricultural (livestock) sectors. The long-term average decrease in the number of all agricultural holdings is between 2% to 3% per year. The decrease in number of sow and broiler farms is higher with 5% to 7% per year.[15] At the same time a trend can be observed of increasing average sow and broiler farm size, keeping the total number of these animals in the Netherlands more or less stable (Figure 3). The antibiotic usage policy has had hardly any impact on these structural trends in the sow and broiler sector.

Antibiotic usage policy has little effect on structural economic trends

13 The Better Life Logo ('Beter Leven Keurmerk') is a label for animal welfare with 1, 2 or 3 stars, that can be found on numerous animal products. The more stars, the better the life of the animals was. The Better Life Logo was developed by the Dutch Society for the Protection of Animals ('Dierenbescherming'), and is being certified by independent certification bodies.

14 Lauwere, C. de, M. Bokma, 2019. Behavioural factors affecting broiler farmers' decision making with regard to reduction of antibiotics use in the Netherlands. Paper prepared for presentation for the 168th EAAE Seminar Behavioural Perspectives in Agricultural Economics and Management, 6-7 February 2019, Uppsala, Sweden; www.

15 Berkhout, P., 2018. Food Economic Report 2017 of the Netherlands. Wageningen Economic Research.

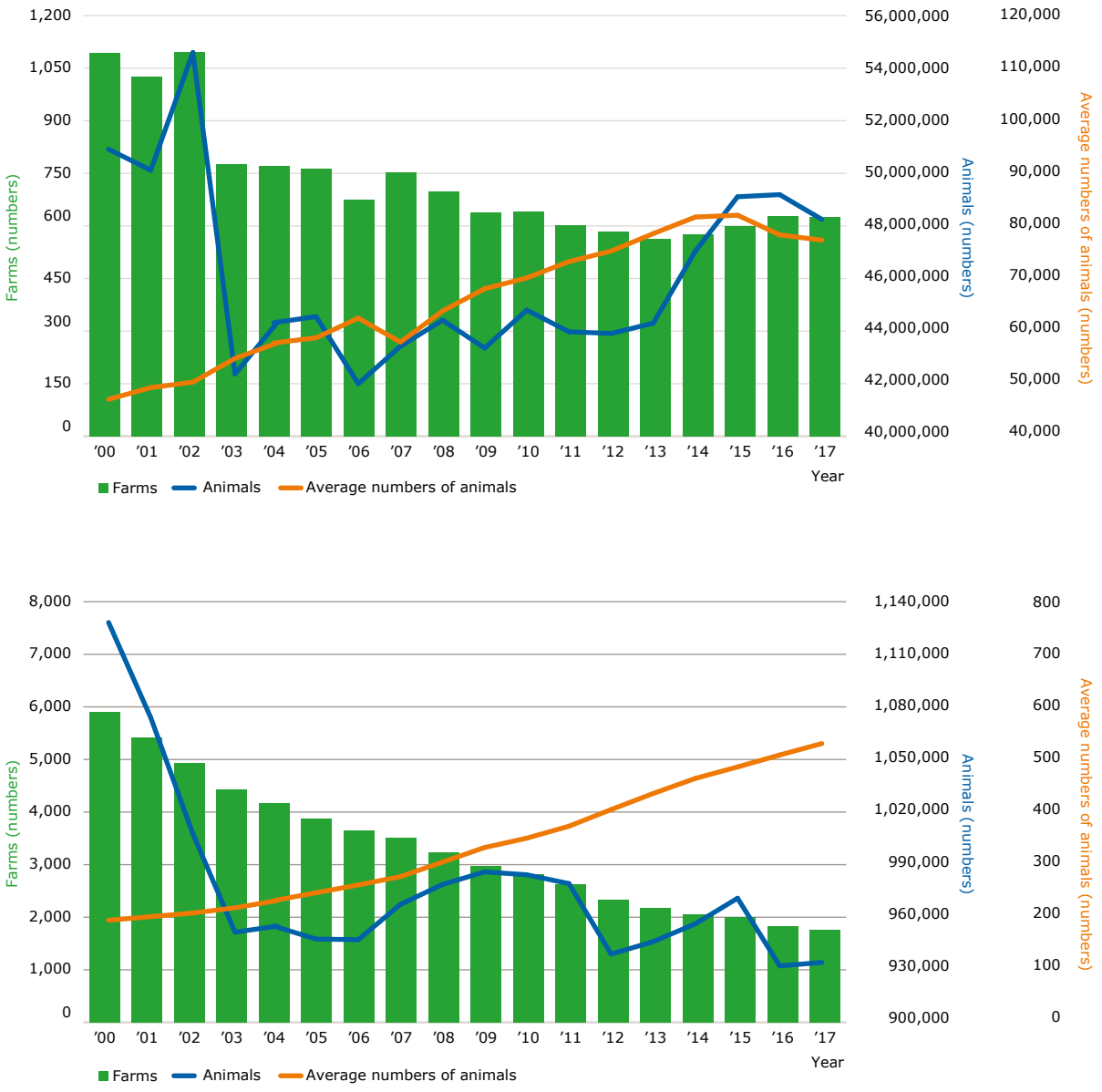


Figure 3 Dutch farming structure sow farms (below) and Dutch broiler farms (above) (source: CBS annual data as published on Agrimatie.nl)

