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Project Title:

Controlling gastrointestinal parasites of livestock with organic materials

FINAL PROJECT REPORT

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Abstract

A one-year project grant to Practical Farmers of Iowa to research livestock gastrointestinal parasite management resulted in a five-year series of experiments during which attention shifted from commercial botanical mixtures to single-ingredient botanical materials. The end of this period sees renewed interest in the role of management, as results of natural anthelmintics have been variable at best and largely disappointing. Our research results have also pointed to difficulties of collecting reliable data from these on-farm trials. The scarcity of available pens was anticipated and addressed through use of completely randomized design (CRD). However, in our experience the number of animals per pen needed to be much larger, or trials needed replication over time. Making sure that fecal samples and weights can be identified with individual animals is especially important when there are a limited number of animals in each treatment group.

Background

Since 1999, when Practical Farmers of Iowa (PFI) received a research grant from the Organic Farming Research Foundation, Iowa producers have been evaluating alternative treatments for gastrointestinal parasites of livestock. The interest in alternative parasite management has grown along with specialty markets for organically raised meats. Organic systems are typically managed with a different philosophy than are conventional animal production systems. The livestock enterprise is often intimately interconnected with cropping, sharing with those other enterprises manure for fertility and crop residue for bedding or grazing. This integration makes possible the efficient cycling of nutrients and ties the scale of the livestock enterprise to that of the cropping enterprises. Organic livestock enterprises also tend to differ from their conventional counterparts in that rather than seeking to achieve a biotic barrier or vacuum, they strive for a positive balance in terms of biotic diversity.

At the same time, many organic livestock systems in the Midwest are only a few steps removed from the conventional systems from which they evolved. As such, they may place animals in proximity to each other in ways that were acceptable when antibiotics and synthetic anthelmintics were customary, but that can contribute to herd health problems when those "silver bullets" are out of the picture. The most successful production systems before the era of synthetic chemicals paid particular attention to management itself as a way to limit disease. The on-farm research project reported here has helped to inform the current discussion on the relative merits of management-based solutions and "silver bullets," since the study was itself a search for effective treatments within the range of organically acceptable materials. The project has also helped the PFI Farming Systems Program to a better understanding of the requisites for and feasibility of on-farm research on this subject.

Early PFI Research, Commercial Products

In the PFI research network, individual producer cooperators have considerable latitude in selecting research topics and treatments. This flexibility helps make trials relevant to current issues and the needs of the farmer. It also can make implementation of a coordinated research program challenging. Livestock trials themselves pose particular challenges for on-farm research. While PFI crops research typically takes the form of a randomized complete block with six replications, most farms in Iowa do not have sufficient, similar pens to replicate experimental

treatments. Consequently PFI parasite trials have utilized the completely randomized design (CRD), with multiple animals in each pen, all receiving the same treatment. As this report will describe, the number of animals per treatment pen is an additional issue for on-farm parasite research.

In these studies, parasite ova (egg) numbers in the feces were taken as the standard indicator of parasite infestation. These were assessed using the McMaster flotation technique at the Iowa State University Department of Veterinary Pathology. Admittedly, fecal ova counts do not tell the whole story of parasite infection. Healthy animals can exhibit quite high fecal counts with no apparent ill effect, whereas in weak animals parasites may combine lethally with other maladies. Nevertheless, other factors being equal, fecal ova counts do provide an indication of the infection level.

Following the lead of the farmer research cooperators, initial PFI trials utilized commercially available products that are acceptable in organic production. These are mixtures of several plant ingredients, for example, walnut hulls, wormwood, garlic, cloves, psyllium seed, fennel, gentian, etc. Figures 1 and 2 (in the Data Appendix) show fecal parasite ova (egg) counts from two of these evaluations of commercial mixtures, in this case used with dairy goats. In the trials shown in Fig. 1, two different products were generally less effective than two synthetic wormers; in Fig. 2, ova counts were all low until near the end of the trial, at which time there was not much difference between the high counts of the herbal product and those of the control treatment.

From the start of PFI's parasite trials, we were confronted with the realization that seasonal factors often are a bigger factor than the experimental treatments, at least for the non-synthetic treatments. When parasite pressure built up, it often did so for both the control and the alternative treatments. But the sampling dates for fecal parasites were only "snapshots," and it was not clear what was occurring between dates. When synthetic treatments wear off, worm egg counts can climb because those animals have no resistance, unlike livestock that have had some parasites all along. This resistance is known in veterinary science as "premunition."

Example Research Protocol – Ebert Sheep Trial, 2003

Day -1 – July 3

We separated sheep into three groups for Panicur®, pumpkin seed, and control. Nine animals in pumpkin and control groups, and eight animals in Panicur group. We tried to achieve three similar groups of animals as far as body weight. While separating animals, we tagged and weighed individuals and took an individual fecal sample. In this way we hoped to more precisely detect individual variation and any treatment effect. Earlier trials in this project did not always measure weights of individual animals, but rather group weights. Fecal samples were collected from the ground or pen floor in the early trials of this project; as a result they did not reflect the individual variability in parasite loads and may have also misrepresented overall parasite presence because of sampling issues and the deterioration of exposed feces.

Fecal samples were taken to the Veterinary Diagnostic and Production Medicine Department of the ISU College of Veterinary Medicine. The animals were separated into three paddocks that were not entirely similar in size, forage quality, shade, and perhaps parasite load. Eight-nine

animals per experimental unit is the bare minimum, given the background variability encountered for measured parameters. Groups 3-4-times larger would have been preferable, but this was never achieved on these cooperating farms. Simply repeating trials that use smaller numbers of animals is problematic because of environmental changes over time and the difficulty of recreating treatment conditions exactly. Neither did these farmers have sufficient holding facilities or paddocks to allow for a blocked experimental design. In this particular trial, a preveterinary student intern helped the farmer collect data and handle animals; this is desirable in measurement-intensive trials.

Day 0, July 4
Panicur® and pumpkin seed treatments were imposed.

Day +10, July 14
Individual weights and fecal samples were collected again.

Day +25, July 29
Individual weights and fecal samples were collected again.

Day +45, Aug. 18
Final weights and fecal samples were collected.

Testing Individual Botanicals

One advantage of the commercial mixtures is that they are quite safe. On the other hand, results of PFI trials on mixtures were less than impressive. Partly as a result, interest turned to individual botanical materials that have a history of use, either before the age of synthetics or in other countries. Some of these materials are quite powerful, with potentially harmful effects on livestock if not dosed correctly. One such material is tobacco. A trial comparing tobacco, pumpkin seeds, and a synthetic anthelmintic to a control group of Suffolk lambs is shown in Figure 3. Another such botanical material is oil of Chenopodium, the extract from *Chenopodium ambrosioides*, or epazote, a relative of the common weed lambsquarter. Figures 4, 5, 7, 8, 9 and 10 show results of trials involving oil of Chenopodium.

