AN OVERVIEW OF RECENT WORK ON ANTIMICROBIAL USE AND ANTIMICROBIAL RESISTANCE IN THE DIRECTORATE AND SOME PRELIMINARY SCENARIO ANALYSIS

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Introduction

1. Work on the use of antimicrobials in agriculture began in the Trade and Agriculture Directorate during the 2013/14 biennium programme of work and budget. This initial work was undertaken by external consultants, Professor Jonathan Rushton et al., and focused on a review of the literature on this topic. The final report “Antimicrobial Resistance: The Use of Antimicrobials in the Livestock Sector” was published under the OECD Food, Agriculture and Fisheries Papers No 68 in 2014.

2. A follow up report “The Economic Costs of Withdrawing Antimicrobial Growth Promoters from the Livestock Sector” was undertaken in 2014. This report was published under the OECD food, Agriculture and Fisheries papers No. 78 in 2015. This report undertaken by Dr. Ramanan Laxminarayan et al. focused on the economic value of antimicrobial growth promoters to livestock producers and consumers.

3. The following section provides a brief summary of what we have learned from the two reports as a background to the analysis. This is then followed by a discussion of selective scenario analysis and preliminary results using the OECD-FAO Aglink-Cosimo model. This analysis is a direct follow on from the work of Dr. Laxminarayan et al. and involves the application of the OECD-FAO Aglink Cosimo model which accounts for a wider range of economic interactions.
4. The report by Rushton et al. on Antimicrobial Resistance provides a synthesis of the information available on the use of antimicrobials in livestock agriculture in the context of its contribution to food security, food safety, animal welfare and the livelihoods of producers. The report surveyed the literature on the use of antimicrobials in livestock production in recent years and noted the paucity of robust information globally on this topic. While noting that antimicrobials have been widely used for several proposes in agriculture over the last 50 year, nonetheless, there are substantial information and data gaps on its use as a growth promoter in livestock production. To-date, the evidence indicates that antimicrobial use can improve livestock productivity; however the extent to which this occurs varies by species and production system. However, the lack of data on the use of antimicrobials as growth promoters, and definitive evidence on the link to increased resistance makes it difficult to draw definite conclusions on the issue.

5. The report also discusses the range of antimicrobials currently used in the livestock sector as well as for treating human health. In many countries, estimates of antimicrobial consumption are rather crude; nevertheless, the estimates indicate that the bulk of antimicrobials consumed (about 80%) are in agriculture. The report also noted the difficulties in getting reliable estimates of the overall consumption of antimicrobials and, moreover, in identifying the split between the use of antimicrobials for preventing disease and treating sick animals from those used for growth promotion. For large livestock producing emerging economies such as China and Brazil the data on antimicrobial consumption is even more limited.

6. The authors identified several examples of possible linkage between antimicrobial use and the development of resistance, and conclude that high usage levels lead to selective pressures for the development of more resistant microbes. The authors outlined a comprehensive overview of the risks and benefits from the use of antimicrobials in animals, as well as the need for more detailed and comprehensive analyses of risk assessment and the cost effectiveness of antimicrobials in livestock agriculture.

7. The final section of the report discussed the policy options for monitoring and controlling the use of antimicrobials at both the national and international levels. The report emphasises the need for the harmonisation of actions in order to be effective; whether these actions are voluntary, via prudent use principle, or involve legislation to control the use of antimicrobials in livestock. As antimicrobials have become an integral part of the global livestock production system, the authors concluded that the perceived policy challenge requires a multidimensional and multi sectoral approach to deal with the scientific concerns, economic impacts and public health concerns.

8. In this report “The Economic Costs of withdrawing Antimicrobial Growth Promoters from the Livestock Sector”, the authors estimated the volume of antimicrobial used in the global livestock sector in 2010 and made projections of the potential global use in 2030. Currently, about twenty seven different classes of antimicrobials are used in livestock production, many of which are also used in human health. The report indicates that antimicrobials are widely used in intensive feedlot cattle production, particularly in the USA, Brazil and Argentina, and in intensive pig and chicken production globally.

9. Drawing on a range of sources on antimicrobial consumption the authors estimated global antimicrobial consumption in livestock agriculture (pigs, poultry and cattle) at 63,151 tonnes in 2010. Based on estimates of the current usage and growth in demand for meat, the authors extrapolated the current trends in antimicrobial use in agriculture to 2030. In summary, they projected that consumption would increase by about 67% to 105,596 tonnes by 2030. This increase would be driven largely by a
significant increase in usage in emerging economies with large intensive livestock and poultry production notably China, Brazil and India, while antimicrobial consumption in developed economies would decline. The authors estimated that in 2010 the five countries with the largest shares of global antimicrobial consumption in food animal production were; China (23%), USA (13%), Brazil (9%), India (3%) and Germany (3%). For 2030, while the ranking would broadly remain similar the shares would change with the projections; China (30%), USA (10%), Brazil (8%), India (4%) and Mexico (2%).