Table 4 and Table 5 show the development of important technical performance indicators, such as mortality and feed intake for pig and broiler farms in the Netherlands from 2005 to 2017. The productivity and feed conversion ratio in both sectors continuously improved. The mortality rate in piglets for weaning remained fairly stable at almost fourteen per cent, and the mortality in broilers fluctuated between three and four per cent. Mortality on pig farms seems to have clearly increased in the years 2005-2010, but already in 2008, before the antibiotic usage started to decrease, mortality was at the same level as in 2010.

Table 4 Main performance parameters on pig farms

Pig farms	2005	2010	2015	2017
Pigs per sow/year	23.5	26.6	29.0	29.2
Mortality before weaning (%)	12.3	13.6	13.7	13.7
Kg feed per piglet (25 kg)	28.0	30.8	30.1	28.1
Growth per finisher per day (g)	733	759	776	790
Feed conversion ratio (finishers)	2.85	2.83	2.71	2.64

Source: Wageningen Economic Research

Table 5 Main performance parameters in the broiler industry (conventional broilers)

Broiler farms	2005	2010	2015	2017[16]
Mortality (%)	4.1	3.7	3.4	3.9
Live weight (g)	2,190	2,260	2,320	2,411
Feed conversion ratio	1.85	1.75	1.66	1.60

Source: Wageningen Economic Research

Most agricultural sectors show an annual fluctuation in family farm income. In general, the pigs and poultry are sectors with the largest fluctuations in family farm incomes. Instability of agricultural markets, and fluctuations of feed prices and prices received by farmers are major reasons for volatile family farm incomes.[17] Feed costs account for 50% or more of total paid costs and depreciation on pig and poultry farms. Moreover, pig and poultry farms in net exporting countries such as the Netherlands suffer severely in times of weak markets. Since the 2009 antibiotic policy reforms, in neither the sow nor the broiler sector a downward trend in family farm income can be observed (Figure 4). Thus, an impact of the reduction in antibiotic usage on family farm income cannot be identified.

