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ivomec

Better products mean better results.

Photo Eric Guillot

INTRODUCTION

Parasites are an important cause of reduced productivity in grower pigs and breeding herds. *Sarcoptes scabiei* var *suis*, the mite responsible for sarcoptic mange (scabies) in swine, affects the majority of herds throughout the world, suppressing growth rate and feed efficiency in growing pigs. The majority of studies demonstrate declines in growth rate of between 4.5% and 12%. Studies also show that improved mange control will reduce piglet mortality (Forgues *et al,* 1988) and increase weaning weights (Arends *et al,* 1990; Dalton and Ryan, 1988). Following prefarrowing treatment of sows, feed utilisation efficiency also improved. Other economic effects of sarcoptic mange include downgrading and trimming of carcasses at slaughter and damage to pens and fixtures caused by rubbing pigs.

Although sarcoptic mange is the most important parasitic disease of swine, lice and worms also can reduce performance of pig herds. The sucking louse (*Haematopinus suis*) causes irritation, blood loss, and loss of productivity. The economic importance of sucking lice has not been critically evaluated to the same extent as mange, but heavy infestations will result in anaemia in young pigs and may affect growth rate and feed efficiency.

Worms also affect productivity. *Ascaris suum*, the large roundworm, is the most common internal parasite of pigs. Clinical signs of infection include diarrhoea and anaemia. Although worms may kill, loss of appetite, reduction in rate of daily gain, poor feed utilisation, and secondary infection by other pathogens are the most common results of parasitism. The damage caused by the migration or presence of roundworms also can result in liver condemnation and increased trim losses. (Corwin and Stewart 1999). However, even if infection is not obvious, parasites can still significantly reduce swine productivity.

A Breakthrough in Parasite Control

In 1975, scientists discovered a soil-dwelling organism, *Streptomyces avermitilis*, which produced highly active antiparasitic compounds. The discovery triggered years of intense scientific activity that resulted in the development of ivermectin, the first compound of the avermectin/milbemycin class, and, eventually, in the introduction of IVOMEC. IVOMEC was the first product that controlled endo- and ectoparasites — a unique feature that gave rise to the term 'endectocide'. Compared to other antiparasitics, IVOMEC offered a breakthrough in efficacy, safety, spectrum and convenience at a dose that was a fraction of that of earlier compounds.

The launch of IVOMEC had an immediate impact on mange control in pigs. Prior to the introduction of IVOMEC, producers relied primarily on topical acaricides to control sarcoptic mange. These sprays achieved variable results, were stressful to pigs, time consuming to apply, required frequent retreatment and posed safety hazards to animals, handlers, and the environment. In contrast, IVOMEC offered unprecedented potency, an excellent safety margin, convenient administration, a novel mode of action and an unparalleled spectrum. These characteristics quickly made IVOMEC the treatment of choice for arthropod and nematode parasitism in pigs and other species, including, cattle, sheep, goats, and horses (Benz *et al,* 1989; Campbell *et al,* 1983; Campbell and Benz, 1984). To date, more than 5 billion doses have been given worldwide, including more than 600 million doses for swine

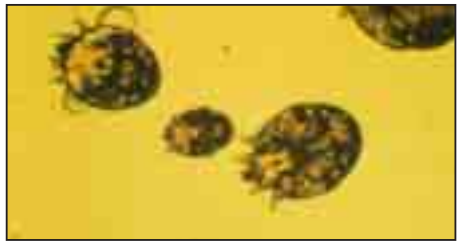
The leap ahead made by IVOMEC remains unsurpassed — no compound has been found that improves on the product's low dose (Shoop *et al,* 1995). Despite imitator endectocides, IVOMEC continues to be the most widely used and trusted brand in the history of animal health. Ivermectin, the active ingredient of IVOMEC, has also revolutionised parasite control in humans. More than 110 million doses have been given to people to combat river blindness, reflecting the compound's excellent safety profile.

Ivermectin is now registered for use in 13 mammalian species and in 90 countries. More than 3,000 scientific publications show ivermectin's efficacy against 190 internal and 120 external parasites. IVOMEC is available in a range of patented, user-friendly formulations. For swine, these include: IVOMEC 1% Injection, IVOMEC 0.27% Injection (a dilute formulation developed to facilitate more accurate dosing of piglets) and IVOMEC Premix, an in-feed formulation for grower and breeding pigs.

The Weight of Evidence

Since the launch of IVOMEC, work has progressed to show how each formulation may be used to improve the profitability of pig production. Global trials focusing on various types of swine operations have proved that parasite control with IVOMEC can lead to increased body weight gain, faster growth to market weight, better sow productivity and improved performance in fattening pigs. Even where there was a low parasite challenge, trials demonstrated that productivity enhancement from parasite control with IVOMEC increased profitability.

The results of the efficacy/productivity trials and mange control and eradication programs described in this publication by recognised experts in swine parasitology, show why IVOMEC remains the gold standard in parasite control. See for yourself the production benefits that IVOMEC brings.



Mange mites (*Sarcoptes scabiei* var *suis*) are responsible for sarcoptic mange, the most important parasitic disease of swine, suppressing growth rate and feed efficiency in swine herds throughout the world.

Large round worms *(Ascaris suum)* are the most significant swine endoparasites, causing extensive economic losses due to morbidity, mortality and condemnation of livers.

Our sincere thanks go to the renowned scientists who contributed their work to this publication. We hope that their informative articles, supported by research which has advanced our knowledge of swine parasite control and eradication, will benefit swine producers worldwide.

Photo Eric Guillot

Superior Efficacy Against Mange Mites

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The unique pharmacological characteristics of ivermectin, related to its potent systemic activity against *Sarcoptes scabiei* var *suis*, have been demonstrated worldwide; several mange efficacy trials performed with ivermectin are described herein.

IVOMEC Acts where Mange Mites and Lice Occur

When IVOMEC is given subcutaneously at a dose rate of 300 µg/kg, high concentrations of ivermectin are found in the ear wax, skin, and ears. The great predilection for mites to concentrate in these sites makes IVOMEC particularly useful against mites (Scott and McKellar, 1992).

Recent studies have confirmed the persistent activity of IVOMEC Injection, with no mites recovered for 6 weeks after pigs were challenged 12 days post IVOMEC treatment (Cargill *et al*, 1999). This finding suggests that IVOMEC outlasts the mite egg incubation period, estimated to be 3 to 10 days. No difference was found between IVOMEC and DECTOMAX® (doramectin) when pigs were challenged more than 12 days post treatment.

The eradication of mange from large pig herds on many farms in Denmark (Ebbesen and Henriksen, 1986; Jensen, 1988; Ebbesen, 1998), Holland (Lambers, 1994, Rambags *et al*, 1998), Belgium (Smets *et al*, 1998), Australia (Cargill *et al*, 1996), Germany (Koheler and Zabke, 1998), USA (Mohr, 1999), illustrates that in practice, the efficacy and prolonged protection induced by IVOMEC Injection or Premix, effectively breaks the mange mite life cycle.

Study after study shows the high efficacy of IVOMEC. Many studies provide evidence that IVOMEC Injection at 300 µg/kg eliminates *Sarcoptes scabiei* from infested pigs (Lee *et al*, 1980; Brokken *et al*, 1983; Alva-Valdes *et al*, 1984). The recommended dose level of IVOMEC Premix 100 µg/kg given for 7 consecutive days has also been shown to provide complete efficacy against internal and external parasites (Alva-Valdes *et al*, 1989; Foster *et al*, 1992; Wallace *et al*, 1996).

