BPEX Intervention Study

An evaluation of the effectiveness, costs and benefits, which three interventions undertaken on farm might have in reducing the prevalence of Salmonella

8th July 2008 – 28th February 2009

BPEX Intervention Study

Introduction

Salmonella is a food safety issue taken very seriously by the pig industry. Following the introduction of PCV 2 vaccines, clinical signs are relatively rare and Salmonella represents more of a hidden threat to the producer. A method of monitoring is needed when a disease is "sub-clinical" (pig shows no outward signs of disease). Finding a "reliable" test is difficult because the organism is only shed in the manure of carrier animals from time to time. If carrier animals are stressed, they are more likely to excrete bacteria in their faeces, which may then be cultured in the laboratory.
An abattoir based monitoring scheme was developed in Denmark based on sampling meat juices. An ELISA™ test is used to measure antibodies; it gives a positive result if the animal has been challenged by Salmonella between 12 and 3 weeks prior to slaughter. It is important to remember that a positive meat juice ELISA test result does **not** mean that pigs are excreting Salmonella at the time of slaughter.

This article describes work undertaken as part of a series of BPEX Salmonella control demonstration trials. The aim was to evaluate the effectiveness, costs and benefits, which three interventions undertaken on farm might have in reducing the prevalence of Salmonella.
Participating farmers were paid an incentive for each unit by BPEX on receipt of the data. This payment was intended to cover the costs associated with sampling and data collection, but the additional cost of any interventions was borne by the producers.

The standard of biosecurity, hygiene, record keeping and pest control was assessed on every farm prior to recruitment onto the trial. All sites were operated on an "all in/all out" basis and a rigid cleansing and disinfection programme was carried out between batches by the unit managers or a professional operator. No significant changes were made to routine medication programs during the trial.

Practical constraints precluded rigorous scientific disciplines. For example, contemporaneous "side by side" comparisons were not possible; data for the previous and subsequent batch of pigs through a particular unit were used as the control for the batch receiving the intervention.

The studies were carried out between the 8th July 2008 and the 28th February 2009 and a total of seventeen thousand and three hundred pigs entered the trial. The interventions were water acidification, feed acidification and oral vaccination.

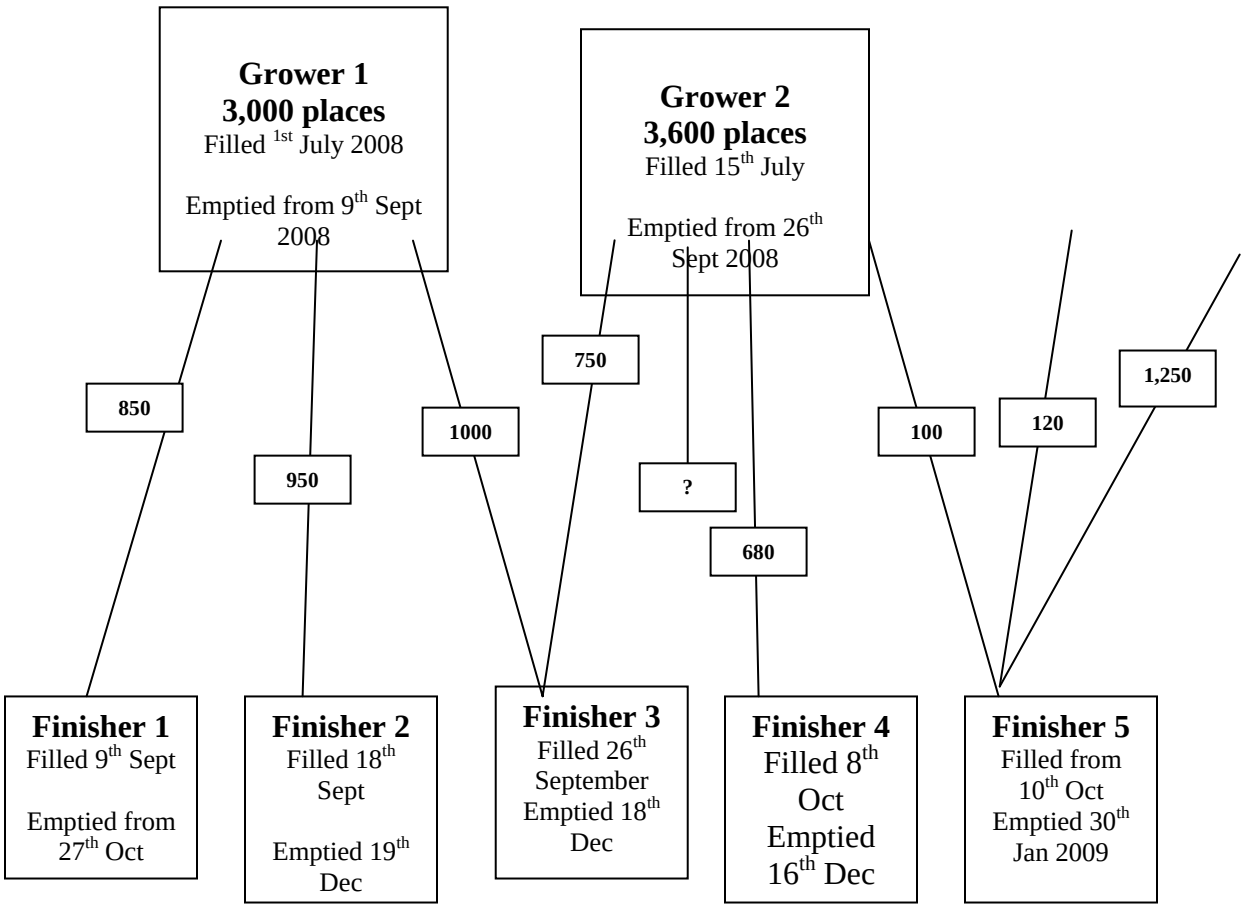
Up to thirty faeces samples were taken from each batch of pigs on entry to the grower sites where the intervention was acidification of the feed or water supply. Further samples were taken at the end of the intervention and monthly thereafter. Trial sites where vaccination was used were sampled three days after weaners arrived, just before vaccine administration. Thereafter samples were taken from each batch monthly.