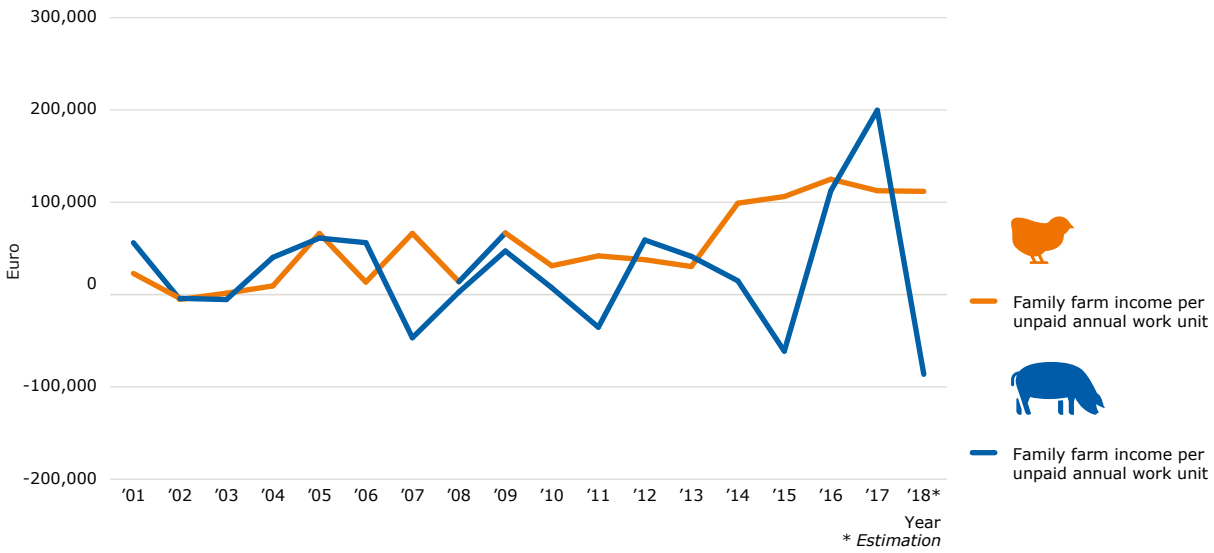


Figure 4 Average family farm income of Dutch sow farms and Dutch broiler farms
(source: Agrimatie.nl)

To study the possible association of antibiotic usage reduction on the technical and economic performance an in-depth statistical analysis was performed based on the Dutch sow and broiler farms in the FADN panel data. The FADN dataset comprises repeated measurements of economic and technical variables per year. The availability of repeated observations per farm makes it possible to specify and estimate more complicated and more statistical robust models, accounting for heterogeneity within and between farms. The analysed sample comprised 74 sow farms and 36 broiler farms with annual observations from 2005 to 2017.

Figure 5 depicts the analysis scheme of the tested associations between antibiotic usage (independent variable) and technical and economic impact indicators (dependent variables). The impact on technical indicators is estimated for the number of delivered piglets per sow and the number of delivered broilers per m^2. The economic impact indicators included aggregated indicators as family farm income, total costs and total revenues, as well as for a more direct indicator comprising animal health costs. The indicators are divided by the number of sows and by the number of broilers (in 1,000s) on average present on the farm, to increase interpretability.

16 The parameters for 2017 had to be adjusted, because of a substantial percentage of slow growing broilers in that year.
17 Van Asseldonk, M. and R. van der Meer, 2016. Coping with price risks on Dutch farms. Wageningen Economic Research. Report 2016-054.

Several other independent variables, apart from antibiotic usage, are entered into the models in order to account for the variation caused by these control variables (farmer characteristics, farm structure, input and output prices).

This enables us to estimate the statistical association between antibiotic usage and economic performance more robustly, since confounding effects are controlled for.