IVOMEC: Trial Designs

In the design of efficacy trials against *S. scabiei*, the detection of mites is critical; a positive diagnosis is made when live mites are found in skin scrapings taken from deep inside the pinna of the ear. Because this technique has a low sensitivity (that is, scrapings will miss mites on many occasions) repeated sampling was completed to increase the chance of detecting mites. The main aim of treatment should be complete elimination of all mites in all animals, as a 100% cure rate will ensure eradication of mites from

a herd. The reduction of clinical signs — erythematous papules, skin abrasions, hair loss, encrusted lesions, pruritus — may be a more sensitive indicator of efficacy, since a high percentage of animals show lesions before mites are detected. Other variables used to determine product efficacy, such as reductions in dermatitis score and antibody concentrations, need to be considered cautiously; they may be more useful when overall control and eradication programs are considered.

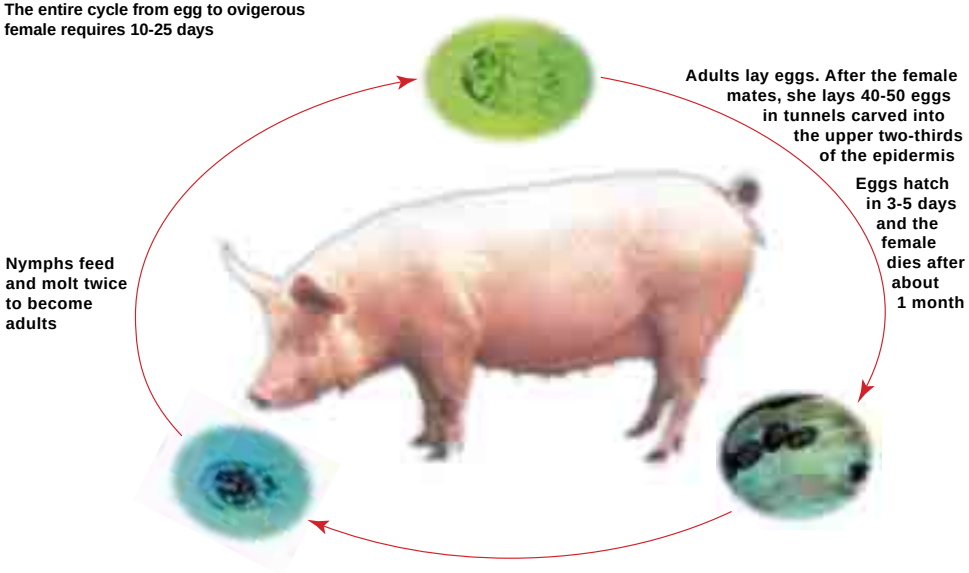
Studies Prove Consistent Efficacy of IVOMEC against *Sarcoptes scabiei* var *suis*

Several studies confirm the efficacy of IVOMEC, in the absence of reinfection, based on the presence or absence of mites in ear scrapings before, and up to 42 days after treatment. TABLES 1 and 2 summarise studies performed with IVOMEC Injection and IVOMEC Premix. In six of the eight studies with IVOMEC Injection, the cure rate was 100%. In the two remaining studies, overall mite reduction was >99%. The cure rate in the eight trials performed with IVOMEC Premix was 100%.

Mite eggs deposited in burrows in skin. Larvae that hatch may create side tunnels or leave the area and migrate to undamaged skin to burrow new tunnels.

Other independent authors have also reported excellent results. Courtney *et al,* 1983, showed that treatment of infected sows with IVOMEC Injection 8 to 37 days before farrowing eliminated mange from the sows and prevented transmission to the piglets. Pigs farrowed by sows treated with IVOMEC remained noninfected until the termination of the experiment at 12 weeks of age (White and

Life cycle of *Sarcoptes scabiei* var *suis* (the sarcoptic mange mite)



Source: Cargill and Davies, 1999

Table 1. Summary of sarcoptic mange efficacy studies in pigs treated with IVOMEC Injection

Trial	No. of Controls	Day -1/0	Day 14	Day 28	Day 42	No. Medicated	Day -1/0	Day 14	Day 28	Day 42
US1	8	71.5	59.3	209.7	43.6	4	70.9	0.0	0.0	0.0
GER1	3	7.4	11.9	11.4	0.6	2	3.7	0.0	0.0	0.0
US2	3	3.3	--	0.6	7.6	6	12.0	--	0.0	0.0
GER2*	5	7.2	2.2	0.0	0.0	5	6.8	0.3	0.0	0.0
US3	6	3.9	4.3	5.8	8.9	6	4.8	0.0	0.0	0.0
S Af	6	342.2	--	335.8	280.7	12	241.2	--	0.0	0.0
GER3	5	108.8	90.9	65.8	57.9	5	238.2	2.3	1.3	0.7
AUS	10	112.0	8.8	29.9	42.2	10	114.5	0.1	0.0	0.3
Overall† reduction from control	46	27.6	14.1	18.4	15.0	50	31.8	0.3 98%	0.1 >99%	0.1 >99%
Reduction from pretreatment										>99%

Data from Cramer *et al* (1996)
*Pigs were treated intramuscularly. Pigs were naturally infested in all studies except GER 2.
†Trials equally weighed.
US = United States; GER = Germany; S Af = South Africa; AUS = Australia.

Table 2. Summary of sarcoptic mange efficacy studies in pigs treated with IVOMEC Premix

Trial	No. of Controls	Day Pre	Day 14	Day 28	Day 42	No. Medicated	Day Pre	Day 14	Day 28	Day 42
SP*	9	71.4	38.3	17.7	22.6	9	63.3	0.0	0.0	0.0
US1*	8	54.1	73.2	31.9	18.4	8	35.3	0.0	0.1	0.0
US2*	28	6.2	9.0	4.7	1.3	27	6.0	0.0	0.0	0.0
US3*	10	18.8	4.7	2.5	0.1	10	15.5	0.0	0.0	0.0
US4*	10	1.0	1.0	0.4	0.1	10	1.4	0.0	0.0	0.0
GER*	10	37.7	9.1	>6.9	3.6	10	32.0	0.0	0.0	0.0
US5*	7	115.6	35.4	21.2	2.2	7	102.3	0.0	0.0	0.0
US6+	8	61.3	53.9	39.4	49.0	8	59.1	0.0	0.0	0.0
Overall reduction from control		26.84	15.9	9.2	4.6	81	23.6	0.0 100%	<0.1 >99%	0.0 100%
Reduction from pretreatment										100%

Pigs were naturally infested in all studies except USA 4 and GER (induced infestation superimposed on natural).
*Data from Cramer *et al* (1996)
+Data from Alva-Valdez *et al* (1989)
SP = Spain; US = United States; GER = Germany.

Ryan, 1987; Dalton and Ryan, 1988; and Martineau *et al*, 1984). Similar results with IVOMEC Premix were reported by Primm *et al,* 1992. Finally, Nilsson *et al,* 1994, Roppa *et al,* 1996, and Garcia *et al,* 1998, described effective control of sarcoptic mange in growing pigs under natural challenge in production-type conditions typical of Sweden, Brazil, and Canada, respectively. Cleaner carcasses, fewer days to achieve market weight, and improvement in feed efficiency were reported.