Trials with oil of Chenopodium have yielded variable results. In the Frantzen trial with young pigs included in Fig. 4, the oil treatment actually was associated with much *higher* ova counts for most of the experiment. In the swine trial shown in Fig. 5, the oil was associated with lower ova counts at all dates but one. However, at that one sampling date, ova counts were extremely high for the Chenopodium treatment. It happened that the spike consisted of one particular kind of gastrointestinal parasite, those in the ascarid family (Fig. 6). The other types of ova remained low, and after the Day 15 sample, overall numbers in the treated group returned to low levels as well. Was this a real treatment effect that was manifested on just one date for one type of parasite, or was it an aberration?

Lessons About Design

The project was forced to ask what these jumpy numbers meant. We began to wonder if the fecal samples were providing misleading results. The samples were coming from the floor of the pens.

It was usually not possible to tell which animals produced the fecal pats, and it was often difficult to find intact pats to sample. In 2003, we made the decision to sample feces directly from individual animals. That way we would know the parasite status both of each group and of every individual within it. In 2003, we also began weighing individual animals. As a result, those trials could test for relationships between the parasite load and weight gain.

But an additional consideration is that in three of the four trials shown in Figs. 4, 5, and 10, there were significant differences between the control group of animals and the treatment groups on Day 0 – *before* the treatments were even applied. In several other trials shown, Day 0 differences were considerable though not statistically significant at 95% confidence. This includes the 2003 swine trial shown in Fig. 11, which did not involve Chenopodium. To yield useful information, trials need to start with animals that are substantially the same. If nothing else, these experiments were an improvement over the 2001 lamb trial in Fig. 3, in which a bulked fecal sample was assumed to represent all treatment groups on Day 0. But the improvement in design merely revealed the extent of the problem.

If one treatment group is handicapped from the beginning, how can trial results be interpreted? It is possible that the animals happened to be poorly sorted in all these trials, but it seems likely that the basic problem is that the groups were too small given the variability from one animal to the next. In a small group, there is less chance of drawing a good representation of the farm's animals. Most of the treatment groups consisted of just 10 animals. Given the facilities available on many Iowa farms, it is difficult to find more or larger pens for a trial. This may be a basic limitation of on-farm research into alternative parasite treatments.

The idea that many of these trials needed larger groups is reinforced by statistics of the results. One of the strengths of a good research design is that it gives not just averages but an understanding of the "scatter" of the data points that make up those averages. Figures 1, 10, and 11 include error bars, brackets that show the 95% confidence interval around a treatment average. Another treatment is considered to be statistically different from that average only if it falls outside the confidence interval bracket; otherwise the difference can't be distinguished from chance (here with 95% confidence of being right). There is nothing magical about the 95% confidence interval, but when it is nearly greater than the value of the average itself, the trial isn't able to reveal much about the experimental question. Including more animals in the trial would shrink the error bars, giving more confidence in the results.

Continuing Questions

The research with individual botanical materials has been inconclusive. This does not mean that natural products are all ineffective; there are dozens of untested materials to choose from. It may even be that the materials tested in these trials are effective, but that they were administered incorrectly. The Chenopodium oil, for example, was given in very conservative doses because we had only 100-year-old veterinary records to help calculate the appropriate dose and method of administration. Everyone was hesitant to subject relatively healthy animals to a treatment that might be more effective but more risky. Unfortunately, oil of Chenopodium has become unavailable commercially, precluding further testing.

Lacking a comprehensive program to study and develop alternative treatments, research will likely consist of producers working around the edges of this question. On-farm research in Iowa

is continuing, again evaluating several commercial products that are promoted to control parasites. Fig. 11 shows results of a trial with swine by Tom Frantzen testing a material that contains kelp and "glabber's salt," which is magnesium sulfate. Because of the issue of animal numbers mentioned earlier, it is important that trials like this be repeated until a clear outcome emerges.

The PFI experience with parasite treatments is part of the context that is pushing some cooperators to reexamine the role of management in herd health. Producers in alternative livestock systems are some of the most skilled in the business. And part of the strategy in these operations is to create a high-health environment through management of the whole system. Yet as rich as these systems are, it is sometimes more difficult than in conventional systems to apply principles such as the separation of stock to avoid cross-contamination or the emptying and cleaning of a facility to allow "cooling off" of disease and parasite pressure. Here are some general principles of disease management; producers can decide how they might best be implemented:

Sanitation: This can mean scraping, power washing, exposure to direct sunlight, use of disinfectants, drying, "cooling off" periods for facilities, adding agricultural lime, adding bedding (Parasite ova sift down and may compost in deep bedding.), rotation of pastures (one month minimum, one year much better; rotation of pasture and crops ideal), and even washing of females prior to birthing.

Separation: Keep young livestock separate from older animals (carrying higher parasite loads) until their immune systems develop. In general, keep animals of similar age together. Fix fencing to prevent wandering animals from carrying parasites and disease around the farm. Avoid holding back runt animals; they are contamination sources for the next parity. In daily chores, move from younger animals to older animals to avoid carrying parasite ova and disease to the animals with the least immunity. Maintain a closed herd or isolate and carefully monitor new animals for disease and parasite infection.

Treatment: Creep feed for baby pigs may be acidified, which will help to prevent parasite larvae from maturing in the small intestines. Acidification of feed or water may be effective for other livestock as well. Test the breeding herd for parasites periodically and treat as appropriate. (No synthetic parasiticides given to breeding stock in last third of pregnancy or during lactation if progeny is to be sold.) Many natural materials have been used as wormers historically, and many are probably effective. We did not discover an effective natural treatment, but we evaluated only a few materials, and those in very safe doses and formulations.

Just because these objectives can't be implemented in the same way as in conventional confinement systems does not mean they are impossible or that they do not bring real benefits. In 1942, the USDA Yearbook of Agriculture described the approach made famous by McLean County, Illinois, where livestock were managed to limit transmission of parasites. Young stock were kept separate from older, infected animals. Facilities were cleaned and sterilized. Animals were even transported from one field to another rather than allowing them to walk down parasite-infested lanes. How far down this lane will today's producers go? Probably as far as they can see results. On-farm research will help develop those answers.

Grant Performance

The proposal originally funded by OFRF called for seven on-farm parasite trials to be carried out

over a period of a little more than one year. Practical Farmers of Iowa used the support to complete 11 on-farm parasite trials, but over a period of five years. The extended duration resulted from the limited number of producers willing to actually carry out trials. However, while this extension of the project was a significant variance from the proposal timeline, it has provided us time to evolve our thinking regarding the role of products and that of management. It has also allowed us to address incrementally the methodological challenges of farm-based parasite research. Our hope is that these experiences will prove useful to other producers and farm organizations.