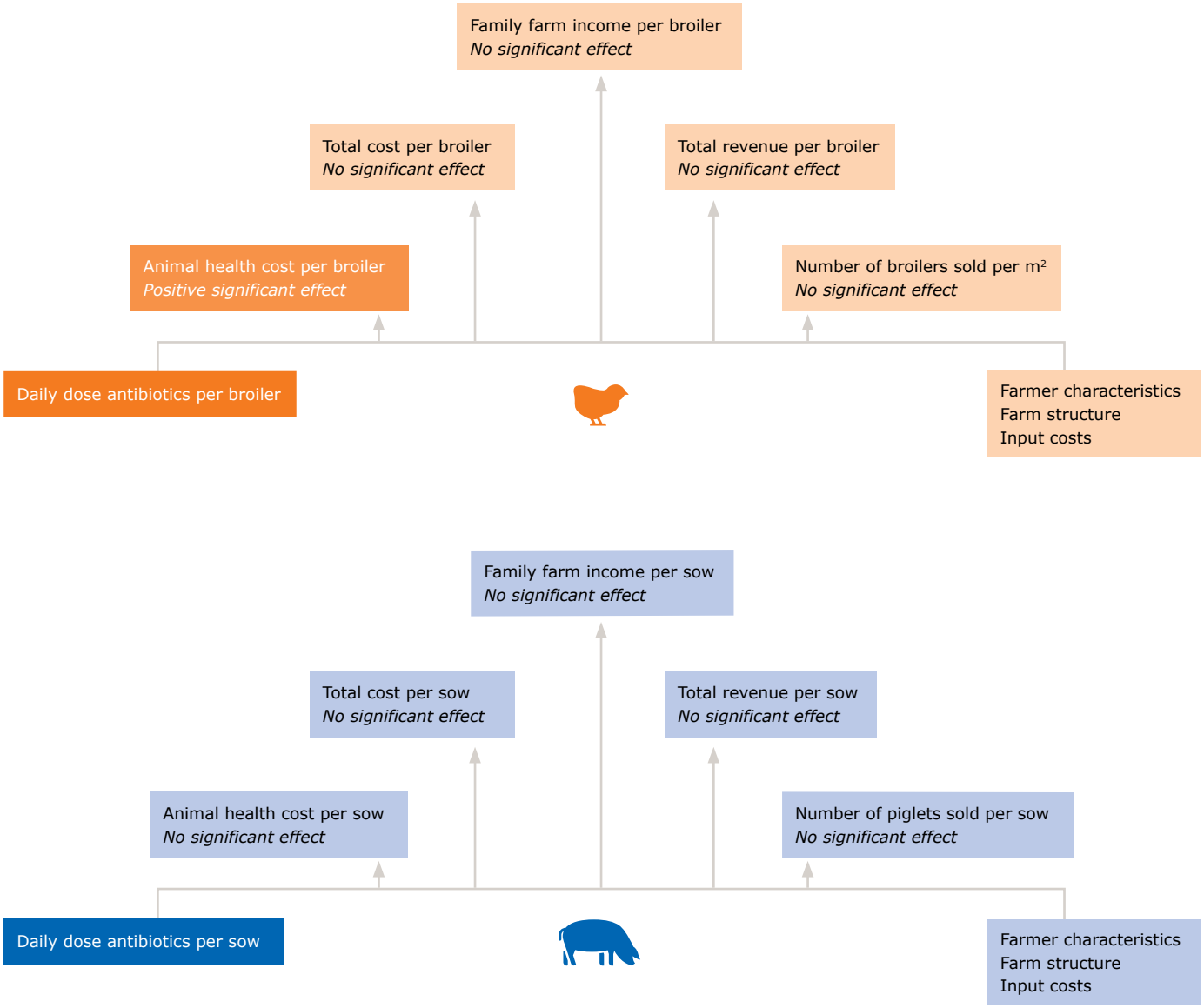


Figure 5 Analysis scheme for sows (below) and broilers (above) for analysing association between antibiotic usage (independent variable) and technical and economic performance indicators (dependent variables)

No effect antibiotic usage on economic and technical performance

Based on the panel analysis it is estimated that antibiotic usage does not significantly affect (neither positive nor negative) the technical performance (delivered piglets per sow) nor the economic performance on sow farms. The panel data analysis of the broiler farm dataset indicates approximately the same insignificant relationships of technical (delivered broilers per m^2) and economic indicators as they both indicate that most performance indicators are not associated with antibiotic usage. The only significant relation that was found was a positive association between antibiotic usage and animal health costs: farms with a higher antibiotic usage also have higher animal health costs (at a significance level of 1%, i.e., 1% risk of concluding that a difference exists when there is no actual difference). The relative importance is minor since a 10% increase in antibiotic usage would result on average in an increase of animal health costs of approximately 0.12%. Whether this incursion of additional costs was solely due to the higher use of antibiotics, or involved

other expenditures could not be established. Note that the general trend of animal health costs in sow production is upward (Figure 6), irrespective of the trend in antibiotic usage reduction.