Discussion

Results of reviewed trials confirm that IVOMEC, administered subcutaneously as a single dose of 300 µg/kg or given in the feed during 7 consecutive days at a dose level of

The cure rate in the eight trials performed with IVOMEC Premix was 100%.

100 µg/kg/day, is safe and highly effective against *S. scabiei* in pigs. Moreover, the extensive use of IVOMEC as an endectocide for pigs has demonstrated its consistent and reliable parasite control to the swine industry for more than 15 years. IVOMEC Premix may be the preferable for-

Pig Breeding Farm, Farrow-to-Finish
Belgium

Treatment with IVOMEC Injection and IVOMEC Premix resulted in overall economic improvements.

■ *Sarcoptes scabiei* var. *suis* was eradicated on a Belgian pig farm with a combined regime of ivermectin injection and ivermectin in feed. The detection of mites in ear scrapings, calculations of an average dermatitis score, and scratching index were used to evaluate the mange status before and after eradication. Before eradication, 28% of ear scrapings of finishers were found positive for the presence of mites, the average dermatitis score (ADS) of the finishers was 0.92 and the scratching index for the finishers was 2.0. A significant decrease was seen for all three parameters during the year after the eradication. One year after treatment, no mites were found in the ear scrapings, the ADS of the finishers was 0.31, and the scratching index for the finishers was 0.16. Adult animals were negative for the presence of mites at all times. The ADS was below the cut-off level before and after treatment and the scratching index decreased clearly after treatment. There was also an overall economical improvement related to the breeding phase and the fattening phase: sow feed consumption was reduced by 5%; re-breeding dropped 4.55%; litter size increased with 0.33 more live piglets born per litter, and farrowing increased by 0.075 more litters per sow per year. As a result, the production index increased, with 1.34 more piglets weaned per sow per year. There was an immediate improvement in feed conversion during the 5 month period after treatment. The return of the cost of treatment on this farm was reached within 3.7 months.

— Smets *et al*, 1999

mulation when treating large groups of swine.

Given the high efficacy of IVOMEC, it is the product of choice for an eradication program in which all swine in the facility are given two strategic IVOMEC treatments. Time intervals may vary, depending on locally approved withholding periods (Ebbesen and Henriksen, 1986; Jensen, 1988; Ebbesen, 1998; Lambers, 1994; Cargill *et al*, 1996; Rambags *et al*, 1998; Smets *et al*, 1998; Koehler and Zabke, 1998; Mohr, 1999). It is also the product of choice for an effective control program for a farrow-to-finish swine facility in which a single treatment to sows is administered just before they are moved into the farrowing house, and to grower pigs when moved to the grower/finisher phase around 8 to 12 weeks of age. ■

Photo Eric Guillot

Evaluation of a mange eradication program can be done by clinical inspection for rubbing, scratching and crusts, particularly in the ears; calculating a rubbing or scratching index (RI); examination of ear scrapings for live and dead mites and mite eggs; and examination of carcasses for papular dermatitis and serological examination (ELISA test).

— Dr. T. J. Ebbesen

Reprinted from *PIG INTERNATIONAL*

Programmes to Eradicate Mange

A recent issue of *Pig International* (September 1999) contained specialists' comments about monitoring sarcoptic mange infestations in pig herds. The authors also had provided remarks which could not be included for reasons of space, concerning the eradication of mange mites from an infested herd. Here are some edited abstracts from those remarks.

Mange mites can be eradicated from a herd either by depopulation/repopulation or by medication. The first of these is relatively expensive and demands that mange-free animals are available for the re-stocking. From an economic viewpoint, mange alone can hardly justify using this method.

Thousands of herds in many countries are now mange-free due to a program of eradication by medication, in which ivermectin is injected twice with an interval of 14 days. In the very few occasions where mites were not eradicated, often the reason was a failure to maintain the barrier between treated and non-treated pigs. Various intervals have been used, from 10 to 28 days, dictated in most cases by the locally approved withholding period. From results of different trials, a special interval cannot be emphasised, but it is important that all animals in the herd be treated at the right dose and at the same time.

No difference in success rates has been found for eradications done in different seasons of the year. Mites and mite eggs survive longer in a cold, humid environment, but most mites will die within the first 1-2 days off the host, and the maximum survival time is considered to be 10-12 days.

Because the whole herd is treated, the amount of acaricide for an eradication program is approximately 1.5-3 times that used during a year for continuous treatment. The amount of labour required by eradication varies, but has been shown to average about 15 hours per 100 sows.

The protocol for eradication in the **Netherlands**, so that a herd can be certified for absence of mange mites by the Dutch Animal Health Services, calls for all pigs on the farm to be injected with ivermectin on Day 0 and Day 14. Any piglets born after Day 0 and up to Day 7 must receive an ivermectin injection on Day 7.

Researchers in **Belgium** used a combination of ivermectin injection and in-feed for a closed breeding herd. Sows, boars and piglets were treated by subcutaneous injection on Days 0 and 14, while growers and finishers were given the oral powder in-feed for 2 periods of 7 days, with an interval of one week between. Feed dosages were 2ppm for 25-40kg pigs and 2.4ppm for those in the 40-100kg weight range.

A programme implemented in **Denmark** used feed medication for a total of 16 days. The medication was given to every gilt, sow, boar, weaner, grower and finishing pig at a level to ensure a dose of 100mcg ivermectin per kilogram of bodyweight per day. On Days 0 and 14, all piglets were injected at a dose rate of 300mcg/kg. An equivalent injection was given on Day 7 to piglets born between Days 0-7, and to all animals in the medicated feed group where feed intake was inadequate.

In **Germany**, an eradication scheme involved whole-herd treatment with IVOMEC Premix (100mcg ivermectin/kg) for 14 consecutive days, mixed in the six feed mixtures used on the farm. Sows which farrowed during the treatment period, piglets just weaned, and suckling piglets received IVOMEC Injection (300mcg ivermectin/kg). Animals that would otherwise have been treated with IVOMEC Premix but showed loss of appetite for at least 2 days, received treatment with IVOMEC Injection.

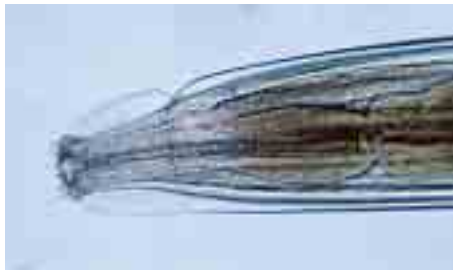
The limited experiences with combined feed/injection programmes, until now, leave the impression that their success rate is at a similar high level to that resulting from two injections of ivermectin. The uncertainty of the dose in feed medication does not seem to influence the safety and efficacy of these programmes. There is a variation in the period of treatment with IVOMEC Premix from 14 to 21 days, and some of the successful eradication schemes have a 7-day interval between two treatment periods of 7 days.

Dr. T. J. Ebbesen is a veterinarian with Danish Bacon & Meat Council in Denmark

Broad-Spectrum Control of Worms

The introduction of ivermectin for pigs in 1984 marked a new era in the control of endoparasites and ectoparasites. Based on natural products of bacterial fermentation, IVOMEC is non-toxic to the host — unlike many of the previously marketed antiparasitics. The broad-spectrum activity of IVOMEC makes it a good choice for the control of most parasites encountered in pigs of all ages.