Data Appendix

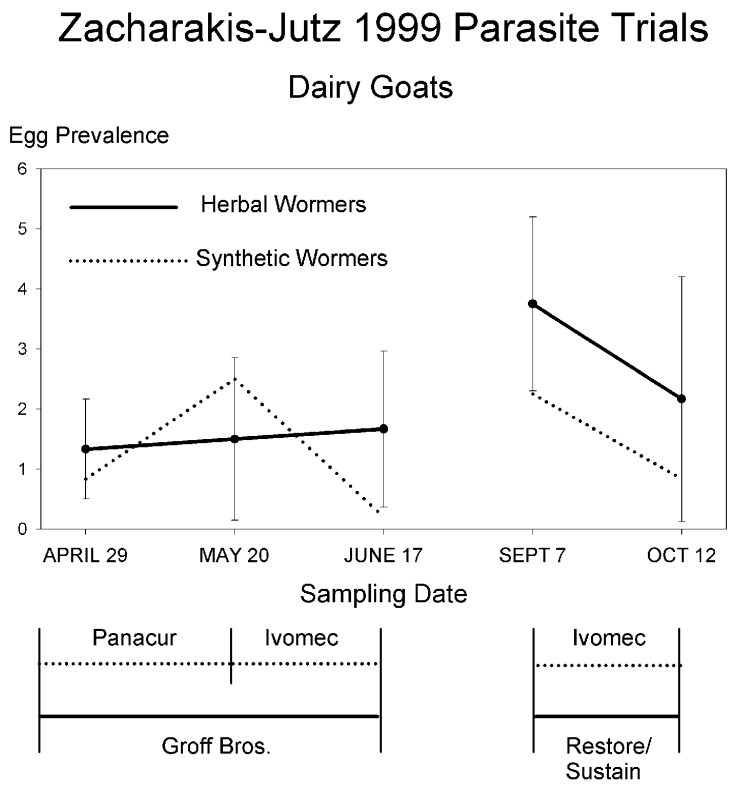

Figure 1. Two 1999 trials with a total of two synthetic wormers and two products that were mixtures of natural, botanical ingredients.

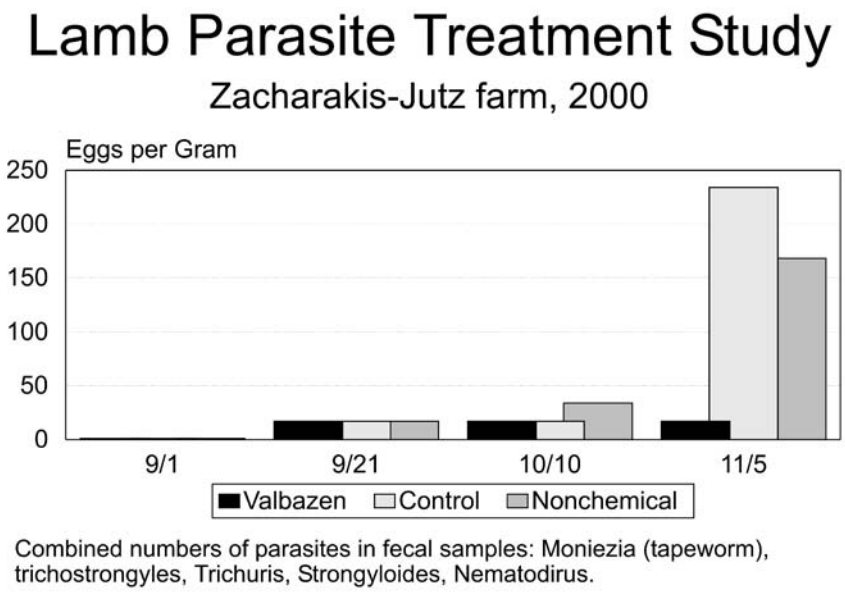

Figure 2. A 2000 trial comparing a synthetic wormer to a control and a natural product sold by 7mFarms & Herbals. Five weeks after the start of the trial, parasite numbers in the control group and in the nonchemical treatment increased dramatically.

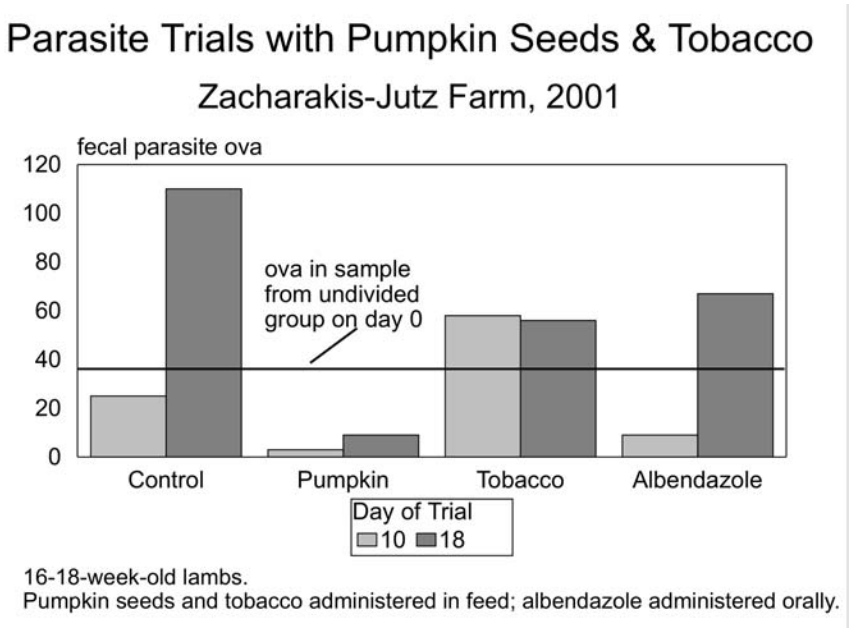

Figure 3. An early trial comparing a synthetic wormer (Valbazen, or Albendazole) and two natural feed additives (tobacco and pumpkin seeds) to a no-treatment control. The subjects were Suffolk lambs. A bulked fecal sample taken before the animals were separated on Day 0 was assumed to represent starting parasite levels for all treatment groups. This assumption has proven to be unsupportable.