The samples were taken directly to the local Veterinary Laboratories Agency at Thirsk to be cultured.
Performance data were gathered from the producers' records (Agrosoft Winpig). *It was not possible to allow for residual feed in bins between batches, which means that the individual Feed Conversion Ratios figures (FCRs) are unreliable*. The batch data for mortality and Daily Live Weight Gain (DLWG) are robust.
Prior notification from BPEX and notes written on the relevant Animal Movement Licences ensured that Salmonella meat juice ELISA testing was carried out at the point of slaughter.

All the pigs were out door bred, "sized" and reared to around 45 kg on a straw based system. Growers were selected and batched according to weight and moved to straw yard finishing accommodation. The target dead weight was 79 kg.

Water Acidification

The trial protocol indicated that the pigs' water supply should be acidified with "Selko pH" ™ according to manufacturers instructions for a three week period at weaning and that this treatment should be repeated on entry to the finishing accommodation. The pH of the drinking water was tested on each unit prior to the pigs arriving. Selko pH concentrate was added via a Dosatron at the required rate to lower the pH to 4.0.
Six thousand six hundred weaners were treated; two thousand three hundred drank acidified water for exactly three weeks and faecal sampling was performed exclusively on these pigs on the grower sites.
Four thousand three hundred drank acidified water for two to four weeks. When these pigs moved to the finisher sites, it was no longer possible to restrict sampling to the pigs treated for exactly three weeks.
On entry to the finisher sites, the same protocol was followed to ensure accurate dosing and **all** the pigs drank acidified water for three weeks.



Grower Sites

Culture results from the incoming weaners to Grower sites 1 and 2 showed a low prevalence of Salmonella infection (14.3% and 5.6% respectively). The Selko pH appears to have successfully controlled the spread of Salmonella over the stressful period of weaning, moving and mixing. The manager at Grower 1 commented that feed intakes dipped once the Selko-pH was withdrawn.

Only 1,000 of the 3,500 pigs on Grower 2 drank acidified water for 3 weeks; faecal samples were taken exclusively from these pigs. Selko pH was removed from the remaining 2,500 pigs after 2 weeks on site. When the site was emptied, finisher 3 received 750 pigs, some of which were only treated for two weeks. This may offer an explanation as to why all the pigs whose faeces cultured positive for Salmonella came from one yard at Finisher 3.
The manager at Grower 2 stated that the trial batch of pigs out performed any previous batch and requested permission to use Selko pH as a routine.

Both unit managers were delighted with the health and vitality of the trial batches. The performance data showed an increase in DLWG of 65g (Grower 1) and 62g (Grower2) when compared to their previous batches.

Finisher Sites

Finisher 1

No Salmonellae were cultured from any samples taken from Finisher 1. These had been some of the first 1,000 pigs to arrive at Grower 1 and they drank acidified water for 4 weeks; Grower 1 is only half a mile from Finisher 1, which is on the same holding. It is tempting to speculate that a short journey was less stressful and that Salmonella excretion was reduced relative to pigs traveling further. It is also possible that the manager's own transport posed a minimal risk of cross contamination. The same phenomenon was evident when pigs vaccinated against Salmonella moved the short distance from Grower 5 to Finisher 9 (on the same holding).
Meat-juice ELISA testing was carried out on 71 pigs at the abattoir and showed 31(44%) positive, 12 (17%) weak positive and 28 (39%) negative.

Performance data showed a higher mortality (3.2%), and worse FCR (0.31) when compared with the previous "control" group; the DLGWs were very similar. The higher mortality was said to reflect a poorer batch of weaners on entry.