10. The second part of this report focused on the potential economic and market impacts of a global ban on the use of antimicrobial growth promoters (AGPs) in livestock production. The report noted the enormous challenge to assess productivity impacts at global level due to the poor quality of information and data on antimicrobial use, outside a small number of OECD countries. In practice, AGPs can influence productivity by enhancing both the growth rate and feed efficiency of animals. While the findings of research studies on the growth response to antimicrobial use varies widely depending on species, management practices, age of the animal, genetic potential and hygiene standards, response rates can range from 1% - 12%. It was also noted that the removal of AGPs is often accompanied by an increase in the use of antibiotics as a prophylactic.

11. The report noted that there is growing evidence to suggest that the productivity effects of AGPs on the livestock sector are much lower than they were in the 1980s, particularly in Europe and in the United States. More specifically, the report summarized the evidence from the literature on the average daily growth rate differences between animals raised with, and without antibiotics as growth promoters. The results for the 1980s literature indicated the following values: 9% for pigs, 7% for cattle and 4% for chicken, while the 2000s literature showed a marked decline with difference of 3% for cattle, 1% for pigs and 0.7% for chicken.

12. The authors also noted that the potential productivity impacts in livestock agriculture in non-OECD countries may be substantially higher than in OECD countries. The authors estimated the potential loss in meat production and meat value for each country resulting from the removal of AGPs in agriculture based on a low growth (2000s scenario), and a high growth (1980s scenario) scenario. In overall terms, the results showed a reduction in meat production ranging from 1.3% to 3% of the 2010 production levels. This would equate to a monetary loss ranging from US$13.5 to US$44.1 billion, with respect to the two scenarios.

13. The authors noted the potential economic incentives for livestock producers from using AGPs including higher animal performance, better overall health, higher profits and reduced production risks. On the other hand, the authors acknowledged that the potential economic impacts of a ban on AGPs in the livestock sector are limited and would depend on a range of factors including management and husbandry practices. When adjustment costs are added, the authors concluded that the net effect on production and prices was still relatively small and ranged from 1% to 3% depending on the specificities of the country.

14. The report concluded that countries that have modern livestock production systems with good hygiene standards and production practices would experience only limited productivity impacts from the phasing out of antimicrobial growth promoters. On the other hand, countries which have sub-optimal production systems could experience much higher productivity and economic effects. While not included in the analysis, the cost savings from not using AGPs would partly offset the financial losses from the reduction in meat production.
Methodology & assumptions

15. Some preliminary work using the OECD-FAO Aglink-Cosimo model has been done to assess the effect on meat output of the removal of antimicrobial growth promoters from the livestock production system. This was done to get a sense of the magnitude of the response on production, trade and prices in each country. Two different production impacts (supply cuts) are assumed; 1% (low impact) and a 5% (high impact) resulting from a ban on the use of antimicrobial growth promoters. The two impact levels are assessed for beef, pigmeat and poultry meat.

16. The analysis is based on the assumption that the use of antimicrobial growth promoters in feedlot cattle, pig and poultry production are banned in. It is also assumed that most of the adjustment in production will take place in the first years of the policy change. The model was run and the impacts on production, trade and prices were reported over the ten year period from 2015 to 2024. Both the direct and indirect impacts were examined and reported based on the degree of substitutability between beef, pork and chicken.

17. In the Aglink model, the five major producing and consuming countries/regions for livestock products are; USA, China, Brazil, India and the EU. The difference in production technology in the different countries is not directly taken into account in this exercise. It should be noted that while AGPs have been banned for livestock production in the EU since 2006, so no changes are introduced for this region. For the four countries AGPs are available and used mainly in intensive production systems for pigs, poultry and feedlot cattle.

18. Together these five countries/regions account for over four-fifths of global annual meat production of chicken, pork and beef. Currently, these four countries are estimated to be the largest users of antimicrobial growth promoters in their livestock sectors. The baseline was taken as the 2015 level of production of beef, pork and chicken as used in the 2015 version of the Aglink-Cosimo model.

Preliminary findings of the analysis

19. This section discusses the preliminary findings of the scenario analysis using the OECD-FAO Aglink Cosimo model for the three meats; beef, pork and chicken for the four countries Brazil, China, India and the USA. The EU is not discussed as AGPs have been banned in the EU since 2006. Based on the assumption of a ban on AGPs in all countries as of 2015, the following supply shifts are assessed; 1% (low impact), and a 5% (high impact) on the supply of the three meats. This analysis is similar to the work carried out by Dr. Laxminarayan et al., where a low and a high case scenario of 1% and 3% were assumed in their analysis. This preliminary analysis using a higher impact assumption of 5% will have a significantly larger effect on production, prices and trade flows.