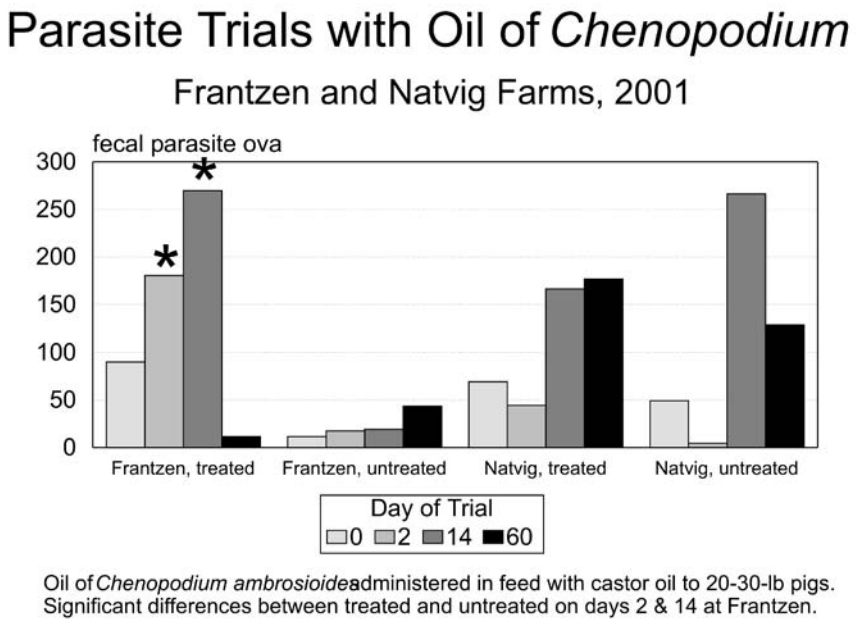

Figure 4. Parasite trials in young swine from 2001 by Frantzen and by Natvig. In the Frantzen trial, the group that received Chenopodium oil had higher parasite egg counts before the treatment was even applied. In neither trial was there a clear treatment effect.

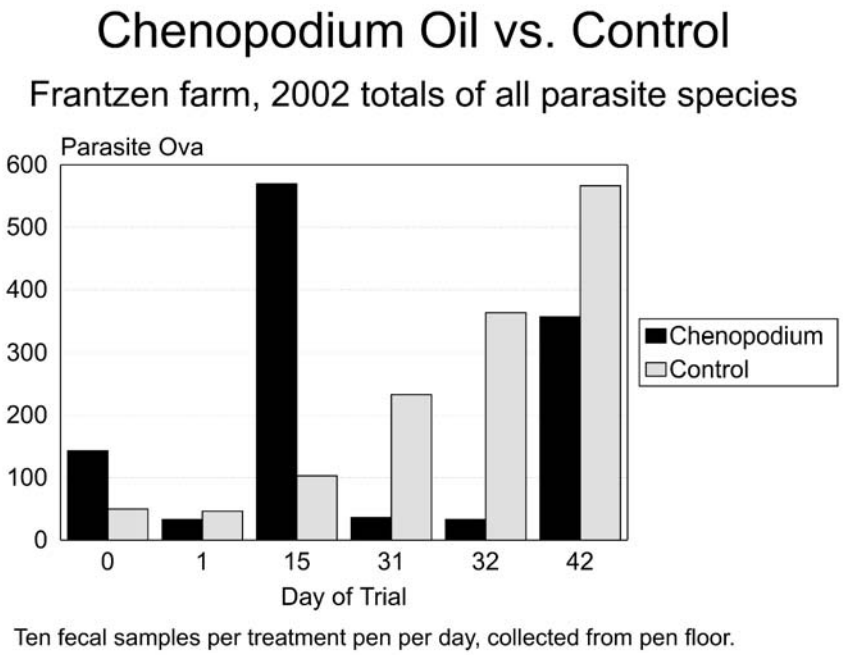

Figure 5. The 2002 Frantzen trial with swine. On the Day 15 sampling, parasite ova jumped in the group that received oil of Chenopodium; the temporary increase was due to one particular kind of parasite, the ascarids.

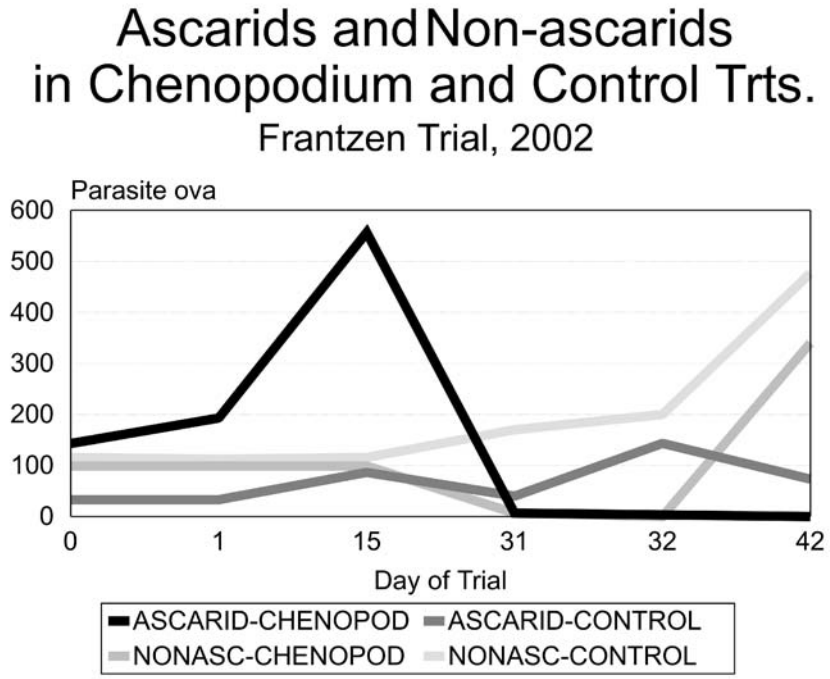

Figure 6. In the trial shown in the previous graphic, the Day 15 spike in the Chenopodium treatment group was limited to parasites in the family Ascaridae. Other types of parasites remained at low levels. Because fecal samples were collected off the pen floor, it was difficult to know how representative those samples were. The Chenopodium group was retreated on Day 31.

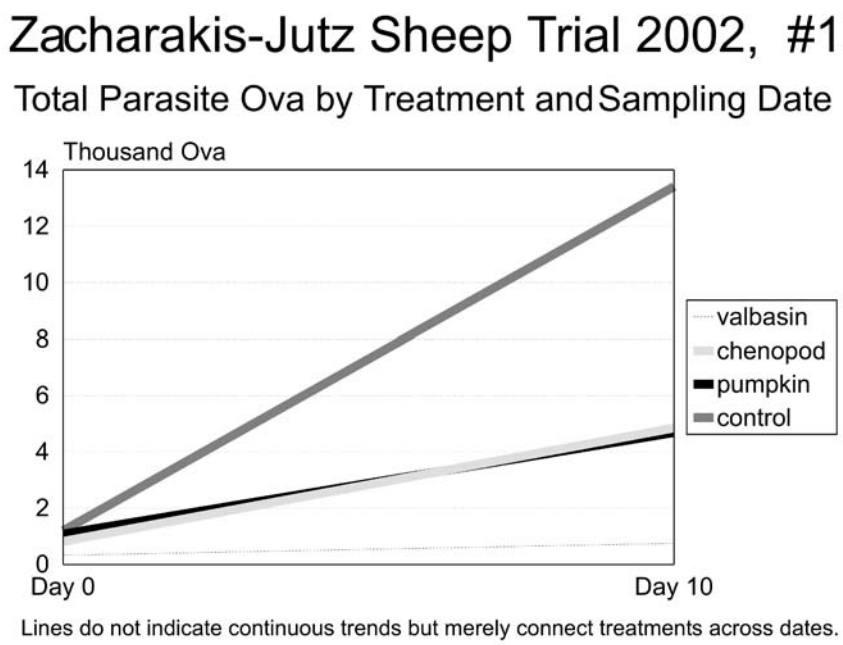

Figure 7. In this 2002 trial in sheep, the two alternative treatments appeared on Day 10 to be more effective than the no-treatment control. However, the trial was discontinued because the producers was concerned about high fecal ova counts in the control group.