Finisher 2

There were no positive faecal cultures three weeks after the pigs arrived on site, when the Selko-pH was withdrawn. Four weeks later there was 100% positivity. This suggests that the water acidification suppressed excretion of Salmonellae, but did not eliminate the carrier status. Another explanation is that the pigs may have been re-infected from a contaminated environment.
Meat-juice ELISA testing was carried out on *24 samples 10 (42%) positive 6 (25%) weak positive and 8 (33%) negative.* The previous batch were 100% positive (only eight pigs sampled).

There was an increase in DLWG of 82 g/day in the trial batch as compared to the previous batch through this unit. There were reports of looseness in the pigs, but there were no signs of ill health. Mortality and FCR deteriorated (0.7% and 0.31 FCR higher) in comparison to the previous "control" group.

Finisher 3

The faecal culture results ranged from 16.7% to 25% positive and the performance data appeared to show no advantage in the trial batch in comparison with the previous control group.
Meat-juice ELISA testing was carried out on *71 pigs at abattoir 39 (55%) positive 14 (20%) weak positive and 18 (25%) negative, the previous batch* (*8/8) was 100% positive.*

The experience on this unit highlighted the importance of enthusiasm and cooperation from unit managers. Repeated visits to the site were required to ensure that the calculated amount of Selko-pH was added to the stock solution entering the Dosatron during the trial period.

Finisher 4

Faecal sampling at the source unit (Grower 2) suggested a low prevalence of Salmonella in the incoming trial batch. All subsequent faecal samples from the same pigs on this unit cultured positive for Salmonellae. It is possible that the renowned starling infestation on this site is the source of infection.

Meat-juice ELISA testing was carried out on 52 pigs at the abattoir and showed 60% positive, 19% weak positive and 21% negative.

Despite the apparent high level of Salmonella challenge, performance remained good and was very similar to the previous batch.

Interestingly, the subsequent batch of pigs entering Finisher 4 (renamed “Finisher 13” for the purposes of this report) had been vaccinated at Grower 5. Faecal cultures from 50% per cent of these pigs were positive 3 weeks after entry. One month later, no Salmonellae were cultured from this batch, suggesting that vaccination may have had a protective effect against the establishment of “carrier status” in these pigs.

Finisher 5

Culture results from Grower sites 2 and 3 suggested a low level of Salmonella infection in the incoming pigs. Despite this, 50% of the faeces samples taken after the water acidification programme cultured positive. Subsequent cultures yielded 70% positivity. This unit appears to provide compelling evidence for the involvement of birds in the transmission of Salmonellae: three of the yards are bird proof and faecal cultures from these buildings remained negative throughout. The other four yards are not bird-proof and these contributed exclusively to the 70% positive cultures. There is a large population of feral pigeons on the site and a more detailed scrutiny of the results showed that pigs in the bird-proof yards remained negative throughout the trial, whereas the yards to which birds have access were 100% positive at their last test. This strongly suggests that the Salmonella challenge was from birds.

Meat-juice ELISA testing was carried out on 57 pigs at the abattoir and showed 75.5% positive, 14% weak positive and 10.5% negative.

DLWG was 45 g/day faster in the intervention batch compared with the previous batch through this unit.

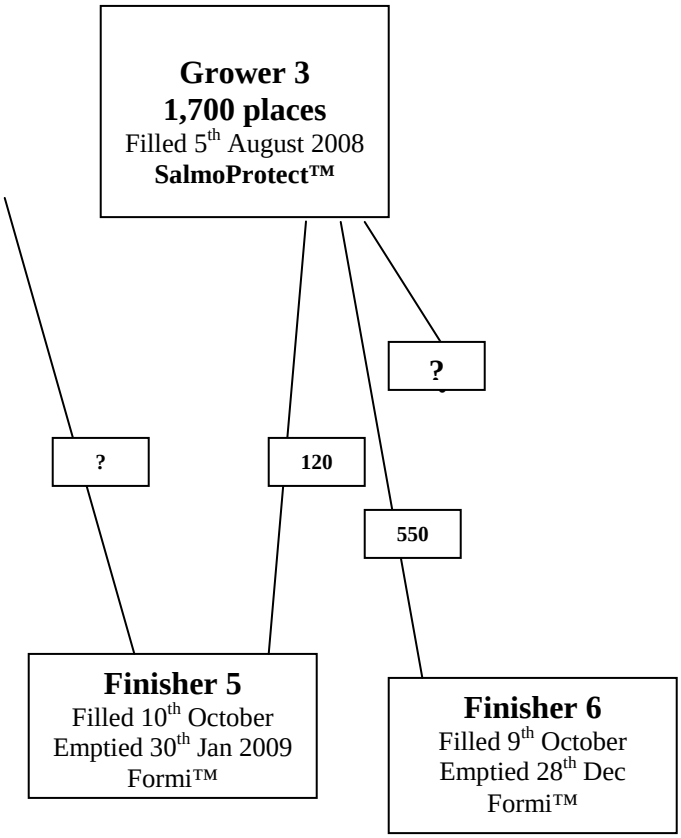
Summary

- Managers of grower sites commented on the health and vitality of the pigs on the trial and the Daily Live Weight Gains were 63.5g higher on average than the previous batches.
- Short-term acidification of the water may suppress, but does not eliminate Salmonella infection; continuous acidification throughout the finisher phase was not investigated.
- Transporting pigs long distances promotes excretion.
- Appetite and performance seem to be enhanced when the water is acidified.
- Birds pose a serious threat to the Salmonella status of pigs.
- There was **no** correlation between serial faecal culture and meat-juice ELISA test results when the drinking water was acidified.