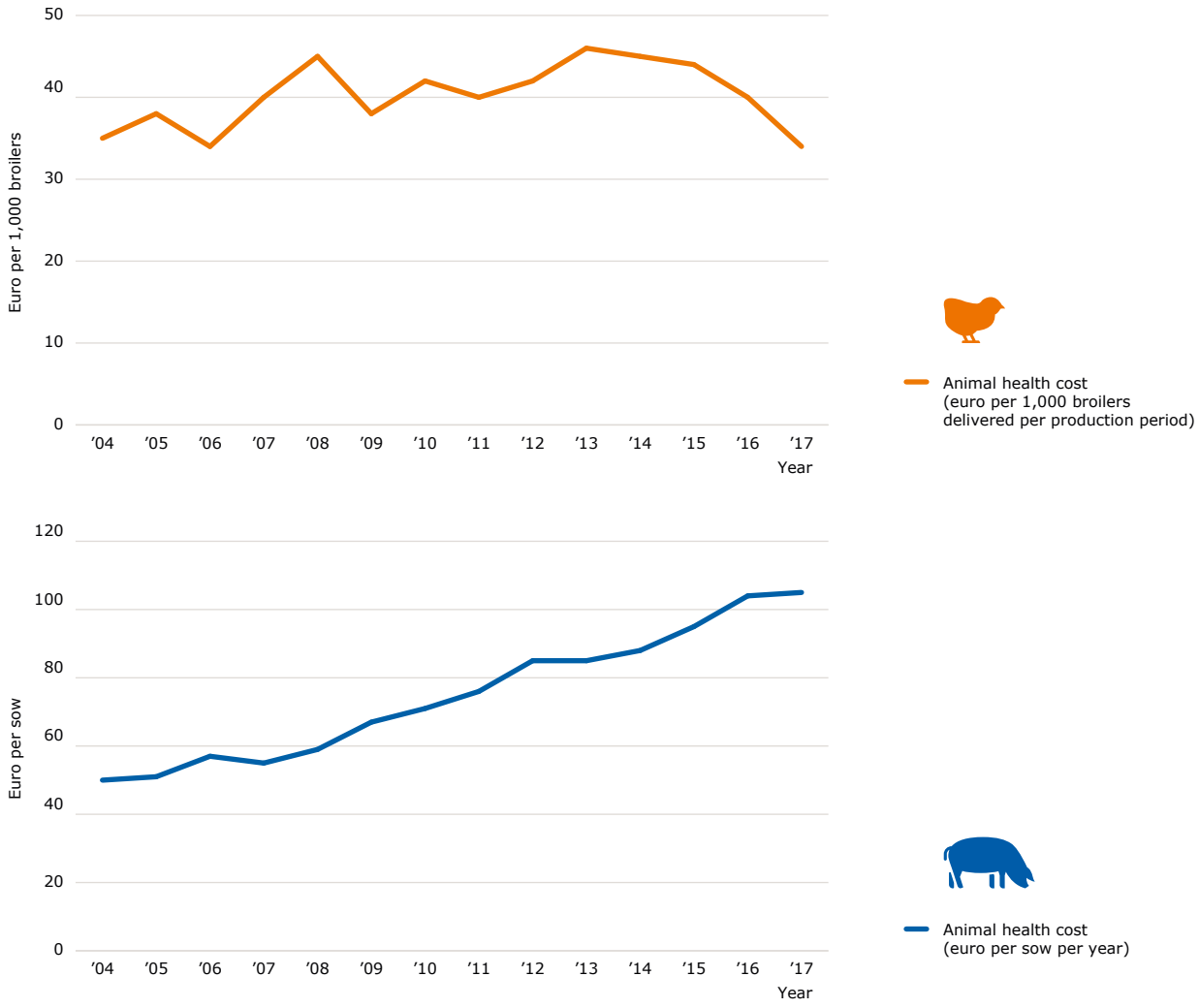


Figure 6 Animal health costs Dutch sow farms (below) and Dutch broiler farms (above) (source: FADN)