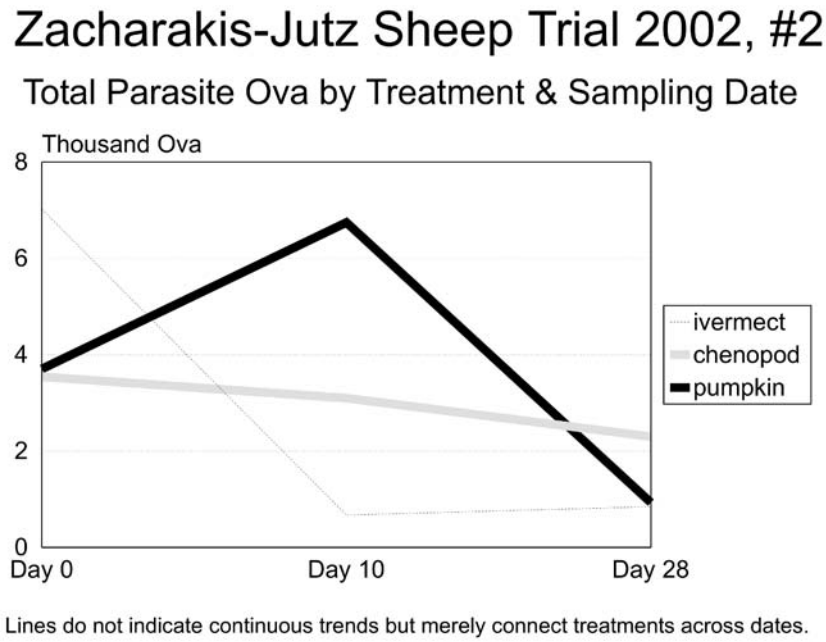

Figure 8. The same sheep producer implemented a second trial in 2002; however this trial included no control group. It was therefore not possible to know whether the alternative treatments had an effect on parasite ova numbers.

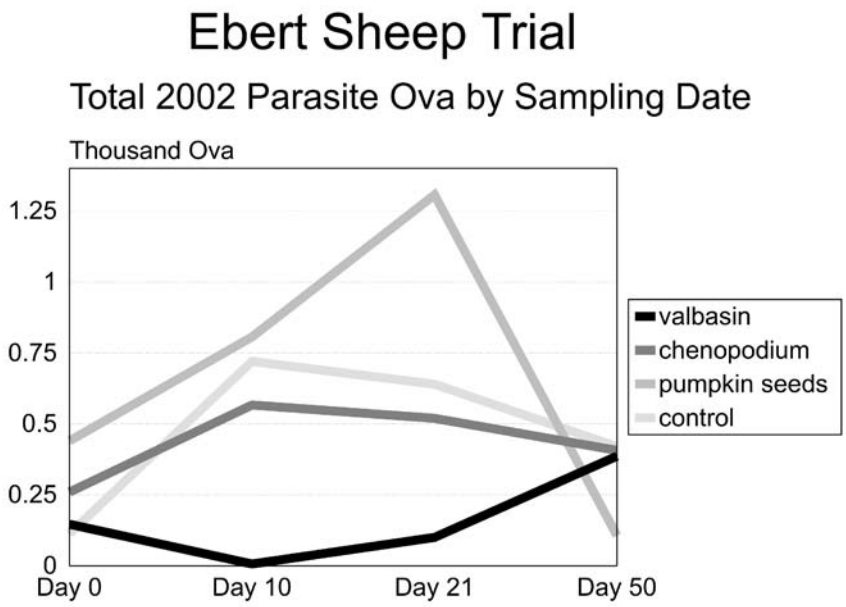

Figure 9. In this 2002 sheep trial, there were significant differences among treatment groups even before treatments were applied. The pumpkin seed group went from having the highest ova counts on Day 21 to having the lowest on Day 50. Fecal samples were collected from the ground.

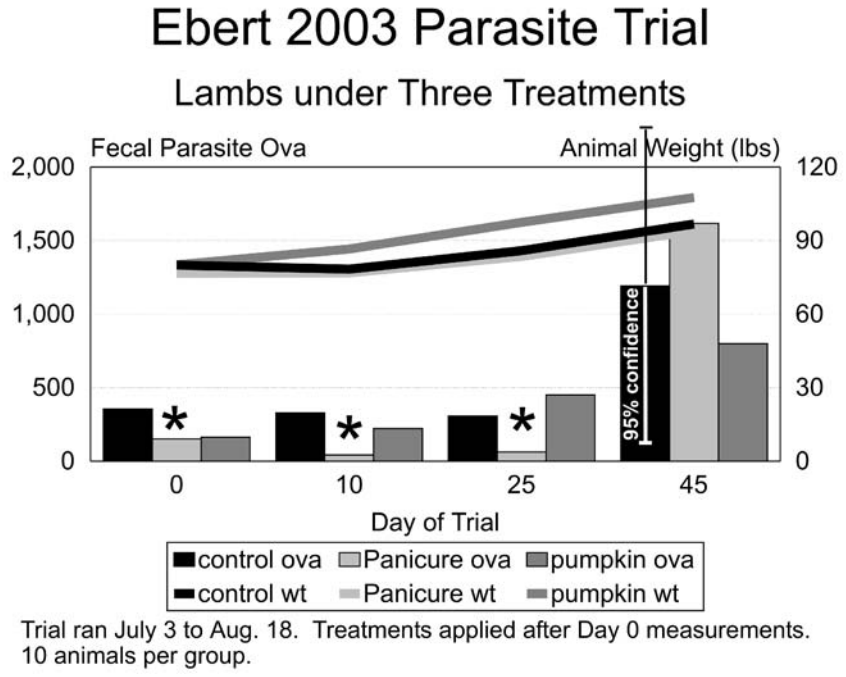

Figure 10. In the Ebert 2003 sheep trial, parasite ova numbers were again significantly different on Day 0, before any treatments were even applied. The group receiving pumpkin seeds gained a weight advantage in the first 10 days and maintained the difference. At the end of the trial, ova counts spiked for all three treatment groups. Fecal samples were collected directly from each animal as body weight was measured. Fecal count and individual weight gain were not significantly correlated in this trial.