Feed Acidification

The trial protocol was to acidify the pigs' feed supply using organic acids for three weeks post-weaning and again for three weeks following transfer to the finishing unit.

The gruel and starter diets of sixteen hundred weaners were medicated with "SalmoProtect" ™ for three weeks following entry. This treatment was repeated on entry to the finishing accommodation with "Formi"™.



Grower Site

Grower 3

11.1% of the faeces samples taken on arrival yielded Salmonella. Thereafter, no Salmonellae were isolated from this group. Performance data showed similar mortality in the trial and previous "control" groups, DLWG was 52 g/day slower and FCR appeared to be 0.76 lower in the treated pigs.

Finisher Sites

Finisher 6

Faecal cultures were all negative on entry, supporting the findings at the source unit (Grower 3). Three weeks later, samples from one yard remained culture negative, whilst the other was 100% positive. Detailed knowledge of the unit does not help to explain these findings, which may reflect the small sample size.

Meat-juice ELISA testing was carried out on 32 pigs at the abattoir and showed 87.5% positive, 12.5% weak positive and no negatives.

The mortality was 1.4% higher in the trial pigs, but they grew 66 g/day faster and FCR appeared to be 0.3 lower.

Finisher 7

On this site, pigs were treated in feed on entry for three weeks with Formi; there had been no intervention or monitoring on the source unit.

Faecal cultures were 70% positive on entry and remained at 60% positive when samples were taken one and two months later. Nevertheless, the pigs out performed the previous batch (mortality 1.3% lower, DLWG 162g faster and FCR 0.2 lower). The unit manager commented on their performance at the time.

Meat-juice ELISA testing was carried out on 47 pigs at the abattoir and showed 83% positive, 17% weak positive and no negatives.

Summary

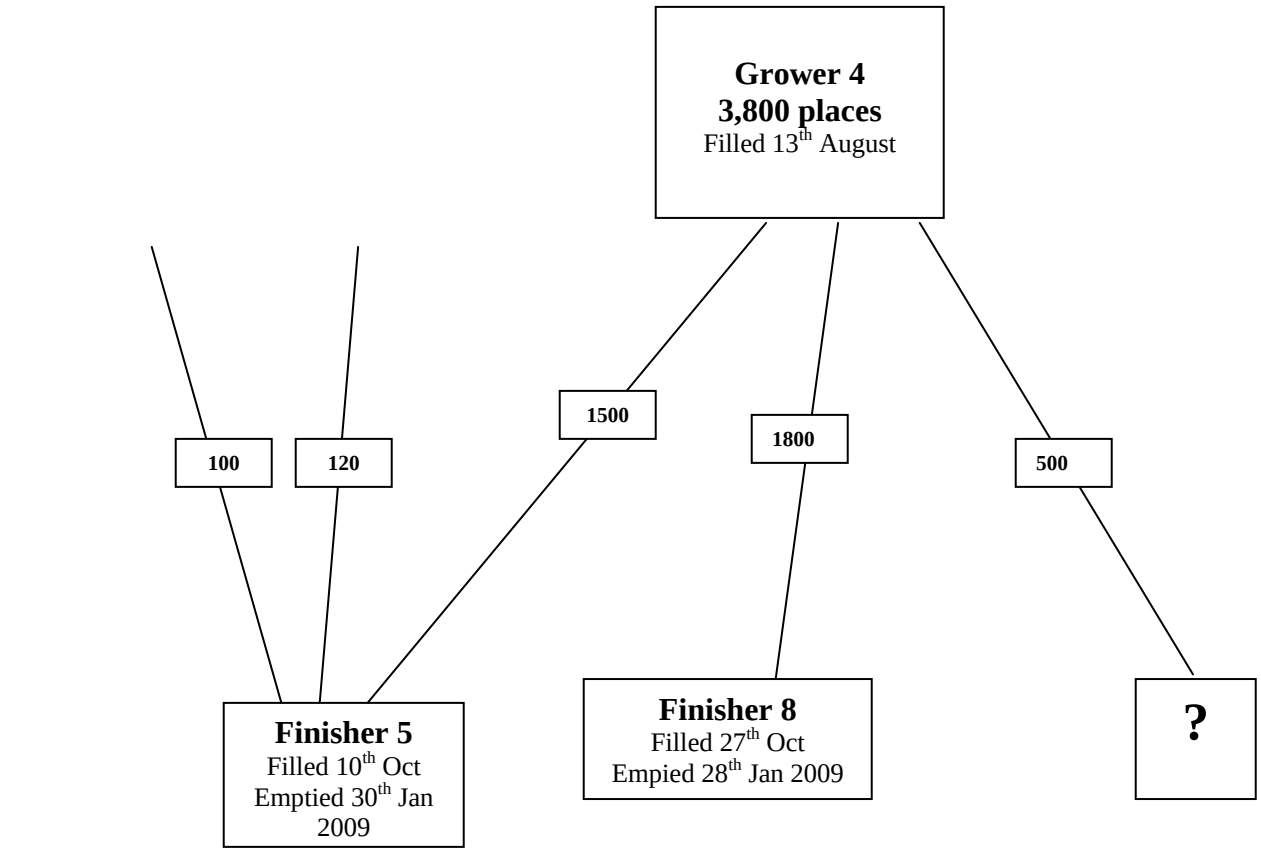
- Short-term acidification of the feed appeared to control Salmonella on the grower site (Salmoprotect), but the results were inconsistent on the finisher sites (Formi).
- Long-term acidification throughout the finisher phase was not investigated
- Performance may be enhanced by feed acidification.
- There is some correlation between serial faecal culture and meat-juice ELISA test results when the feed is acidified study.