20. The countries chosen for this preliminary analysis are either large producers and/or large consumers of beef, pork and chicken and consequently any changes in supply can have significant impacts on international trade and market prices.

21. However, it should be noted that large meat producing countries are not necessarily large exporters. In many cases, exports tend to represent a relatively small share of total production. Therefore, relatively small changes in production or prices tend to have a significantly larger impact on trade.
22. The global supply of beef, pig meat and poultry meat are expected to increase over the next decade as reported in the OECD-FAO Agricultural Outlook 2015-2024. The projections show that poultry production is expected to rise by about 2.3% over the decade, while beef and pork production is expected to rise by about 1.2%, respectively (see Graph 1). On the other hand, global meat consumption is estimated to rise by about 5% over the next decade.

Figure 1: World Meat Production and Reference Prices

23. However, there is a big divergence between developed and developing countries. More specifically, beef production in developed countries is projected to show little change, while pork production will show a small increase (6%), but poultry production is projected to increase by 20% over the next decade. For developing countries, beef, pigmeat and poultry meat production are expected to increase more strongly, with projected increases of 20%, 14% and 27% respectively, by 2024 (see Graph 2).
Scenario 1

24. The low impact case assumes that a ban on the use of AGPs would result in a 1% fall in the productivity of beef, pork and poultry meat production. The impact on production, prices and net trade are discussed in the following section. It should be noted that these results are preliminary and are indicative of the potential impacts on production, domestic prices and trade based on these simplified assumptions.

Production effects

25. Table 1 shows the impact on production of beef and veal, pigmeat and poultry meat assuming a ban on the use of antimicrobial growth promoters as of 2015. The preliminary analysis examines the impacts over a 10 year period, but the discussion focuses on the early years when most of the effects are experienced.

Table 1: First year impact on meat production following a ban on the use of AGPs

(Change in % between Scenario and Baseline)

<table>
<thead>
<tr>
<th></th>
<th>Beef&amp;Veal</th>
<th>Pigmeat*</th>
<th>Poultry meat</th>
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<tbody>
<tr>
<td>Brasil</td>
<td>-0.80</td>
<td>-0.50</td>
<td>-0.33</td>
</tr>
<tr>
<td>China</td>
<td>-0.92</td>
<td>-0.33</td>
<td>-0.26</td>
</tr>
<tr>
<td>India</td>
<td>-0.81</td>
<td>-0.63</td>
<td>-0.60</td>
</tr>
<tr>
<td>USA</td>
<td>-0.87</td>
<td>-0.66</td>
<td>-0.43</td>
</tr>
</tbody>
</table>

Source: OECD calculation

*Brazil, China and USA 2nd year supply response is shown as 1st year is exogenous
26. **Beef & Veal**: Brazil and India are large producers and exporters of beef, while both China and the USA are small, but growing net importers. In the first year after introducing a ban on the use of AGPs, beef production in the four countries would fall by 0.8% to 0.9%. In effect, practically the full impact of the ban on AGPs would be absorbed in the early years, with only small effects on production in the 2nd and 3rd years.

27. **Pigmeat**: the USA and Brazil are significant exporters of pork onto the world market, while China is a growing net importer, and in the case of India, the volume of trade in pork is not significant. In the first year after introducing a ban on the use of AGPs, pigmeat production in the four countries would fall by 0.3% to 0.6%, with the largest supply response in the USA. In effect, the impact of a ban on AGPs would have a relatively small effect in the first year, with additional effects in subsequent years.

28. **Poultry meat**: the USA and Brazil are large exporters of poultry meat onto the world market, while China is a small, but increasingly important net exporter. For India the volume of trade in poultry meat is not significant. In the first year after introducing a ban on the use of AGPs, poultry meat production in the four countries would fall by 0.3% to 0.6%, with the smallest response in China and the largest in India. The impact of a ban on AGPs would have a relatively small effect on overall production of poultry over the projection period.

**Domestic price effects**

29. Table 2 shows the impact on domestic prices for beef & veal, pigmeat and poultry meat assuming a ban on the use of antimicrobial growth promoters as of 2015. The preliminary analysis examines the impact over a 10 year period, with emphasis on the early years, when most of the effects are experienced.

| Table 2: First year impact on domestic meat prices following a ban on the use of AGPs |
|---------------------------------------------|------------------|------------------|
| **(Change in % between Scenario and Baseline)** | **Beef & Veal** | **Pigmeat** | **Poultry meat** |
| Brasil | 1.73 | 2.09 | 0.58 |
| China | 1.63 | 4.02 | 0.73 |
| India | 1.80 | 3.00 | 2.01 |
| USA | 2.57 | 2.76 | 0.64 |

Source: OECD calculation

30. **Beef & Veal**: the overall price effect of a 1% fall in productivity based on the removal of AGPs in the production system is relatively small across the four countries. The smallest price effects are in China, where domestic prices would rise by about 1.6%, while the largest price impact is in the USA, where prices would rise by about 2.6%.