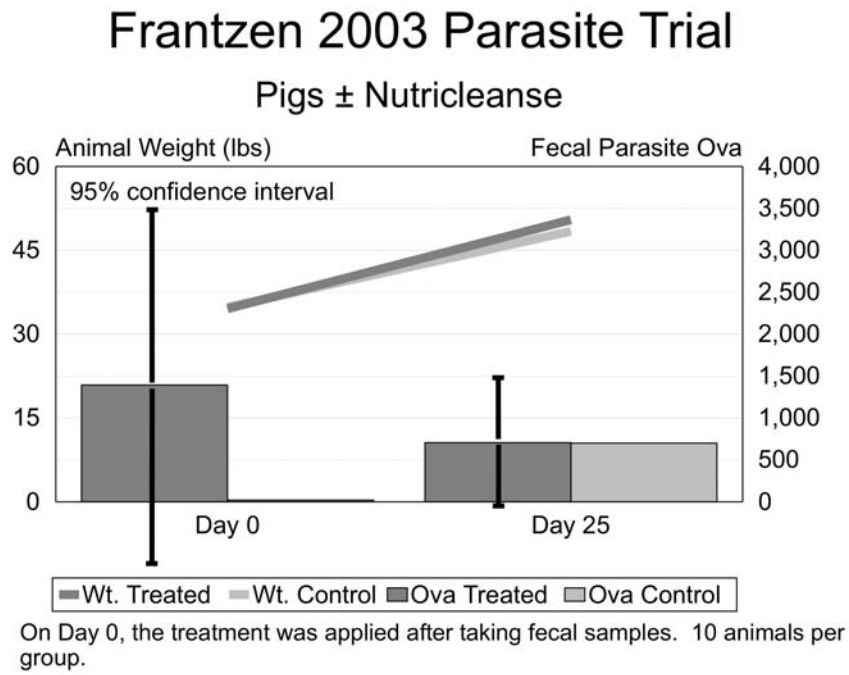

Figure 11. Frantzen 2003 parasite trial. At both sampling dates the difference between treatments was much less than the statistical confidence interval.

Trial Data Tables

Ova Counts, 1999 Zacharakis-Jutz Parasite Trial (Fig. 1)

				Fecal Ova Counts, Total Parasites			
Farm	Trial	Date	Day	Herbal	Synthetic	LSD	Pr>F
Zj	1	April 29	0	1.3	0.8	0.8	0.209
Zj	1	May 20	22	1.5	2.5	1.4	0.130
Zj	1	June 17 *	50	1.7	0.2	1.3	0.031
Zj	2	Sept 7 *	0	3.8	2.3	1.5	0.044
Zj	2	Oct 12	35	2.2	0.8	2.0	0.176

6 animals per treatment group.

Zacharakis-Jutz Sheep Parasite Trial, 2000 (Fig. 2)

	Ova Counts, Total Parasites §		
	Valbazen	Control	Nonchemical
1-Sep	1	1	1
21-Sep	17	17	17
10-Oct	17	17	34
5-Nov	17	234	168

§ One composite sample per treatment group, per date.
Five animals per treatment group

Zacharakis-Jutz Parasite Trial in Sheep, 2001 (Fig. 3)

	Fecal Ova Counts §§			
Day	Control	Pumpkin	Tobacco	Valbazen
0 ¶¶	36	36	36	36
10	25	3	58	9
18	110	9	56	67

¶¶ One composite fecal sample ova count on Day 0.
§§ One composite sample per treatment group, Days 10 and 18.
Five animals per treatment group

2001 Swine Trials Comparing Oil of Chenopodium to Control (Fig 4)

		Fecal Ova Counts					
		Frantzen			Natvig		
Day		treated	untreated	Pr>F	treated	untreated	Pr>F
0		90.0	11.6	0.1669	69.3	49.3	0.7206
2		180.4	17.5	0.0618	44.4	4.4	0.2984
14		269.7	19.2	0.0048	166.3	266.3	0.1960
60		11.7	43.6	0.2587	176.6	129.1	0.5305

	Day	0	2	14	60
Frantzen	treated	90.0	180.4	269.7	11.7
	untreated	11.6	17.5	19.2	43.6
Natvig	treated	69.3	44.4	166.3	176.6
	untreated	49.3	4.4	266.3	129.1

Frantzen trial: 8 pigs per treatment group.
Natvig trial: 10 pigs per treatment group.

Frantzen 2002 Parasite Trial of Chenopodium Oil in Pigs (Figs. 5, 6)

	Total Parasites				Trichur		Ascaris		Strongyl		Other		Non-ascaris	
Day	Chenopodium	Control	Pr>f		Chenopodium	Control	Chenopodium	Control	Chenopodium	Control	Chenopodium	Control	Chenopodium	Control
0	143.1	49.8	0.3941	Pretreatment	33.0	49.8	143.1	33.0	33.0	33.0	33.0	33.0	99.0	115.8
1	33.0	46.4	0.3726	Post-treatment	33.0	46.4	193.0	33.0	33.0	33.0	33.0	33.0	99.0	112.4
15	569.7	103.1	0.1154		33.0	49.7	556.5	86.4	33.0	33.0	33.0	33.0	99.0	115.7
31	36.4	233.1	0.2445	Pretreatment	3.3	166.7	6.7	40.0	3.3	3.3	0.0	0.0	6.6	170.0
32	33.0	363.1	0.1111	Post-treatment	0.0	200.0	3.3	143.3	0.0	0.0	0.0	0.0	0.0	200.0
42	356.5	566.5	0.6911		333.3	476.7	0.0	73.3	6.7	0.0	0.0	0.0	340.0	476.7