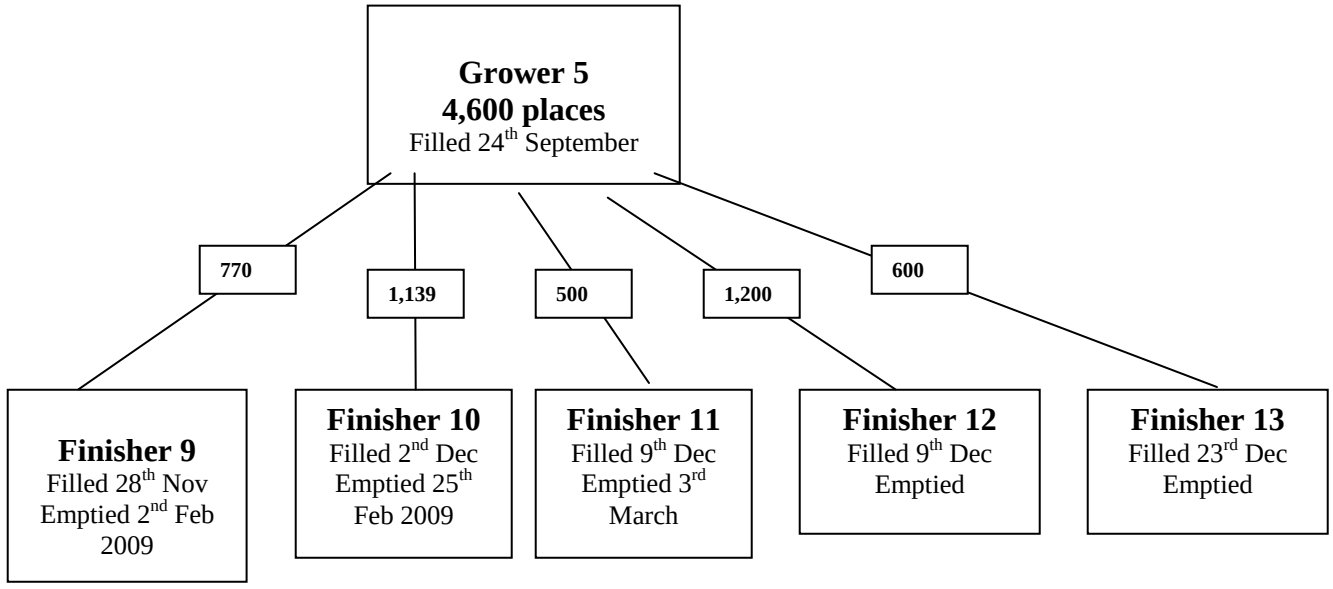
Vaccination

Avipro Salmonella Vac T* (live Salmonella typhimurium vaccine) was administered to eight thousand and four hundred weaners in the gruel three days after entry to the grower sites.

Following a feed recovery trial, a dose of five times the poultry dose was chosen as the target dose per pig. Sterilised plastic containers and equipment were used to mix the vaccine with the required amount of water to make up an amount of gruel which it was known would be eaten by the pigs within twenty minutes, whilst ensuring that all pigs were fed (estimated at sixteen grammes dry matter per pig).

No medication was administered prior to, or for four days after vaccination.


Grower 4
3,800 places
Filled 13th August
100
120
1500
1800
500
Finisher 5
Filled 10th Oct
Emptied 30th Jan 2009
Finisher 8
Filled 27th Oct
Empied 28th Jan 2009
?