Furthermore, in both sectors more modern buildings are associated with lower animal health costs (at a significance level of 1%). Modernity is operationalised as the share of the current balance value compared to the original new value of the building(s). Most other farmer characteristics and farm structure control variables are not significant. As expected, input and output price control variables have a large influence on overall costs, revenues and income.

Competitiveness of the Dutch pig and broiler sector compared to major competitors

To investigate whether the implementation of the policies to reduce antibiotic usage affected the international competiveness of the industry, the production costs in the Dutch pig and broiler industry were compared with three EU competitors: Denmark, Germany and Spain. Denmark was selected because it has had a low average usage of antibiotics for a number of years, Germany because it is the main export market for Dutch broilers, pigs and pig meat and has a moderate average antibiotic usage, and Spain because it has a relatively high average usage of antibiotics.

Both in broilers and pig production there is a high volatility

of production costs over years (Figure 7 and Figure 8), mainly due to variation in feed prices. Figure 7, based on InterPIG data, shows that the average cost of pig production in the Netherlands substantially increased (+0.22 € / kg carcass weight) compared to the other three countries, partly because the autonomous increase of sow performance lags behind (-/- 1.6 marketed pigs per sow per year). It can be concluded that the cost competitiveness

No link between reduction and decreasing cost competitiveness

of Dutch pig production is deteriorating, since 2013. However, no evidence was found of any relation between the decreasing cost competitiveness and antibiotic usage reduction.