10 Fecal Samples per Date, Collected from Pen Floor.
10 Animals per Treatment Group.

2002 Sheep Trials on Zacharakis-Jutz Farm and Ebert Farm (Figs. 6,7,8)

					Fecal Ova Counts						
Year	Farm	Trial	Day	Treatment	trichos	Trichuri	Strongyl	Nematodi	Marshall	Total	Group
2002	ZJ	1	0	valbasin	233.40	19.80	39.80	39.80	0.00	332.80	b
2002	ZJ	1	0	chenopod	693.20	40.00	56.80	33.20	0.00	823.20	ab
2002	ZJ	1	0	pumpkin	1,033.40	0.00	40.00	13.20	0.00	1,086.60	a
2002	ZJ	1	0	control	1,146.80	0.00	53.40	0.00	0.00	1,200.20	a
2002	ZJ	1	0	Significance	0.0158	0.0476	0.9048	0.2020		0.0185	
2002	ZJ	1	10	valbasin	753.00	0.00	0.00	0.00	0.00	753.00	b
2002	ZJ	1	10	chenopod	4,827.00	6.60	6.60	13.20	0.00	4,853.00	b
2002	ZJ	1	10	pumpkin	4,613.00	0.00	59.80	13.20	6.60	4,693.00	b
2002	ZJ	1	10	control	13,373.00	6.60	0.00	26.80	0.00	13,407.00	a
2002	ZJ	1	10	Significance	0.0006	0.5847	0.0105	0.3425	0.4182	0.0006	
2002	ZJ	2	0	ivermect	6,658.00	0.00	341.80	24.80	0.00	7,025.00	a
2002	ZJ	2	0	chenopod	3,533.00	0.00	11.00	13.20	0.00	3,544.00	a
2002	ZJ	2	0	pumpkin	3,620.00	6.60	66.60	0.00	0.00	3,706.00	a
2002	ZJ	2	0	Significance	0.6675	0.5419	0.0122	0.3734		0.6097	
2002	ZJ	2	10	ivermect	473.00	0.00	186.80	13.40	0.00	673.00	b
2002	ZJ	2	10	chenopod	2,933.00	0.00	133.20	33.40	0.00	3,100.00	ab
2002	ZJ	2	10	pumpkin	6,500.00	0.00	213.40	33.20	0.00	6,746.00	a
2002	ZJ	2	10	Significance	0.0360		0.8375	0.5979		0.0344	
2002	ZJ	2	28	ivermect	833.00	0.00	0.00	0.00	0.00	846.00	a
2002	ZJ	2	28	chenopod	2,060.00	0.00	226.60	13.20	0.00	2,300.00	a
2002	ZJ	2	28	pumpkin	870.00	6.60	40.00	13.40	0.00	930.00	a
2002	ZJ	2	28	Significance	0.4938	0.3966	0.2926	0.5055		0.4476	
2002	Ebert	3	0	valbasin	126.60	13.40	0.00	6.60	0.00	146.60	b
2002	Ebert	3	0	chenopod	213.40	26.60	19.80	0.00	0.00	259.80	ab
2002	Ebert	3	0	pumpkin	406.60	26.80	0.00	0.00	6.60	440.00	a
2002	Ebert	3	0	control	73.20	40.00	0.00	0.00	0.00	113.20	b
2002	Ebert	3	0	Significance	0.0051	0.8853	0.0061	0.4182	0.4182	0.0189	
2002	Ebert	3	10	valbasin	0.00	6.60	0.00	0.00	0.00	6.60	b
2002	Ebert	3	10	chenopod	320.00	220.00	13.20	13.20	0.00	566.40	a
2002	Ebert	3	10	pumpkin	653.20	100.00	33.20	13.20	6.60	806.20	a
2002	Ebert	3	10	control	646.80	46.60	26.60	0.00	0.00	720.00	a
2002	Ebert	3	10	Significance	0.0090	0.0217	0.3705	0.1919	0.4182	0.0069	
2002	Ebert	3	21	valbasin	80.20	0.00	20.00	0.00	0.00	100.20	b
2002	Ebert	3	21	chenopod	466.40	40.00	13.20	0.00	0.00	519.60	b
2002	Ebert	3	21	pumpkin	1,193.20	80.00	33.20	0.00	0.00	1,306.40	a
2002	Ebert	3	21	control	613.20	13.20	0.00	13.20	0.00	639.60	b
2002	Ebert	3	21	Significance	0.0009	0.3221	0.3008	0.0829		0.0017	
2002	Ebert	3	50	valbasin	373.20	0.00	6.60	6.60	0.00	386.40	a
2002	Ebert	3	50	chenopod	380.20	26.40	0.00	0.00	0.00	406.60	a
2002	Ebert	3	50	pumpkin	73.20	33.20	0.00	0.00	0.00	106.40	b
2002	Ebert	3	50	control	380.00	26.40	0.00	6.60	6.60	419.60	a
2002	Ebert	3	50	Significance	0.0015	0.1448	0.4182	0.5847	0.4182	0.0030	

Summary, 2002 Sheep Trials (from previous page)

Farm	Trial	Day	Treatment	Total Ova
ZJ	1	0	valbasin	332.8
ZJ	1	0	chenopod	823.2
ZJ	1	0	pumpkin	1086.6
ZJ	1	0	control	1200.2
ZJ	1	10	valbasin	753.0
ZJ	1	10	chenopod	4853.0
ZJ	1	10	pumpkin	4693.0
ZJ	1	10	control	13407.0

Farm	Trial	Day	Treatment	Total Ova
ZJ	2	0	ivermect	7025
ZJ	2	0	chenopod	3544
ZJ	2	0	pumpkin	3706
ZJ	2	10	ivermect	673
ZJ	2	10	chenopod	3100
ZJ	2	10	pumpkin	6746
ZJ	2	28	ivermect	846
ZJ	2	28	chenopod	2300
ZJ	2	28	pumpkin	930

Farm	Trial	Day	Treatment	Total Ova
Ebert	3	0	valbasin	146.6
Ebert	3	0	chenopod	259.8
Ebert	3	0	pumpkin	440
Ebert	3	0	control	113.2
Ebert	3	10	valbasin	6.6
Ebert	3	10	chenopod	566.4
Ebert	3	10	pumpkin	806.2
Ebert	3	10	control	720
Ebert	3	21	valbasin	100.2
Ebert	3	21	chenopod	519.6
Ebert	3	21	pumpkin	1306.4
Ebert	3	21	control	639.6
Ebert	3	50	valbasin	386.4
Ebert	3	50	chenopod	406.6
Ebert	3	50	pumpkin	106.4
Ebert	3	50	control	419.6

5 animals per treatment group in each trial.

Ebert 2003 Parasite Trial in Sheep (Fig. 10)

			Fecal Ova Counts			
Day	Trt	Lbs	Strongyloides	Strongyl	Whip	Total eggs
0	control	80.0 a	103.7 a	233.3 a	18.6 a	355.6 a
0	Panicure	76.6 a	24.9 a	118.4 a	8.4 a	151.6 b
0	pumpkin	80.1 a	22.3 a	129.7 a	11.1 a	163.1 b
	Pr>F	0.8872	0.0351	0.1196	0.7589	0.0102
10	control	78.3 a	66.7 a	214.8 a	14.8 a	329.1 a
10	Panicure	76.9 a	14.3 a	23.7 a	4.7 a	42.7 b
10	pumpkin	86.6 a	50.0 a	161.0 a	11.0 a	222.0 ab
	Pr>F	0.36610	0.22160	0.09770	0.81240	0.03500
25	control	85.9 a	0.0 a	277.7 a	29.6 a	307.2 a
25	Panicure	83.5 a	0.0 a	62.5 b	0.0 b	62.5 b
25	pumpkin	97.4 a	11.0 a	426.0 a	14.7 ab	451.0 a
	Pr>F	0.1216	0.0387	0.0048	0.0468	0.0038
45	control	96.8 a	22.1 b	1,162.9 a	7.3 a	1,192.3 a
45	Panicure	94.0 a	8.3 b	1,608.3 a	0.0 a	1,616.5 a
45	pumpkin	107.6 a	177.6 a	611.0 a	11.0 a	799.6 a
	Pr>F	0.1536	0.0045	0.0808	0.4904	0.1985

Note: Pr>F is the probability of getting a more extreme value by chance. If that value is less than 0.05, there is a greater-than-95% chance the difference isn't due to chance. If the value is 0.15, there is an 85% probability the difference is a treatment effect, etc.

