SWEDISH POULTRY PRODUCTION WITHOUT IN-FEED ANTIBIOTICS - A TESTING GROUND OR A MODEL FOR THE FUTURE?

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Summary

Poultry production in Sweden has undergone many changes and faced many challenges during the past two decades. The ban on the non-therapeutic use of antibacterial feed additives appears to have had mainly positive effects on the poultry industry prompting producers and the feed industry to improve management and feed formulation standards. As a result, poultry production is more efficient and safer (from a consumer health viewpoint) than ever before.

I. INTRODUCTION

During the past 10 to 15 years poultry production in Sweden has undergone major changes both with regard to the structure of the industry and the feeding and management of the birds. Whereas the total egg production has not changed very much, the industry has undergone major structural changes resulting in fewer flocks of increased size. For example, in 1980, the number of layer flocks was approximately 24,000 whereas in 1997 the number had decreased to approximately 8000 (Figure 1, SCB, 1998). However, the average head count is still rather low with less than 300 flocks of 5000 layers or more.

![Graph showing the number of layers and layer flocks in Sweden between 1970 and 1997.](image)

Figure 1. Number of layers and layer flocks in Sweden between 1970 and 1997.

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In contrast to egg volumes, chicken meat production has more than doubled during the last ten years (Figure 2, Swedish Poultry Meat Association, 1999). This reflects the increasing popularity of chicken meat and the competitiveness of the industry compared with other kinds of meat production such as pork and beef. Turkey and duck production in Sweden are of little significance.

![Graph showing chicken meat production](image)

Figure 2. Number of broilers (millions) and amount of broilermeat (thousand tonnes) produced in Sweden between 1985 and 1998.

Another major change and challenge to the broiler industry was the implementation of the ban on in-feed antibiotics in 1986. In this paper, the background of the ban and the consequences of it in terms of bird management, feeding and hygiene status will be discussed.

II. NON-THERAPEUTIC USE OF ANTIBIOTICS BANNED SINCE 1986

The debate in the Swedish press that eventually led to the ban on the non-therapeutic use of antibiotic growth promoters was initiated in the early 1980s. A journalist of the daily Dagens Nyheter revealed that 30 tonnes of antibiotic substances were fed to healthy animals every year. In 1981, the Federation of Swedish Farmers and the cooperatives (representing approximately 90 per cent of the farmers) issued a joint policy statement declaring their ambition to reduce the use of antibiotics in animal production. Prophylactic actions, such as improved hygiene standards, better management systems and feed in combination with increased knowledge were corner stones of the policy. The use of antibiotics needed to be based on actual needs of the animals and, therefore, the justification for a general use for growth promotion was questioned. A proposal in 1981 by the Federation of Swedish Farmers to stop using in-feed antibiotics was not regarded as justifiable at that time by the authorities.

However, the debate was kept alive by both politicians and farmers' organisations. In 1985 a new feed law was formulated. According to this, antibiotic and chemotherapeutic
substances in feeds could only be used on prescription by a veterinarian. Furthermore, their use was only to be allowed with the purpose of preventing, relieving or curing illness. The new legislation came into force on January 1st 1986.

(a) Production without antibiotics

Despite a lively debate and a lot of speculation on the consequences that preceded the ban, the entire farming community, the feed industry and advisers alike seemed to have been taken by surprise. Very little had been done in preparation for this new situation, which without doubt, affected the pig producers more than any other group of farmers. Since no antibacterial feed additives had ever been authorised for use in layer feeds in Sweden, the ban had no impact on egg production.

At the time of the ban, virginiamycin was the main antibacterial feed additive use in broiler feeds. It had been used from the early 1980s when it replaced avoparcin. At the beginning, virginiamycin was used at a dose of 10 ppm but in the autumn of 1985 the dosage was increased to 20 ppm following reports of outbreaks of necrotic enteritis (NE) with increasing frequency. This disease in its subclinical and clinical forms was identified as the main problem to tackle as the in-feed antibiotic was withdrawn. The problem was addressed by a committee consisting of representatives from the producers, the feed industry, veterinarians and the meat inspection services. The outcome of the work was an agreement on a transition period during which virginiamycin would be prescribed for use in broiler feeds at 20 ppm (SOU, 1997).