31. **Pigmeat**: the overall price effect of a fall in productivity of 1% is much larger for pigmeat in the four countries. The smallest price effects are experienced in Brazil, where domestic prices would rise by about 2%, while the largest price effects are in China, where producer prices would rise by about 4%.

32. **Poultry meat**: the overall price effect of a fall in productivity of 1% based on the removal of AGPs in the production system is small in Brazil, China and the USA, but somewhat larger in India. The
smallest price effects are experienced in Brazil and the USA, where domestic prices would rise by less than one percent (0.6%), while the largest price effects are in India, where prices would rise by a modest 2%

*Net trade effects*

34. Table 3 shows the impact on trade for beef & veal, pigmeat and poultry meat assuming the introduction of a ban on the use of antimicrobial growth promoters in production as of 2015. The preliminary analysis examines the impact over a 10 year period, with the emphasis on the early years.

<table>
<thead>
<tr>
<th></th>
<th>Beef &amp; Veal</th>
<th>Pigmeat</th>
<th>Poultry meat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brasil</td>
<td>-1.48</td>
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<td>China</td>
<td>-3.23</td>
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<td>-5.59</td>
</tr>
<tr>
<td>India</td>
<td>-1.10</td>
<td>ns</td>
<td>ns</td>
</tr>
<tr>
<td>USA</td>
<td>5.00</td>
<td>-4.09</td>
<td>-1.81</td>
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Table 3: First year impact on net trade following a ban on the use of AGPs

(Change in % between Scenario and Baseline)

Source: OECD calculation

35. **Beef & Veal**: the overall net trade effect of a fall in productivity of 1% based on the removal of AGPs in the production system indicates that exports from India, Brazil and China would fall by 1% - 3%. However for the USA, which is a small net importer of beef, net imports would rise by about 5% from a relatively low base level.

36. **Pigmeat**: the overall trade effect of a fall in productivity of 1% has a larger effect on trade in pigmeat. For Brazil and the USA, estimates indicate that exports would decline by 3% and 4%, respectively. For China, imports would rise substantially from a relatively modest level.

37. **Poultry meat**: the overall trade effect of a fall in productivity of 1% is relatively small for Brazil and the USA, but significantly larger for China. The estimates indicate that exports of poultry meat from China would rise by almost 6%.
Scenario 2

38. The high impact scenario assumes that the removal of antimicrobial growth promoters from the production system for beef & veal, pork and poultry meat would result in a 5% reduction in the production of these meats the effects on production, domestic prices and trade in the four countries were also examined.

39. The overall results indicate that for beef & veal, pigmeat and poultry meat a 5% scenario would yield similar results to the 1% scenario, but approximately five fold greater (due to the nature of the model). In summary, this high impact scenario would have significant economic effects on global markets and prices, as well as on the production location for the major meats.

Summary of the preliminary findings

40. These preliminary results from the simplified analysis should be interpreted with caution due to the lack of empirical data on the use of AGPs and the extent that they influence productivity. Nevertheless, the broader findings are interesting and useful in terms of getting a better understanding of the direction of the potential economic impacts using the different scenarios across the four major meat producing countries.

41. The analysis indicates that the removal of antimicrobial growth promoters from the production systems for feedlot cattle, pigs and poultry can vary significantly from country to country. The critical question relates to the actual growth response rates in cattle, pigs and poultry to the use of AGPs in different production systems in different countries.

42. In overall terms, the results broadly conform to the standard economic expectation that a decrease in production would lead to an increase in price and less product to trade. In addition, there would be some degree of substitutability between the different meats with an increase in demand for the cheaper meats. Moreover, countries that do not use AGPs could see an increase in production as a result of the price rise.

43. Most of the benefits from removing antimicrobial growth promoters from current intensive beef, pig and poultry production systems would occur in the first years, while the adjustment costs would tend to be spread over a longer time span.

44. The adjustment costs in the large intensive livestock producing emerging economies are likely to be significantly higher than for most OECD countries.

45. The direct production, trade and price effects are likely to be significantly higher in large emerging economies than in more developed economies. Of the top five largest users of AGPs, three are emerging economies namely China, Brazil and India.

46. The impact of banning the use of AGPs in meat production on consumer preferences has not been closely examined. In emerging economies, the impact on consumer demand for beef, pork and chicken is likely to be higher as demand tends to be more price sensitive. However, in other countries it is likely to have a positive impact.