Grower 5
4,600 places
Filled 24th September
770
1,139
500
1,200
600
Finisher 9
Filled 28th Nov
Emptied 2nd Feb 2009
Finisher 10
Filled 2nd Dec
Emptied 25th Feb 2009
Finisher 11
Filled 9th Dec
Emptied 3rd March
Finisher 12
Filled 9th Dec
Emptied
Finisher 13
Filled 23rd Dec
Emptied

Grower Sites

Grower 4

No significant trend was evident in the faecal culture results (62.5% positive on entry) and the performance data were very similar to the previous batch through the unit.

This study highlighted that the practicalities of delivering a measured dose of vaccine to a large number of pigs should not be under-estimated.

Grower 5

Faecal cultures remained negative throughout the sampling period. This suggests differences in the status of weaners from the breeding units supplying Growers 4 & 5.

The performance data from the vaccinated pigs were similar to the previous batch through this unit except that the vaccinated batch grew 46 g/day slower. It is possible that the vaccine was responsible for this apparent loss of performance and it will be interesting to compare the subsequent batch.

Finisher Sites

Finisher 8

Faecal culture results fluctuated from 70 to 90%.

Meat-juice ELISA testing was carried out on 68 pigs at the abattoir and 100% were positive.

Performance improved dramatically in comparison with the previous batch (mortality 1.7% lower, DLWG 119g faster but FCR 0.1 higher). The unit manager was convinced of the cost-benefit of this intervention.

Finisher 9

Faecal culture results from the source grower unit (Grower 5) showed no evidence of Salmonella and faecal cultures remained negative throughout sampling on this unit. Grower 5 has a large wild bird population and is located within a mile of a tip. Previous ZAP investigations undertaken by the VLA have highlighted the bird population as a source of Salmonella. It seems that the vaccination policy may have been helpful in providing some protection against an ongoing challenge. Grower 5 is only a mile from Finisher 9, which is on the same holding. As noted under Grower 1 and Finisher 1, it is tempting to speculate that a short journey was less stressful and that Salmonella excretion may have been reduced relative to pigs traveling further. Again it is possible that the manager's own transport posed a minimal risk of cross contamination. It is possible to argue against this because some of the same weaners were transported 35 miles to Finisher 13 and this batch also remained negative on culture despite the prevailing starling problem.

Meat-juice ELISA testing was carried out on 28 pigs at the abattoir and showed 7.14% positive, 10.72% weak positive and 82.14% negative.

The performance data showed a higher mortality (1.4%) in the trial group and a lower DLWG (40g). The FCR data were spurious because feed deliveries had been allocated incorrectly to Grower 5 and Finisher 9.

Finisher 10

Faecal cultures suggested a high prevalence of Salmonella in this batch of pigs throughout the trial period.

Meat juice ELISA testing was carried out on 34 pigs at the abattoir and showed 76.4% positive, 23.5% weak positive and no negatives.

Despite the high prevalence of Salmonella, the performance data were impressive; mortality was lower, DLWG 133 g/day higher and FCR appeared to be 0.4 lower in the vaccinated batch.

Finisher 11

Faecal cultures suggested a high prevalence of Salmonella in this batch of pigs throughout the trial period. The DLWG was 76 g/day higher in the vaccinated pigs, but otherwise the data were unremarkable in comparison to the previous batch.

Meat-juice ELISA testing was carried out on 48 pigs at the abattoir and showed 38 (79%) positive, 8 (17%) weak positive and 2 (4%).

S. Derby was isolated and the known rat infestation in the adjacent ditch represents a likely source of infection.

Finisher 12

Faecal cultures showed a 40% prevalence of Salmonella on entry, which halved a month later. *Meat juice ELISA testing was carried out on 8 pigs at the abattoir and showed 7 (87.5%) positive, 1 (12.5%) weak positive and no negatives.*

Mortality was higher in the trial group, but they grew 60 g/day faster.

Finisher 13

Faecal cultures from 40% of this batch of pigs yielded Salmonella on entry. One month later, no Salmonellae were cultured, suggesting a possible protective effect of vaccination. *Meat-juice ELISA testing was carried out on 14 pigs at the abattoir and showed 4 (29%) positive, 1 (7%) weak positive and 9 (64.3%) negatives.*

This is the same unit as Finisher 4 and so the previous “control” batch formed part of the Selko pH intervention trial. Performance data were superior for the Selko pH treated group, which yielded 100% positive faecal cultures on entry and again one month later. The vaccinated pigs were 50% positive on faecal culture on entry and 100% negative one month later. It will be interesting to compare performance in the subsequent batch.

Summary

- The vaccination programme seemed to be protective on one site with a known history of a high prevalence of Salmonella.
- Transporting pigs long distances promotes excretion
- There appears to be some correlation between serial faecal culture and meat-juice ELISA test results in vaccinated pigs.
- It appears that sub-clinical Salmonellosis does impair performance.