Summary, 2003 Ebert Trial

	Total Ova			Weight (lbs)		
Day	control	Panicure	pumpkin	control	Panicure	pumpkin
0	355.6	151.6	163.1	80.0	76.6	80.1
10	329.1	42.7	222.0	78.3	76.9	86.6
25	307.2	62.5	451.0	85.9	83.5	97.4
45	1,192.3	1,616.5	799.6	96.8	94.0	107.6
No. animals	9	8	9	9	8	9

Frantzen 2003 parasite Trial: Nutricleanse® vs. Control (Fig 11)

Day	Trt	Corrected Wt. (lbs)	Fecal Parasite Ova: Trichuris	Ascaris	Strongyl	Other	Total	Comment
0	Nutricleanse	34.5	41.0	1,351.5	0.0	0.0	1,392.5	The Nutricleanse treatment group had fewer worms even before the treatments were applied, especially ascarid worms. However it was spotty, with several of the Nutricleanse animals showing zero parasites. The statistics would say that there is an 80% chance the two groups were different for total parasites.
0	Check	34.8	0.0	147.1	0.0	0.0	0.0	
25	Nutricleanse	50.5	0.0	693.0	0.0	13.3	706.3	So by the end of the trial, the two groups were almost identical. Was the relative improvement "caused" by the Nutricleanse treatment, or did the two groups just reach an equilibrium together? We cannot say for certain. There was no hint of a statistical difference in weights at the end of the trial (a 34% chance of the difference being nonrandom, which is far less than the 90 or 95% confidence we usually require). Repeating this trial several more times would answer these questions.
25	Check	34.8	0.0	147.0	0.0	0.0	0.0	

11 animals per treatment group.
Nutri-cleanse is a product of Ralco, Inc., Marshall, MN.

Treatments in PFI Parasite Trials, 1999 – 2003						
Year	**Cooperator**	**Subjects**	**Trial #**	**Treatment**	**Dose**	**Comments**
1999	Jutz *	goats (milking does)	1	herbal	30 cc orally for a 175-lb doe, daily for 10 days	mfg. by Groff Bros. Farm. Contains black walnut, cloves, echinacea, hyssop, & wormwood
				Panacur / then Ivermectin pour-on	Panacure administered orally at start. Ivermectin pour-on administered at one month. Both at 1 cc per 22 lb body weight.	(Panacur® = Fenbendazole) (Eprinex® = Ivermectin)
1999	Jutz	goats (milking does)	2	Restore & Sustain®	1 Tablespoon Restore and 1 Tablespoon Sustain in feed morning and evening for 10 days, then weekly	Farmstead Health Supply -- Restore: Wormwood, Garlic, Gentian, Fennel, Psyllium, Centaury Sustain: Coltsfoot, Coriander Seed, Fennel Seed, Irish Moss, Juniper Berry, Yarrow Herb, Rosehips, Rhubarb Root, Sea Kelp
				Ivermectin pour-on	1 cc per 22 lb body weight	Eprinex®
2000	Jutz	2-3 month-old lambs	1	control		trial conducted on concrete, beginning in late August. All lambs received Valbasin 1 week prior to trial.
				Herbal Wormer and Tonic ®	added to feed daily for 1 week, then weekly	7mFarm & Herbals "Ingredients: Wormwood, garlic, cloves, psyllium seed, fennel, gentian, black walnut hulls, etc."
				Valbasin (albendazole)	3 cc per 75 lbs body wt., administered orally	
2001	Frantzen, Natvig	30-40-lb pigs	1, 2	control	feed untreated gruel	Withdraw from feed 24 hr before treatment. Scrape and lime pen before start of trial.
				oil of Chenopodium	4 ml Chenopodium plus 60 ml castor oil per 100 lbs of body weight, mixed with cod liver oil in feed gruel	
2001	Jutz	16-18-week-old Suffolk lambs	1	control		
				whole pumpkin seeds, unsalted	mixed into feed at 6 oz per 75 lbs of body weight. Administered for a single feeding.	
				ground, untreated leaf tobacco	mixed into feed at 1 oz per 75 lbs body weight. Administered for a single feeding.	
				Valbasin (albendazole)	3 cc per 75 lbs body wt., administered orally	
2002	Jutz	lambs	1	control		
				whole pumpkin seeds, unsalted	mixed into feed at 6 oz per 75 lbs of body weight. Administered for a single feeding.	

				Chenopodium, dried and ground	mixed into feed at 1 Tablespoon per lamb. Administered for a single feeding.	
				Valbasin (albendazole)	3 cc per 75 lbs body wt., administered orally	
2002	Jutz	lambs	2	whole pumpkin seeds, unsalted	mixed into feed at 6 oz per 75 lbs of body weight. Administered for a single feeding.	
				Chenopodium, dried and ground	mixed into feed at 1 Tablespoon per lamb. Administered for a single feeding.	
				Ivermectin	Ivermectin pour-on administered at 1 cc per 22 lb body weight.	
2002	Ebert	lambs	1	control		
				whole pumpkin seeds, unsalted	mixed into feed at 6 oz per 75 lbs of body weight. Administered for a single feeding.	
				Chenopodium, dried and ground	mixed into feed at 1 Tablespoon per lamb. Administered for a single feeding.	
				Valbasin (albendazole)	3 cc per 75 lbs body wt., administered orally	
2002	Frantzen	30-40-lb pigs	1	control	feed untreated gruel	Withdraw from feed 24 hr before treatment. Scrape and lime pen before start of trial.
				oil of Chenopodium	4 ml Chenopodium plus 60 ml castor oil per 100 lbs of body weight, mixed with cod liver oil in feed gruel	
2003	Ebert	lambs	1	control		
				whole pumpkin seeds, unsalted	mixed into feed at 6 oz per 75 lbs of body weight. Administered for a single feeding.	
				Chenopodium, dried and ground	mixed into feed at 1 Tablespoon per lamb. Administered for a single feeding.	
				Valbasin (albendazole)	3 cc per 75 lbs body wt., administered orally	
2003	Frantzen	20-lb pigs	1	control		contains kelp and "glauber's salt", which is sodium sulfate decahydrate, $Na_2SO_4 \cdot 10H_2O$
				Nutri-Clense®	2 oz per head per day, or 40 lbs/T of feed	
	* The "Jutz" trials were largely carried out by Frances Zacharakis-Jutz.					
	Note: All animals were fed organic rations on the Jutz, Natvig, and Frantzen farms, but not on the Ebert farm.					