Large roundworm (*Ascaris suum*)



***Oesophagostomum* spp (anterior end)**

Intestinal threadworm (*Strongyloides ransomi*)

Whipworm (*Trichuris suis*)

Dr. T. Bonner Stewart
Professor of Parasitology, Department of Veterinary Microbiology and Parasitology, School of Veterinary Medicine, Louisiana State University, Baton Rouge, LA

Worms in Pigs

Ascaris suum, the large roundworm, is the most common parasite of pigs worldwide. The success of *A. suum* is due to the great reproductive potential of a single female worm in producing 250,000 or more eggs per day and the longevity of the thick-shelled, sticky egg that can survive for 6 years or more in cracks and crevices of buildings or sheltered areas of lots and pastures.

Oesophagostomum spp. — *O. dentatum*, the common nodular worm, and *O. quadrispinulatum*, the long-tailed nodular worm — are found worldwide and are of greater importance in breeding animals. Unlike most of the worm parasites of pigs, initial infection with nodular worms does not elicit a strong immune response and populations tend to build up in older animals that are re-exposed.

A review of the worm parasites of major importance in pig production throughout the world begins with *Strongyloides ransomi*, the intestinal threadworm of the suckling pig. This is a particularly important parasite in warmer temperate areas. *Strongyloides ransomi* can be transmitted from the sow directly to the suckling pigs in the colostrum. Unlike most parasitic worms, strongyloids can reproduce outside the pig. Eggs passed in the faeces can develop into free-living adults within a few days to produce large numbers of infective larvae that are skin penetrators.

Trichuris suis, the whipworm, is an important parasite in many areas of the world, especially in pigs raised outdoors, but also can be a problem in housed pigs. The thick-shelled egg can survive for 6-years in protected areas.

Metastrongylus spp, the lung worms, require earthworms as intermediate hosts and are common in pigs raised outdoors. Earthworms can retain lungworm infective larvae their entire lives.

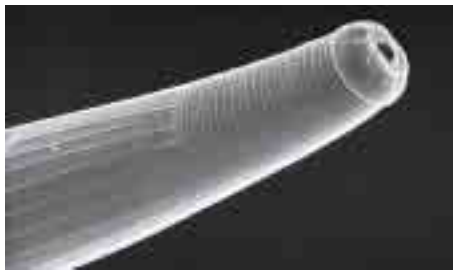
Hyostrongylus rubidus, the red stomach worm, is more common in pigs on pasture and can be of special concern in sows on pasture. Along with the nodular worms, the red stomach worm is responsible for "thin sow syndrome."

Physocephalus sexalatus and *Ascarops strongylina* are thick stomach worms of swine that require the dung beetle as an intermediate host and can be present in swine on pasture. Likewise, *Macracanthorhynchus hirudinaceus* also require a beetle as an intermediate host.

Stephanurus dentatus, the swine kidney worm, is a very important parasite of outdoor pigs in the warmer temperate and tropical areas of the world. Condemnation of livers, kidneys, loins, and even entire carcasses can result from migration of immature worms.

Worm parasites can kill pigs; more commonly, however, they stress pigs. Stress leads to loss of appetite, reduction

Lung worm egg (*Metastrongylus* spp)



Scanning electron microscope photo of anterior of red stomach worm (*Hyostrongylus rubidus*)

Swine kidney worm (*Stephanurus dentatus*) male and female (bottom).

of daily gain, and poor feed utilisation. The weakened pig can have an increased susceptibility to bacterial and viral diseases that may be easier to detect than the underlying subtle performance problems generated by the parasites.

Worm parasites can kill pigs; more commonly, however, they stress pigs. Stress leads to loss of appetite, reduction of daily gain, and poor feed utilization.

TABLE 1 shows controlled trials carried out with most of the important worms of pigs. It is clear that even low infections have detrimental effects on the performance of growing pigs.

Efficacy of IVOMEC against worms is excellent. Worldwide trials conducted with infected pigs have shown that both the injectable formulation and the in-feed premix formulation have an efficacy of 97% to 100%.

A series of controlled trials was conducted in the United States and Europe; TABLE 2 shows results for IVOMEC Injection at the rate of 300 µg/kg. TABLE 3 shows results for IVOMEC Premix given at 100 µg/kg for 7 consecutive days.

In some trials with naturally infected pigs, other parasites were present in low numbers for statistically significant results. IVOMEC had good efficacy against some of the parasites found in small numbers, including the thick stomach worm, *P. sexalatus*; the short-tail nodular worm, *Oesophagostomum brevicaudum*; and the thorny-headed worm, *M. hirudinaceus*.

IVOMEC has substantial effect on reduction of migrating *A. suum* and efficacy against the 4th and 5th intestinal stages (Stewart, 1995). A significantly lower number of larvae were detected in the lungs of pigs treated with IVOMEC compared to nontreated pigs (Urban *et al*, 1989). In trials with IVOMEC Premix, the larvicidal effect was borne out. Pigs were infected with *A. suum* eggs

Internal organs of swine showing predilection sites of worms

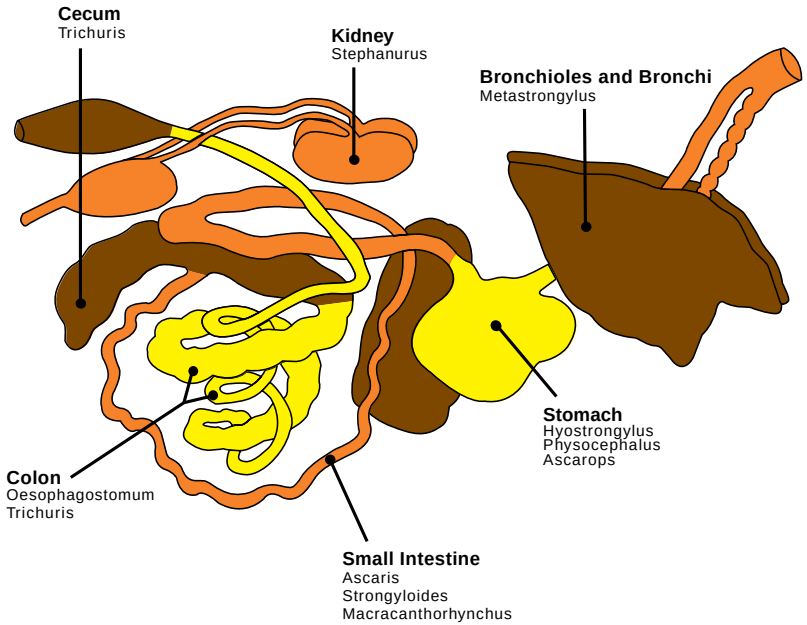


Table 1. Effects of worm parasites on the productivity of growing pigs.

Parasite	No. of Pigs	ADG* (kg)	% Diff.	F/G* (kg feed/ kg gain)	% Diff.
Ascarid	8	.85	-2	3.20	-5
Control	8	.87		3.03	
Nodular worm	12	.81	-2	3.04	-6
Control	24	.83		2.86	
Whipworm	12	.84	-6	3.30	-3
Control	12	.89		3.21	
Threadworm	16	.70	-9	3.03	-6
Control	16	.77		2.86	
Kidney worm	10	.65	-20	3.05	-3
Control	10	.81		2.97	
Red stomach worm	6	.59	-21	3.52	-6
Control	6	.75		3.29	
Lung worm	12	.79	-26	4.17	-18
Control	12	1.06		3.43	

*ADG=daily gain, F/G=feed-to-gain ratio. ADG and F/G values based on 91-day feeding period except for the red stomach worm (based on a 83-day feeding period) and lung worm (based on a 56-day feeding period). Data from Stewart *et al*,1985; Stewart & Hale, 1988; Baudena *et al*, 1997.