Field trials with non-medicated feeds indicated that a number of factors needed to be corrected to get control over NE. It was concluded that the construction and the climate of the buildings, hygiene management and feed composition all contributed to the occurrence of NE in broilers. Furthermore, ionophore coccidiostats were found to prevent NE. The main emphasis was placed on improving the environment of the birds because many diseases, including NE, have a multifactorial background. A bonus programme was developed for the producers giving an economic incentive to maintain a high hygiene status and good management systems in production.

In 1988, all prophylactic medications were abandoned and, in case of outbreaks of NE, a two-day treatment with phenoxyethyl penicillin in the drinking water was applied. The amount of active substance of antibiotics used for treatment decreased from approximately 2000 kg of virginiamycin in 1987 to 100 kg of phenoxyethyl penicillin in 1988. Today the need for such treatment of NE has almost disappeared.

(b) Maintaining performance

Whilst performance and health status of cattle and poultry farms were only marginally affected by the ban, the situation on pig farms was quite the contrary. As a consequence of the ban, the use of antibiotics in compound feeds was reduced by 2/3 and the number of pigs treated with antibiotics for post weaning diarrhoea fell in 1986 to nearly 1/10 the level used in the previous year. However, this resulted in clinical problems and health disorders, which resulted in an increased demand and use of antibiotics in feeds at therapeutic levels. For example, in 1988 and 1989 the use of Olaquindox (g/pig) increased to levels higher than prior to the ban. In 1989, 75 per cent of the pig population in Sweden were treated with antibiotics (Wierup, 1996).

Most affected were the sow herds with post weaning pig mortality increasing by 1.2 percentage units and age of piglets at 25 kg LW increasing by 5.2 days in the first year of the ban (Robertsson and Lundehelm, 1994).
Broiler performance was not as severely hit as that of pigs. At the time the ban was introduced, broiler production was quite extensive, with low bird densities (25 kg live weight per m²) and good health status. However, the new situation prompted nutritionists within the feed industry and researchers at the universities to search for alternatives and develop new management and housing systems in order to maintain broiler performance and control NE. The years following the ban were a period of intense activity to test and evaluate any non-antibiotic concept such as:

- lactic acid bacteria, yeasts, acidifiers (organic and inorganic acids), energy and protein levels, feed texture, whole grain feeding, feed enzymes.

After a few years of "trial and error" a few concepts emerged having been proven to contribute to a better health status and to improve the performance. With regard to feeds and feeding, nutrient density of feeds, in particular energy and protein levels, were reduced, coarse grinding was introduced, the inclusion levels of soybean meal was reduced and feed enzymes were included in all broiler feeds. All these measures in combination with strict hygiene programmes have, in fact, led to clearly improved broiler performance (Figure 3). Although the average live weight at slaughter has increased by some 20 per cent, feed conversion ratios have decreased by approximately 5 per cent, resulting in a 20 per cent increase in production efficiency (PE) values since 1986.

PE is calculated as follows: \( \text{Ave Wt(g)} \times (100-(\% \text{mortality+culls})/10 \times \text{FCR} \times \text{age(d)}) \)

![Figure 3](image-url)

Figure 3. Average live weight, feed conversion ratio and PE-values (all corrected to 35 days of age) of broilers slaughtered in the Kristianstad processing plant between 1986 and 1996 (Lundström, 1999, personal communication).

Today over 95 per cent of broiler producers meet the health and management requirements of the national producer organisation, allowing those producers to keep their birds at a density of 36 kg/m² floor area, the highest bird density allowed today.
(c) Use of in-feed antibiotics

Today the use of in-feed antibiotics (excluding coccidiostats) is approximately 1/5 of that in the years prior to the ban (Figure 4).

Figure 4. The use of in-feed antibiotics and coccidiostats in Sweden between 1980 and 1996 expressed as kg active substance (SOU, 1997).