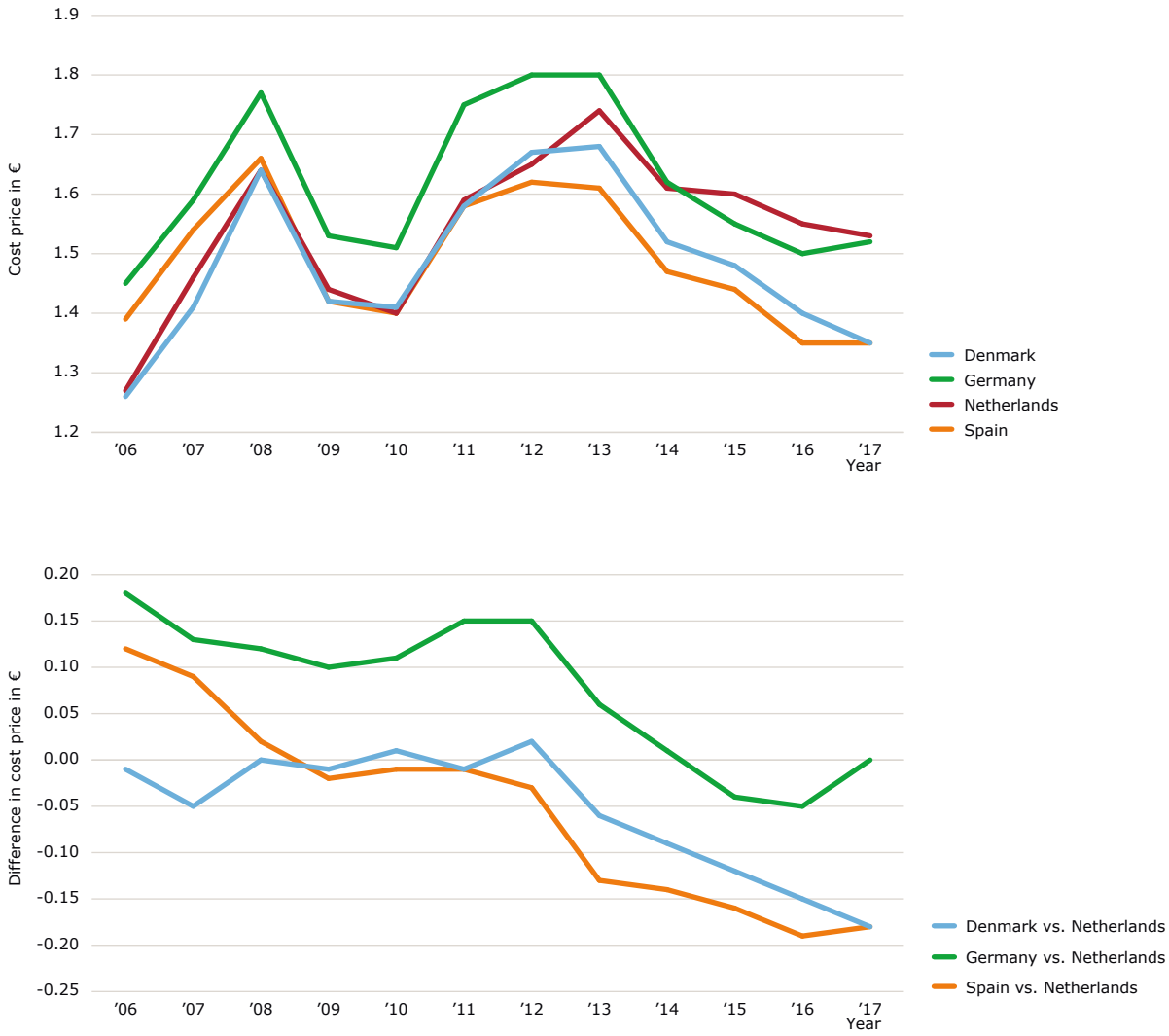


Figure 7 Average cost of pig production in the Netherlands compared with the costs in Denmark, Germany and Spain. The upper figure gives the actual cost price whereas the bottom figure gives the difference with the Dutch production costs.
Source: InterPIG/Wageningen Economic Research

A similar analysis was done for the broiler sector, based on several Wageningen Economic Research reports about the cost competitiveness of the EU broiler sector. Figure 8 shows the cost differences (euro per kg live weight) with the Netherlands, since 2007. The conclusion is that broiler production costs remain the lowest in the Netherlands (0-level), compared to the three other countries. No evidence was found of any relation between the cost competitiveness and antibiotic usage reduction.