It is clear that even low infections [of worms] have detrimental effects on the performance of growing pigs.

Efficacy of IVOMEC against worms is excellent. Worldwide trials conducted with infected pigs have shown that both the injectable formulation and the in-feed premix formulation have an efficacy of 97% to 100%.

Table 2. Results of trials with IVOMEC Injection.

Parasite	Stage	No. of Trials	No. of Pigs	% Efficacy
Ascaris suum	adult	10	178	100.0
	L4	4	70	99.5
Oesophagostomum spp	adult	5	102	99.0
Metastrongylus spp	adult	3	49	100.0
Hyostrongylus rubidus	adult	3	62	98.0
	L4	1	12	99.0
Strongyloides ransomi	adult	1	20	98.5

*Data taken from trials conducted for dose confirmation efficacy are available on request.

Table 3. Results of trials with IVOMEC Premix.

Parasite	Stage	No. of Trials	No. of Pigs	% Efficacy
Ascaris suum	adult	6	118	100.0
	L4	1	56	100.0
Oesophagostomum spp	adult	4	76	99.0
O. quadrispinulatum	adult	1	20	99.0
Hyostrongylus rubidus	adult	3	56	100.0
Metastrongylus spp	adult	5	94	100.0
Ascarops strongylina	adult	5	98	100.0
Stephanurus dentatus	adult	1	33	100.0
	L4	2	60	100.0

*Data taken from trials conducted for dose confirmation efficacy and from Alva-Valdez *et al*, 1989.

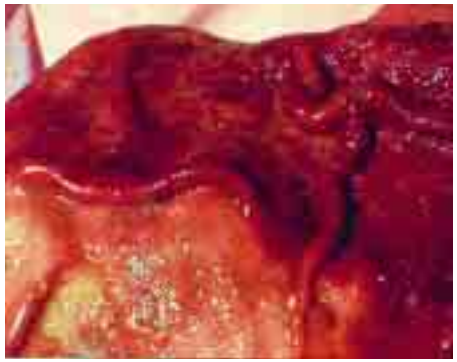
Tissue section showing intestinal threadworm (*Strongyloides ransomi*) larvae.

Liver of pig showing scars due to large roundworms (*Ascaris suum*). Migration through the liver causes the white scarlike "milk spots," which are the major reason for swine liver condemnations in packing plants.

Adult whipworm (*Trichuris suis*) attached to intestinal wall.

Lung of pig showing lesions caused by lungworm (*Metastrongylus*).

Kidney worms (*Stephanurus dentatus*) in cyst.



Adult red stomach worms (*Hyostrongylus rubidus*) burrow into the gastric mucosa.

and given IVOMEC Premix for 7 days beginning either on Day 2 or on Day 9. Efficacy was 98.9% and <99% in the two treated groups, respectively (Rehbein *et al*, 1996).

The net profit per pig from treatment [with IVOMEC] was $5.30.

IVOMEC Premix is >99% to 100% effective against *S. ransomi* somatic (tissue dwelling) larvae in sows when fed for 7 consecutive days during mid- to late pregnancy (Barth and Preston, 1985). This should prevent transmission of the worms to the piglets when they are being suckled and, in fact, IVOMEC Injection given to sows 10 to 16 days prior to farrowing prevented the discharge of *S. ransomi* larvae into the colostrum (Barth *et al*, 1996). Pigs born to sows injected with IVOMEC prior to farrowing weighed 0.78 kg more at 28 days than pigs from untreated sows on the same German farm (Busse *et al*, 1992). Treating sows with IVOMEC prior to farrowing is an excellent method of preventing transmission of two important parasites of suckling pigs, *S. ransomi* and *Sarcoptes scabiei* (the mange mite), that are normally transmitted directly from the nursing sow.

Whipworms (*T. suis)* are the most difficult intestinal worms to control, and all have poor to variable results. Apparently, *T. suis* needs to be exposed to a drug over a longer time period than other nematodes for high efficacy. IVOMEC Premix fed to infected pigs reduced egg counts to 0 within 6 days after treatment; the efficacy at 14 days was 97.7%. After treatment, only 0%-14% of eggs developed during the first 5 days and no eggs developed after Day 6 (Arends *et al*, 1996).

Benefit of Worm Removal

What good is it to remove parasites? Once infected with parasites, will their removal yield enough benefit to justify the expense? If so, when should treatments be given — to the young pig, to the older pig, or both?

In an attempt to answer these questions, two trials with 90 pigs infected with *A. suum*, *Oesophagostomum* spp and *S. ransomi*, were performed. Treatment of smaller pigs resulted in greater feed conversion efficiency (FCE) and a higher carcass dressing percentage. The value for treatment was estimated at $3.32 above the cost. Treatment of larger pigs resulted in even higher daily gain and better FCE, yielding a net profit of $3.83 (Stewart *et al*, 1991; Stewart *et al*, 1996). The results point to an important biological fact: a young growing animal's energy intake is directed to the production of bone and muscle. By removing parasites, there is reduced impairment of the process, resulting in a carcass with a high dressing percentage (Garriz *et al*, 1987). In the older animal, the compensatory gains after worm removal will tend to the deposition of fat as well as muscle. It is clear, however, that young and older pigs benefit from worm removal.

In another trial, 90 pigs treated with IVOMEC achieved greater gains and were more efficient in feed con-

The Effect of IVOMEC on Gastrointestinal Parasites

Growers
United States

Treatment with IVOMEC Injection prevented the negative effects caused by gastrointestinal worms in growing pigs.

■ Ninety weanling pigs were assigned to 3 treatment groups on the basis of weight, sex and ancestry:

Group 1 infected, nontreated

Group 2 infected, treated with IVOMEC

Group 3 uninfected, untreated

Two groups of growing pigs were challenged with *Ascaris suum*, *Oesophagostomum* spp, and *Strongyloides ransomi*. The pigs in one group were treated with IVOMEC Injection 35 days later. Pigs infected with parasites had reduced growth rate and feed conversion efficiency. The group treated with IVOMEC Injection had better growth rate than untreated pigs. The economic gain was US $3.55 per pig treated with IVOMEC over infected, untreated pigs.

— Stewart *et al*, 1991

Summary of growth performance data (kg) for pigs challenged with gastrointestinal parasite eggs before and after treatment with IVOMEC Injection.