Coccidiostats are used on prescription in virtually all broiler feeds. The amounts used have increased at the same rate as broiler production (Figure 5). Narasin has been the coccidiostat of choice for the last six to seven years.
III. HYGIENE STATUS OF THE POULTRY INDUSTRY

(a) Salmonella control and outbreaks

A voluntary salmonella programme has been running in Sweden since 1970. Within the programme all generations are sampled for bacterial examination. The sampling procedure has been designed to detect salmonella infection if the prevalence of infected birds in a flock is higher than 5 per cent. Today the programme is compulsory for all egg and meat producing flocks, with a compliance of more than 95 per cent.

When salmonella of any serotype is found in grandparents, parents or meat producing birds the entire flock is destroyed. Layer flocks, however, are only destroyed if invasive serotypes are found.

The entire bird and egg handling chains are today covered by legislation and guidelines to prevent and detect salmonella infection in the poultry industry to prevent infection from reaching the consumers. These measures have proven to be quite effective as can be judged from the number of reported outbreaks during the past decades (Figure 6; Mårtensson et al., 1983; Eld et al., 1991; Malmqvist et al., 1995.).

![Graph](image)

**Figure 6.** Number of reported salmonella outbreaks in poultry during two five-year periods in Sweden.

In 1992 a nation-wide investigation was carried out in order to examine the prevalence of salmonella bacteria in carcasses of beef, pigs and broilers after slaughter (Wahlström et al., 1993). Approximately 3000 carcasses of each animal species were sampled. Salmonella was found in less than 1 per cent of the samples (Table 1).
Table 1. Prevalence of salmonella in carcasses of cattle, pigs and broilers after slaughter.

<table>
<thead>
<tr>
<th>Animal species</th>
<th>No of abattoirs</th>
<th>No of animals</th>
<th>No of animals contaminated</th>
<th>Percentage contaminated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cattle</td>
<td>13</td>
<td>2924</td>
<td>22</td>
<td>0.8</td>
</tr>
<tr>
<td>Pig</td>
<td>13</td>
<td>3026</td>
<td>4</td>
<td>0.1</td>
</tr>
<tr>
<td>Broiler</td>
<td>10</td>
<td>2730 (910*)</td>
<td>12</td>
<td>0.2-0.7</td>
</tr>
</tbody>
</table>

* three samples pooled to one

Certain salmonella serotypes seem to appear, disappear and then reappear again. There is no data suggesting that any serotype would have completely disappeared. Moreover, there is no evidence of any serotypes that would have been found year after year in poultry, for example. However, it appears that the number of reported outbreaks has decreased during the last decade. This is probably a result of the salmonella control programmes in place covering the entire chain of birds, eggs and feeds.

(b) *Salmonella control in the feed industry*

Monitoring and control of salmonella in animal feedstuffs has been carried out in Sweden since the late 1940s. Since 1958, data on salmonella of imported raw feed materials of animal origin as well as of domestic meat meals and feedstuffs have been compiled. In that same year, the major compound feed manufacturers formed the Association of Veterinary Feed Control (AVFC). The members agreed to set up and sponsor a laboratory at the National Veterinary Institute (NVI) to focus on feed hygiene. Salmonella soon became an important part of the work at the laboratory. Since this time, the laboratory for feed hygiene at the NVI has been actively involved in the process of developing methods for salmonella analysis and control in the feed industry as well as monitoring the hygiene status of feeds and feedstuffs (Häggblom, 1995).