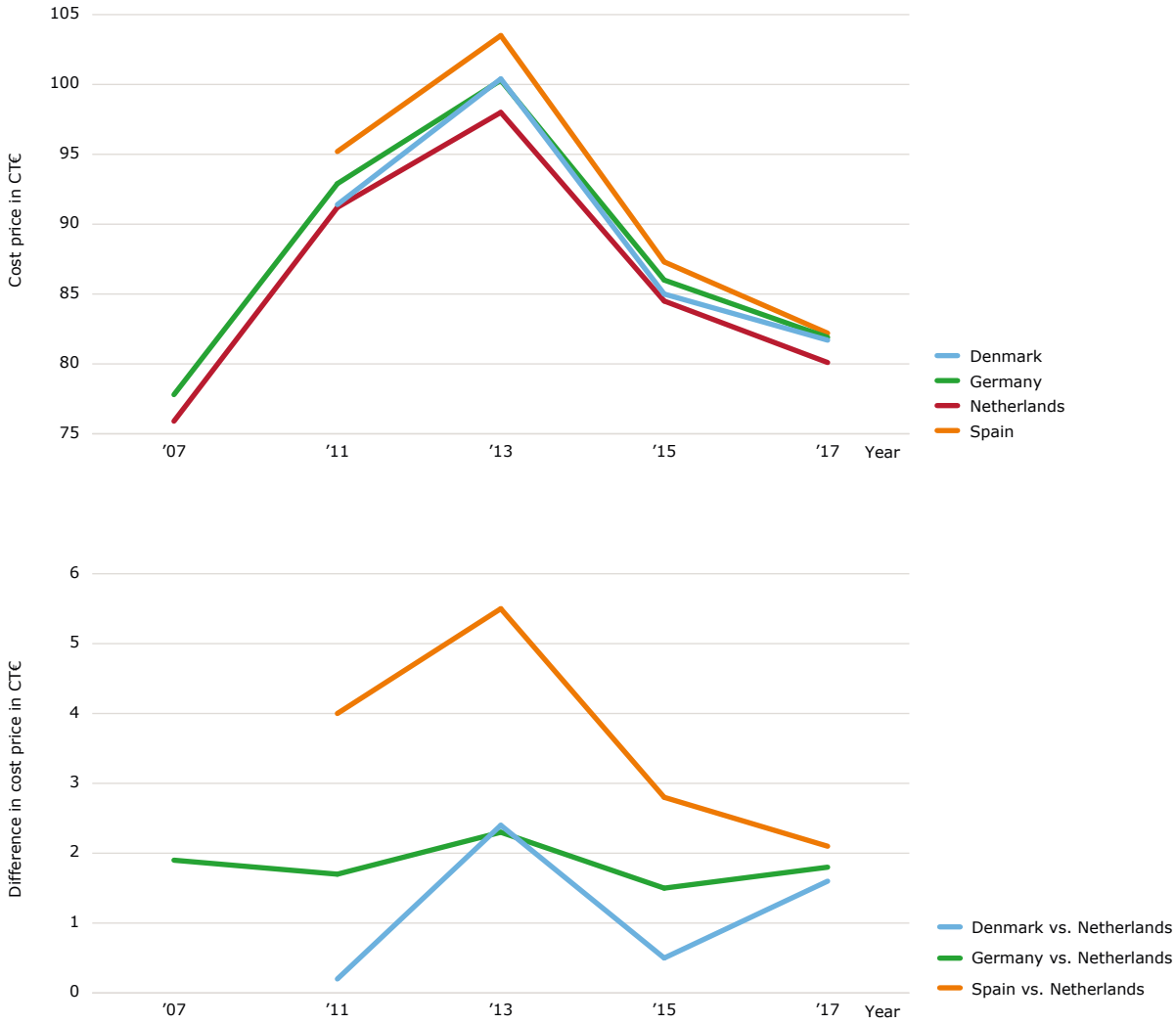


Figure 8 Average cost of conventional broiler production in the Netherlands compared with the costs in Denmark, Germany and Spain. The upper figure gives the actual cost price whereas the bottom figure gives the difference with the Dutch production costs.

Conclusions and policy implications

Experiences in the Netherlands show that an active policy towards antibiotic usage reduction can work:

- a substantial reduction of antibiotic usage was accomplished at broiler and pig farms through the implementation of relatively easy and cheap measures at farm level;
- a decrease in production or economic performance of farms to reach a substantial reduction of antibiotic usage was not observed;
- overall cost competitiveness of the Dutch pig and broiler farms was not affected due to the implementation of the national strategy to reduce antibiotic usage.

Besides, as illustrated by the example of the slow growing chicken, implementation of measures to improve animal welfare, can also contribute to the decrease of antibiotic usage, while maintaining the economic performance of the farms.

These conclusions lead to the following policy implications for countries that are considering to start with antibiotic reduction:

- Farm advisors and suppliers, such as veterinarians, and the feed industry will have to be actively involved to establish this reduction of antibiotic usage, because farmers have to choose the most appropriate combination of measures that are suitable for their specific farm.
- To achieve a substantial reduction in antibiotic usage, a clear sense of urgency is needed, combined with a target-based policy and ambitious targets.

Contact & information

Wageningen Economic Research
PO Box 29703
2502 LS Den Haag,
wur.eu/economic-research

2019-026

dr. Ron Bergevoet:
ron.bergevoet@wur.nl

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