	Infected pigs left untreated	Infected pigs treated with IVOMEC	Noninfected pigs left untreated
Before treatment with IVOMEC			
ADG (g/day)	695	716	786*
Feed conversion ratio (kg feed/kg pig)	2.96	3.10	2.87
After treatment with IVOMEC			
ADG (g/day)	874	921*	948*
Feed conversion ratio (kg feed/kg pig)	3.24	3.11*	3.25
Carcass dressing	68.65	69.80*	69.54

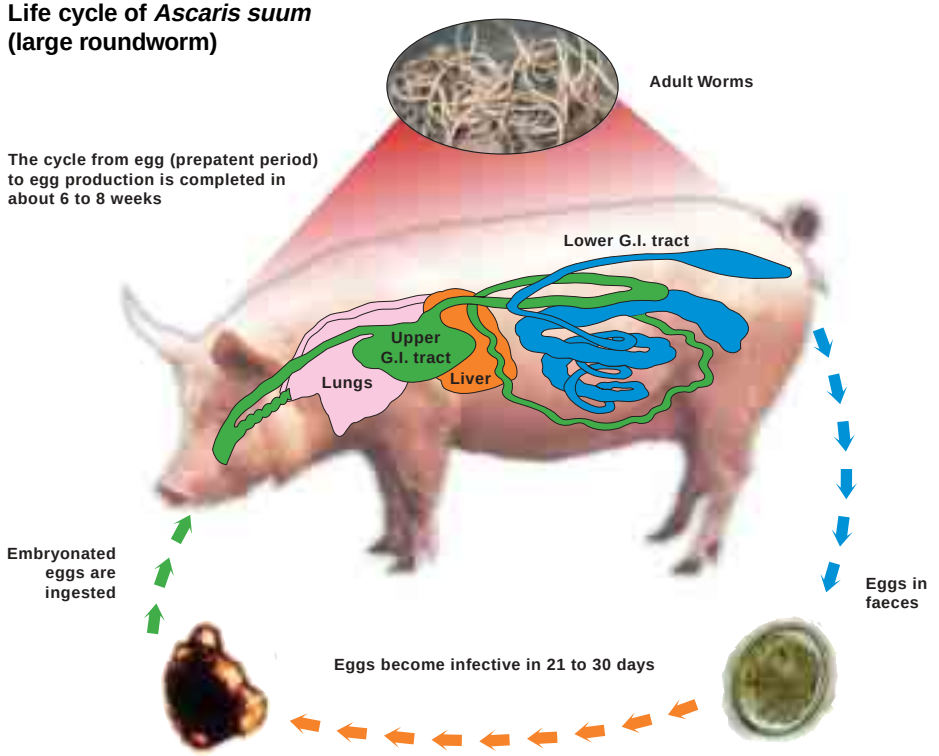
*significantly better than pigs in infected, untreated group.

version than nontreated controls. The net profit per pig from treatment was $5.30 (Gutierres-Poster *et al*, 1990).

It has been shown that natural untreated exposure to worms during the growing phase permanently reduces the growth potential. In a dirt lot study with 96 pigs, those treated every 60 days with IVOMEC had a 19% greater gain and were 5% more efficient in feed utilisation than nontreated pigs (Urban *et al*, 1989).

Decontamination of premises harbouring ascarid eggs is very difficult. Most disinfectants actually improve the chances of egg survival because they are not effective against the embryonated egg but kill the microorganisms that prey on the eggs. Thorough scrubbing of floors, walls and equipment followed by steam that reaches into cracks and crannies comprises one of the most satisfactory ways of sanitising to prevent ascarid transmission from contaminated premises. There is no doubt that ascarids are the most difficult of worms to eliminate from a herd; constant vigilance is necessary to prevent their introduction by cockroaches, mice, rats, birds and contaminated shoes and boots. ■

Life cycle of *Ascaris suum* (large roundworm)



The eggs of *Ascaris suum* are in the one-cell stage as they pass out in the faeces. They develop within the egg to the 3rd stage in about 28 days and require an additional 14 or more days to become infective.*

Eggs ingested by the pig hatch and the ensuing larvae penetrate the wall of the large intestine and enter the circulatory system.

Larvae are in the liver from 18 hours to 4 days after leaving the intestine, then move to the lungs where they can be found for about 4 days.

Beginning on day 8 to day 10, larvae penetrate the alveoli of the lungs and enter the airways and are swept to the mouth and swallowed. Shortly after reaching the small intestine, larvae molt to the fourth stage from days 9 to 10.

The final molt occurs 25 to 45 days after infection. Egg production by the female begins from 40 to 53 days after infection.**

*Genneen *et al* 1999
**Douvres *et al* 1969

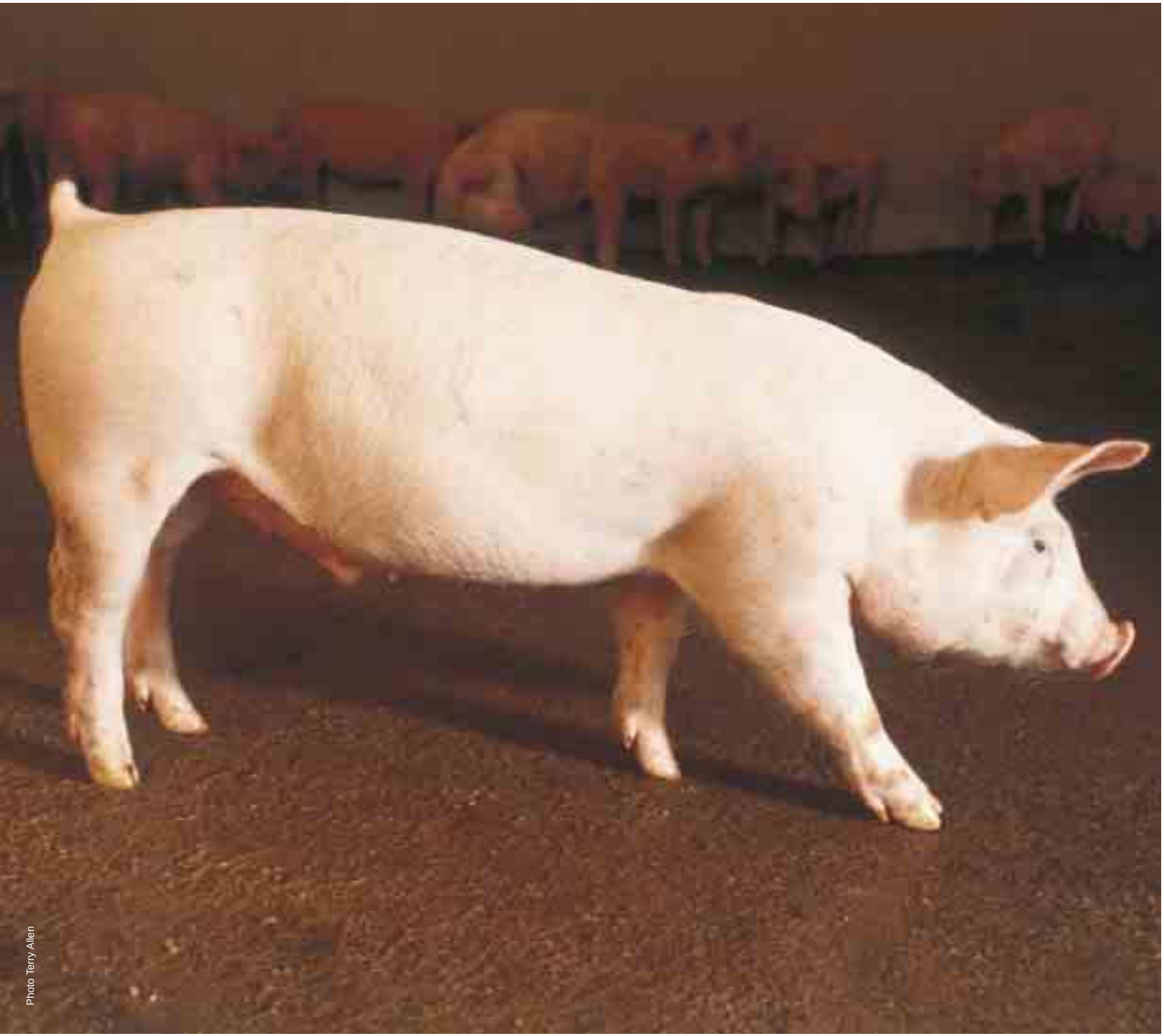


Photo Terry Allen

Worldwide Productivity Results in Grower/Finisher and Adult Pigs

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Introduction

Herd managers often overlook or underestimate the severity of clinical signs of mange in growing pigs, but even subclinical mange can be a cause of reduced reproductive efficiency in breeding herds.