Today a hygiene control scheme, which is partly voluntary and partly implemented by legislation, is in place in the feed mills of the AVFC members, representing more than 90 per cent of the compound feed production in Sweden. This scheme is based on a HACCP (Hazard Analysis of Critical Control Points) approach, with the aim of preventing salmonella-contaminated raw materials from entering the feed mills and keeping bacteria counts at a minimum in all stages of the manufacturing process. This scheme includes:

- storage of high risk raw materials in quarantine until declared free of salmonella;
- hygiene control programmes at the feed mills, including cleaning and sampling of critical points (raw materials, dust, feeds) every week (5 samples/feed mill/week) for salmonella analysis;
- inspection of feed mills by authorised people once a year;
- mandatory heat-treatment of poultry feeds (min. 75°C), and of all other feeds manufactured in feed mills with poultry feed production;

Raw materials that frequently have been found contaminated with salmonella have been categorised into three classes based on previous records as follows:

- **S1** - all raw materials of animal origin (e.g. fish meal, meat meal, feather meal). These are put in quarantine and stored by the manufacturer until proven free of salmonella;
• S2 - high risk raw materials of plant origin (e.g. soybean meal, rapeseed meal, coconut). These are kept in quarantine outside the feed mill until proven free of salmonella;
• S3 - low risk raw materials of plant origin (e.g. "by-pass" soybean meals). These can enter the feed mill before the results of the salmonella analysis are available.

The number of samples to be drawn is related to the size of each shipment or batch. The sampling procedure has been developed to detect salmonella with a probability of 99 per cent. Sampling is usually carried out by skilled personnel of authorised companies.

In case salmonella is found in a "S2" raw material, it has to be decontaminated either by heat- or chemical treatment (e.g. acids or formaldehyde). The treatment adds USD 13.18/metric tonne to the raw material costs. New samples are taken and have to be free from salmonella before the material is allowed to be delivered to the feed mill.

When salmonella is found in any of the weekly samples from the feed mills different action programmes are carried out depending on where the contamination has been found. In some cases, e.g. if salmonella is found on the "clean" side i.e. after pelleting, manufacturing must stop and no feed must be delivered. The production lines have to be cleaned and disinfected and subsequent samples found salmonella-free before manufacturing can restart and feeds can be delivered again.

Each year a number of shipments of raw materials are found to be contaminated by salmonella. In 1995, on average 1.6 per cent of the samples were salmonella positive. Samples of compound feeds had the same incidence of salmonella positives, i.e. 2 out of 124. Of the two positive ones, one represented dog food and the other mink food. Out of more than 6,400 samples from the feed mills only 75 or 1.2 per cent were salmonella positive. This shows that the hygiene programmes are quite effective for controlling salmonella.

Further proof of the excellent salmonella status in Sweden is the fact that at present, less than 0.05 per cent of the farms holding either cattle, pigs or poultry are in quarantine due to salmonella infections.

The cost of the hygiene control schemes are quite high. In 1995, the cost of analysis amounted to US$260,000 (SEK 2 million). Additional costs arise from other activities e.g. sampling, cleaning, heat-treatment of feeds, disinfection of equipment and feed mills, decontamination of raw materials and reformulation of feeds. These are estimated to be around US$950,000 per annum (SEK 7.3 million) adding US$0.55/metric tonne to the cost of feed based on the annual national tonnage of 2.2 million metric tonnes.

(c) Campylobacter infections

In a small scale investigation of 42 samples of frozen and 13 samples of fresh chickens taken from food stores in the Stockholm area nine were found contaminated with Campylobacter (Ekman, 1994). Due to the small number of samples, however, the results are not to be considered as representative for the Campylobacter status in Swedish poultry meat.

IV. CONCLUSIONS

The Swedish farmers and farmers' organisations have set themselves the goal of having "the cleanest agriculture in the world". Within the framework of the so called "Swedish model" the means and activities to reach this goal have been described. In short, these are as follows:

• restrictive use of antibiotics in animal production;
• salmonella-free animal production;
• a ban on the use of hormones;
• high animal welfare status;
• environmental care.

The ban on the use of antibacterial feed additives in 1986 together with the strict hygiene regulations in animal and feed production are corner stones of the “model”. Meeting the standards has cost Swedish agriculture a lot of money. In return it has gained the confidence of the consumers and created an excellent marketing tool both for the domestic and export markets. It remains to be seen how this tool is being used. However, as the pro-ban forces seem to gain momentum the Swedish experiences appear increasingly valuable and can most likely be applied in many other countries. The Swedish “testing ground” has become a model for the future.

REFERENCES