This study highlights the difficulties associated with controlling Salmonellosis. Controlling spread of sub-clinical disease in welfare friendly, out-door bred, straw based systems is notoriously difficult. A delicate balancing act is required to satisfy the consumer, pacify the processor and magnify any potential benefits to the producer.

Acknowledgements:
A great deal of hard work went into these field studies in the certain knowledge that there would be no earth shattering conclusions; I would like to thank John Ward for organizing the whole trial and taking all the samples - without his enthusiasm the study would have undoubtedly foundered. I would also like to thank the owners, managers and staff on all the farms. Geoff Cartwright (Orffa UK Ltd.) and David Hodson (Rosehill Agricultural Trading Co.) provided encouragement, technical support and practical guidance on farm.

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Appendix 1 – Results and Performance Data

(1) Water scidification sites

(a) Grower Sites

Grower 1

Faecal Cultures:

Date Sampled	Entry	One month	Two Months
Total Sampled	14	10	10
Total Positive	2	0	0
% Positive	14.3	0	0

Performance Data:

	Control Batch (previous)	Intervention Batch
Total Mortality	41	41
Percentage Mortality	1.5	1.4
DLWG (g/day)	475	540
FCR	1.84	1.84
Age at Exit (days)	62	77
Weight at Exit (kg)	39.9	48.2

Grower 2

Faecal Cultures:

Date Sampled	Entry	One month	Two Months
Total Sampled	18	9	10
Total Positive	1	0	1
% Positive	5.6	0	10

Performance Data:

	Control Batch (previous)	Intervention Batch
Total Mortality	102	44
Percentage Mortality	3.0	1.3
DLWG (g/day)	537	599
FCR	1.88	1.57
Age at Exit (days)	74	70
Weight at Exit (kg)	47.2	48.5

(b) Finisher Sites

Finisher 1

Faecal Cultures:

Date Sampled	Entry	One month	Two Months
Total Sampled	10	10	10
Total Positive	0	0	0
% Positive	0	0	0

Performance Data:

	Control Batch (previous)	Intervention Batch
Total Mortality	2	29
Percentage Mortality	0.8	4
DLWG (g/day)	1107	994
FCR	2.63	2.94
Age at Exit (days)	52	57
Weight at Exit (kg)	74.1	81.4

Finisher 2

Faecal Cultures:

Date Sampled	Entry	One month	Two Months
Total Sampled	10	10	-
Total Positive	0	10	-
% Positive	0	100	-

Performance Data:

	Control Batch (previous)	Intervention Batch
Total Mortality	10	17
Percentage Mortality	1	1.7
DLWG (g/day)	778	860
FCR	2.63	2.83
Age at Exit (days)	77	69
Weight at Exit (kg)	79.3	81.1

Finisher 3

Faecal Cultures:

Date Sampled	Entry	One month	Two Months
Total Sampled	12	12	-
Total Positive	2	3	-
% Positive	16.7	25	-

Performance Data:

	Control Batch (previous)	Intervention Batch
Total Mortality	33	32
Percentage Mortality	2.2	1.8
DLWG (g/day)	843	861
FCR	2.49	2.88
Age at Exit (days)	69	69
Weight at Exit (kg)	77.7	81.1

Finisher 4

Faecal Cultures:

Date Sampled	Entry	One month	Two Months
Total Sampled	10	10	-
Total Positive	10	10	-
% Positive	100	100	-

Performance Data:

	Control Batch (previous)	Intervention Batch
Total Mortality	10	16
Percentage Mortality	1.7	2.4
DLWG (g/day)	836	858
FCR	3.04	2.93
Age at Exit (days)	71	66
Weight at Exit (kg)	78.2	80.1

Finisher 5

Faecal Cultures:

Date Sampled	Entry	One month	Two Months
Total Sampled	10	10	-
Total Positive	5	7	-
% Positive	50	70	-

Performance Data:

	Control Batch (previous)	Intervention Batch
Total Mortality	35	55
Percentage Mortality	2	3.1
DLWG (g/day)	747	792
FCR	2.31	3.03
Age at Exit (days)	71	69
Weight at Exit (kg)	76.1	77.4

(2) Feed Acidification sites

(a) Grower Site

Grower 3

Faecal Cultures:

Date Sampled	Entry	One month	Two Months
Total Sampled	9	10	10
Total Positive	1	0	0
% Positive	11.1	0	0

Performance Data:

	Control Batch (previous)	Intervention Batch
Total Mortality	20	22
Percentage Mortality	1.2	1.3
DLWG (g/day)	593	541
FCR	2.15	1.39
Age at Exit (days)	67	65
Weight at Exit (kg)	47.1	43

(b) Finisher Sites

Finisher 5

Faecal Cultures:

Date Sampled	Entry	One month	Two Months
Total Sampled	10	10	-
Total Positive	5	7	-
% Positive	50	70	-

Performance Data:

	Control Batch (previous)	Intervention Batch
Total Mortality	35	55
Percentage Mortality	2	3.1
DLWG (g/day)	747	792
FCR	2.31	3.03
Age at Exit (days)	71	69
Weight at Exit (kg)	76.1	77.4

Finisher 6

Faecal Cultures:

Date Sampled	Entry	One month	Two Months
Total Sampled	10	10	-
Total Positive	0	5	-
% Positive	0	50	-

Performance Data:

	Control Batch (previous)	Intervention Batch
Total Mortality	5	12
Percentage Mortality	1	2.4
DLWG (g/day)	813	879
FCR	2.92	2.58
Age at Exit (days)	69	68
Weight at Exit (kg)	78.3	79.8

Finisher 7

Faecal Cultures:

Date Sampled	Entry	One month	Two Months
Total Sampled	8	10	10
Total Positive	6	6	6
% Positive	75	60	60

Performance Data:

	Control Batch (previous)	Intervention Batch
Total Mortality	24	7
Percentage Mortality	2.7	1.4
DLWG (g/day)	694	856
FCR	2.98	2.8
Age at Exit (days)	83	73
Weight at Exit (kg)	77.2	81.4

(3) Vaccination Sites

(a) Grower Sites

Grower 4

Faecal Cultures:

Date Sampled	Entry	One month	Two Months
Total Sampled	8	10	10
Total Positive	5	5	4
% Positive	62.5	50	40

Performance Data:

	Control Batch (previous)	Intervention Batch
Total Mortality	78	87
Percentage Mortality	2.2	2.3
DLWG (g/day)	525	553
FCR	1.85	1.82
Age at Exit (days)	70	68
Weight at Exit (kg)	44	44.6

Grower 5

Faecal Cultures:

Date Sampled	Entry	One month	Two Months
Total Sampled	12	10	10
Total Positive	0	0	0
% Positive	0	0	0

Performance Data:

	Control Batch (previous)	Intervention Batch
Total Mortality	77	53
Percentage Mortality	1.5	1.2
DLWG (g/day)	570	524
FCR	2.1	1.8
Age at Exit (days)	82	68
Weight at Exit (kg)	54	42.8

Finisher Sites

Finisher 8

Faecal Cultures:

Date Sampled	Entry	One month	Two Months
Total Sampled	10	10	-
Total Positive	7	9	-
% Positive	70	90	-

Performance Data:

	Control Batch (previous)	Intervention Batch
Total Mortality	58	31
Percentage Mortality	3.9	2.2
DLWG (g/day)	738	857
FCR	2.95	3.06
Age at Exit (days)	75	68
Weight at Exit (kg)	77.3	78.2

Finisher 9

Faecal Cultures:

Date Sampled	Entry	One month	Two Months
Total Sampled	10	10	-
Total Positive	0	0	-
% Positive	0	0	-

Performance Data:

	Control Batch (previous)	Intervention Batch
Total Mortality	6	16
Percentage Mortality	0.8	2.2
DLWG (g/day)	1029	989
FCR	2.08	1.02
Age at Exit (days)	67	61
Weight at Exit (kg)	81.5	76.3

Finisher 10

Faecal Cultures:

Date Sampled	Entry	One month	Two Months
Total Sampled	10	10	-
Total Positive	9	7	-
% Positive	90	70	-

Performance Data:

	Control Batch (previous)	Intervention Batch
Total Mortality	17	9
Percentage Mortality	1.6	0.8
DLWG (g/day)	779	912
FCR	3.22	2.81
Age at Exit (days)	67	69
Weight at Exit (kg)	81.7	80.5

Finisher 11

Faecal Cultures:

Date Sampled	Entry	One month	Two Months
Total Sampled	10	10	-
Total Positive	9	8	-
% Positive	90	80	-

Performance Data:

	Control Batch (previous)	Intervention Batch
Total Mortality	11	13
Percentage Mortality	2.2	2.7
DLWG (g/day)	750	826
FCR	2.95	2.83
Age at Exit (days)	67	67
Weight at Exit (kg)	79.8	76.3

Finisher 12

Faecal Cultures:

Date Sampled	Entry	One month	Two Months
Total Sampled	10	10	-
Total Positive	4	2	-
% Positive	40	20	-

Performance Data:

	Control Batch (previous)	Intervention Batch
Total Mortality	23	39
Percentage Mortality	1.7	3.1
DLWG (g/day)	799	859
FCR	2.33	2.5
Age at Exit (days)	55	68
Weight at Exit (kg)	79.8	77.4

Finisher 13

Faecal Cultures:

Date Sampled	Entry	One month	Two Months
Total Sampled	10	10	-
Total Positive	4	0	-
% Positive	40	0	-

Performance Data:

	Control Batch (previous)	Intervention Batch
Total Mortality	16	31
Percentage Mortality	2.4	4.7
DLWG (g/day)	858	778
FCR	2.93	2.75
Age at Exit (days)	66	73
Weight at Exit (kg)	80.1	76