In studies in which growth rate in mange-infected and mange-free pigs was measured over more than 12 weeks (from <20 to >60 kg liveweight), mange suppressed growth rate up to 11.8% and reduced feed utilisation efficiency by up to 12%. Reduced feed utilisation also has been correlated with rubbing and scratching. Reductions in growth rate in groups of pigs appear to be related to the average dermatitis score (ADS) for the group at slaughter (Cargill *et al*, 1997; Cargill and Davies, 1999). Damage to pen structures and carcasses also must be included in the economic effects of mange infestation. The effects of mange in sows range from reduced litter size and weight, and reduced viability and growth rates in suckling pigs, to increased abnormal behaviours such as biting, rubbing, and damage to pen structures. Heavy lice infestations will result in anaemia in young pigs and may affect growth rate and feed conversion efficiency.

The Value of IVOMEC Premix

Fattening Pigs, Germany

The profit margin in a large fattening unit with subclinical mange and ascarid problems was increased by 37% per pig from use of IVOMEC Premix.

■ Six lots of 600 to 700 weaner pigs (25-26 kg) were divided into two treatment groups:

Group 1 — Untreated (Control)

Group 2 — IVOMEC Premix

Pigs were penned in groups of 12, and monitored for 137 days. Liquid feed was provided to all pigs 3 times each day and all pigs were weighed in and out of the trial.

No mites were detected in treated pigs at slaughter. Less than 1% of treated pigs had milk spots at slaughter; <5% of pens were positive for ascarid eggs versus 8.8% of controls. Pigs treated with IVOMEC gained more weight than untreated animals and had a net profit per animal of DM 3.18 over the control group (Table 1).

— Matthes and Rehbock, 1998

Table 1. Summary of infection levels, growth rates (kg), and economic data for pigs treated with IVOMEC Premix and untreated pigs.

	IVOMEC Premix	Untreated	Difference
Infection level			
% pigs positive for mites at slaughter	0%	16.7%	16.7%
% pigs with milk spots	0.8%	4.8%	4.0%
Productivity			
ADG (g/day)	695 g	670 g	25 g
Economic gain			
Net profit per pig (DM)*	DM 8.51	DM 5.33	DM 3.18

*Based on carcass weight improvement and reduction of pig losses.

Fattening Pigs, Sweden

Feeding IVOMEC Premix to growing pigs reduced the number of days fattening pigs took to reach market weight by 5.5%.

■ 324 parasitized 12-week-old pigs weighing between 20 and 30kg were divided into two treatment groups based on farm size and litter weight:

Group 1 — Untreated (Control)

Group 2 — IVOMEC Premix

Pigs were randomly allocated to pens; faecal samples were examined for worm eggs and ear scrapings were examined for mites. Pigs were examined again after slaughter and the number of days taken to reach 110 kg liveweight was recorded.

Ascarid eggs were present in faecal samples from untreated pigs on all sampling days during the trial. Ascarid eggs were present in pigs treated with IVOMEC only on the day treatment began and 90 days later; samples taken 41 and 69 days after treatment were negative. A limited number of ascarid eggs were found in the group treated with IVOMEC towards the end of the grow-out period but remained significantly less ($p<0.05$) than the control group at all post-treatment samplings. The average dermatitis score for untreated pigs was >1.5, indicating severe mange. As a contrast, the group treated with IVOMEC had cleaner carcasses (ADS= 0.34, a difference of 81% as compared with untreated pigs) and reached market weight 5.7 days earlier (Table 2).

— Nilsson *et al*, 1994

Table 2. Infection and production data for pigs fed IVOMEC Premix at the commencement of the fattening period.

	IVOMEC Premix	Untreated	Difference
Average mange score at slaughter	0.34	1.76	81%
N^{0}. days to reach 110 kg	99.4	105.1	5.4%

Fattening Pigs, Brazil

IVOMEC Premix increased weight gain and feed conversion efficiency in pigs with a mild mange infestation.

■ A total of 128 pigs were randomly allocated to two treatment groups:

Group 1 — Untreated (Control)

Group 2 — IVOMEC Premix

Pigs were allocated to pens on the basis of sex and weight and were examined for mites and worm eggs prior to treatment and during the trial. No worm eggs were detected in either treated or untreated pigs at any time during the trial. Mites were only detected on the day of treatment in one pig in the treated group and in one pig in the untreated group 28 days later. Only 14% of the pigs given IVOMEC Premix had positive dermatitis scores at slaughter compared with 100% of the untreated pigs. Pigs fed IVOMEC Premix had significantly ($p<0.05$) higher feed efficiency (+6.3%) and increased weight gain (2.1%) than untreated controls (Table 3).

— Roppa *et al*, 1996

Table 3. Summary of productivity improvements in pigs given IVOMEC Premix in-feed.

Productivity measure	Improvement	
Feed conversion	6.3%	($p<0.05$)
Weight gain	2.1%	($p<0.01$)

Fattening Pigs, Canada

Feeding IVOMEC Premix to growing pigs increased growth rates, improved feed conversion efficiency, and reduced the number of days pigs took to reach market weight.

■ A total of 168 pigs (8 to 16 weeks old) were used to evaluate the efficacy of in-feed ivermectin and its influence on productivity when administered to parasitized pigs. Pigs were allocated by restricted randomisation on initial weight within sex to two treatment groups:

Group 1 — Untreated (Control)

Group 2 — IVOMEC Premix

The pigs were weighed and the feed was weighed back on Day 28 and at 28-day intervals until the pigs reached the target market weight of approximately 110kg. Ear scrapings and faecal samples were collected. Faecal samples and one ear were collected from each animal at slaughter.

Pigs in the treated [with IVOMEC] group took an average of 3.3 fewer days to reach final weight.

Average daily gain (ADG) was improved in the IVOMEC treated group by 26 g/day ($p = 0.0794$), which represents a 3% improvement. The pigs in the treated group took an average of 3.3 fewer days to reach final weight. The IVOMEC group had a 3% lower feed/gain (F/G) ratio. On Day 28 and at the end of the study when pigs reached market weight, control pigs continued to be infested (17% and 50%, respectively), while the IVOMEC group remained mite-free. All faecal samples were negative for nematode eggs.

— Garcia *et al*, 1998

The Value of IVOMEC Injection

Growing Pigs, United States

Prefarrowing treatment of mange-infested sows and post-weaning treatment of pigs with IVOMEC resulted in better growth rates in grower pigs.

■ 245 pigs from 42 sows treated prefarrowing were injected with IVOMEC when moved from the nursery (weaner rooms), to the finishing barn. Their growth rate was compared with 245 untreated pigs from 42 untreated sows. Overall, the results demonstrate the value of effective mange control in sows and their progeny. Pigs treated with IVOMEC grew 6.5% faster than untreated controls which would have taken 8.6 days to reach the same slaughter weight. Better performance of treated pigs resulted in increased financial return per sow on average of US$84 to US$115 per sow per year (Table 4).

— Arends *et al*, 1990

Table 4. Summary of growth performance data (kg) of pigs born to sows treated with IVOMEC and injected with IVOMEC.

	Pigs treated with IVOMEC	Untreated Pigs	Difference
Average weight at start (kg)	10.48	10.38	0.10
Average weight at market (kg)	98.94	93.05	5.89
Weight gain (kg)	88.45	82.66	5.79* (7%)
ADG (g/day)	718	668	50 (7.5%)

*difference between IVOMEC and untreated pigs was significant (p<0.05)

Growing Pigs, United States

Mange-infested growers that received IVOMEC showed improved productivity.

■ 108 pigs naturally-infested with mange were divided into two treatment groups:

Group 1 — Untreated (Control)

Group 2 — IVOMEC Injection

All pigs were weighed at 4-week intervals throughout the trial.

All pigs in both treatment groups were positive for mange mites on the day of treatment. Pigs treated with IVOMEC were all mange-free at trial completion, but 25 out of 54 (46.3%) of untreated pigs were positive for mange. The IVOMEC group gained an average of 4.8kg (5.8%) more weight than the Control group (Table 5).

— Alva-Valdes *et al*, 1986

Table 5. Summary of growth performance data (kg) for pigs treated with IVOMEC Injection and untreated pigs.

	IVOMEC Injection	Untreated Pigs	Difference
Weight 112-days post-treatment (kg)	87.5	82.7	4.8 (5.8%)
Feed conversion ratio (kg feed/kg pig)	2.83	2.84	0.01

Growing Pigs, Australia

Treatment of mange-infested pigs at weaning with either IVOMEC or DECTOMAX gave improved growth rates, but IVOMEC performed better in the face of heavy infestation.

■ A total of 180 pigs were randomly allocated into three treatment groups at weaning, based on body-weight and evidence of mange infestation:

Group 1 — Untreated (Control)

Group 2 — DECTOMAX Injection

Group 3 — IVOMEC Injection

Pigs were marketed at 90 to 105kg liveweight.

Pigs were examined for mites the day before treatment and for clinical signs of mange at treatment and up to slaughter. Mange infestation in pigs treated with IVOMEC resolved more rapidly than in pigs treated with DECTOMAX. Pigs treated with IVOMEC grew faster (1.6%) than pigs treated with DECTOMAX and significantly faster than untreated pigs (6.6%).

The presence of mange mites at 16 days after treatment with IVOMEC was significantly less as compared to DECTOMAX (Table 6). In this well replicated study, IVOMEC outperformed DECTOMAX in body weight gain (Table 7), which could be related to the faster and better efficacy of IVOMEC against mange mites, particularly under high field challenge in the period immediately after treatment.

— Cargill, 1999

Table 6. Summary of infestation data for treated and untreated groups: prior to treatment and 121 days later.

Treatment	IVOMEC Injection	DECTOMAX Injection	Untreated
Before treatment			
Mean mite count	400.2	434.6	434.9
% pigs positive for mites	98	98	98
16 days after treatment			
Mean mite count	0.32	5.42	261
% pigs positive for mites	1.7	23	97
121 days after treatment			
Mean mite count	0	0	182
% pigs positive for mites	0	0	53.3
Rubbing index	0	0.05	1.48
% pigs rubbing	0	5	48.3
Average dermatitis score	0.28	0.37	1.25
% pigs with dermatitis	28.3	36.7	73
% pigs with score 1*	28.3	36.7	31.6
% pigs with score 2/3†	0	0	42

Average dermatitis score at slaughter: 1* = mild mange; 2/3† = severe.

Table 7. Summary of growth performance data (kg) for pigs treated with IVOMEC Injection or DECTOMAX Injection and untreated pigs.

	IVOMEC Injection	DECTOMAX Injection	Untreated
ADG (g/day)	650	640	610
Adjusted days to market*	153	156	168
Feed/gain ratio (70-100 kg)	2.83	2.86	2.98

*Days to market based on slaughter liveweight of 100 kg.

IVOMEC improves growth rate in growing pigs

Growing Pigs, Brazil

Treatment with IVOMEC of 20kg pigs having minimal mange and low worm burdens resulted in improved growth rate and feed efficiency and increased profit.

■ 180 male and female pigs were divided into three treatment groups:

Group 1 — Untreated (Control)

Group 2 — Levamisole injection and diazinon spray

Group 3 — IVOMEC Injection

Pigs were treated at the start of the fattening period (2 months of age) and weight gain, feed/gain ratios, and economic returns were compared among the 3 groups for 70 days.

Average weight gains during the 70 days for pigs treated with IVOMEC were 2.6kg/pig higher than for pigs treated with levamisole and diazinon (49.2kg/pig vs 46.6kg). Pigs treated with IVOMEC required 235 to 310g less feed to return 1kg of gain than pigs in the other groups. The net profit gained by treating pigs with IVOMEC was US$1.87 to US$2.14 per head.

— Roppa *et al*, 1988

The net profit gained by treating pigs with IVOMEC was US$1.87 to US$2.14 per head.

The Value of IVOMEC Injection in Breeding Herds

Breeding Herd, United States

Prefarrowing treatment increases weaning weight of piglets.

■ A total of 84 sows with natural mange infestations were randomly allocated to two groups:

Group 1 — Untreated (Control)

Group 2 — IVOMEC Injection

All groups were dewormed with dichlorvos (ATGARD®) 7 days before farrowing and their feed consumption recorded while housed in the farrowing house.

No mites were found on either treated sows or weaners, but all groups of untreated pigs were positive for mange mites. Treated sows consumed significantly less feed per piglet weaned than untreated sows. Litters from treated sows were significantly heavier than those from untreated sows (Table 8).

— Arends *et al*, 1990

Table 8. Summary data for feed consumption in sows and litter weights.

	IVOMEC Injection	Untreated
Adjusted 21-day litter weight (kg)	54.60*	50.46
Sow feed per weaned piglet (kg)	14.60†	16.55
Feed conversion ratio (kg feed/kg weaned piglet)	1.16†	1.29

*/†difference significant (*p<0.07; †p<0.05).

Breeding Herd, France

Prefarrowing injections of IVOMEC were associated with increased birth weight, increased weaning weight and a higher weaning percentage.

■ Sows on 41 farms were randomly divided into two treatment groups:

Group 1 — Non-ivermectin anthelmintic and acaricide spray (positive Control)

Group 2 — IVOMEC Injection

The progeny of sows treated with IVOMEC had heavier birth weights and weaning weights at Day 27. The weaning percentage for pigs born to sows treated with IVOMEC was greater than with the other treatments (Table 9).

— Forgues *et al*, 1988

Table 9. Summary data for litter weight and percentage weaned.

	IVOMEC Injection	Other treatments	Difference
Average birth weight (kg)	1.32	1.23	7.3%
Average number of pigs weaned/litter	8.87	8.81	0.68%
Average weight at Day 27 (kg)	7.40	6.70	10.5%
% pigs weaned	78.3%	75.4%	3.9%
ADG birth to Day 27 (g)	225	203	10.8%

IVOMEC improves production efficiency in breeding herds

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