Internal Parasite Issues Impacting Grazing Flocks

J. S. Rook D.V.M. & Linda Mansfield, V.M.D., PhD,
MSU Extension & MSU Ag Experiment Station
Department of Large Animal Clinical Sciences
College of Veterinary Medicine
Michigan State University

Key Words: internal parasites, worms, sheep, grazing, strategic deworming, grass-based production systems, prevention, economics, lambs and ewes

Routine annual health expenditures for commercial flocks are modest and typically amount to about $3 to $5 per ewe. While exact dollar amounts vary between farms and production systems, expenditures addressing health issues generally include 1) vaccination against enterotoxemia and abortion losses (campylobacter and/or chlamydia) and 2) medication costs related to the control of internal and external parasites. Although routine health care often represents less than 10% of annual ewe maintenance costs, producers should recognize that a significant portion of the health care budget depends upon the purchase price and frequency of administration of anthelmintic medications.

Typically, recommendations regarding frequency, timing, and type of anthelmintic administration vary, but are usually designed around individual farm management strategies and goals. Successful deworming programs are generally based upon parasite life cycle, weather conditions and individual farm management practices - not "cookbook" recommendations. However, the ultimate goal of any deworming strategy should be reduction of pasture contamination from parasite ova and larva. Adhering to a flock specific *"strategic deworming"* strategy should reduce risks of reinfection. Furthermore, timely administration of anthelmintic medications and proper dosing should greatly reduce treatment frequency by maximizing the efficacy of each administration. To monitor the effectiveness of deworming programs, producers should also have their veterinarian regularly evaluate composite fecal samples to determine parasite type, parasite load and the effectiveness of the deworming program.

***The problem for Midwestern producers*:** During the past 15 years many commercial sheep producers in the Midwest have switched from a winter lambing production scheme to a grass-based, spring lambing program. Winter lambing flocks producing creep-fed lambs that never graze pasture, view pasture/parasite issues as insignificant - because in traditional winter lambing systems only parasite resistant, older ewes go to pasture each spring. Thus, with the exception of coccidiosis, internal parasites are seldom a concern for winter born, dry-lot lambs. In contrast, spring lambing flocks typically release ewes and their lambs to pasture each spring to utilize their primary resource - grass. While spring lambing and management intensive grazing (MIG) practices can offer reduced feed costs and increased profitability, losses from internal parasites impact health and production issues. Midwestern producers generally recognize that strategic deworming and grazing management have the potential to reduce parasite losses, however, economic and labor constraints often "derail" even the best deworming programs.

Additionally, many producers believe that rotational grazing systems reduce parasite problems. In the Midwest, this premise may or may not be correct. Intensive rotational grazing may actually contribute to parasite reproduction, survival and reinfection of the flock. Rotating large groups of ewes and lambs through small grazing paddocks (cells) often concentrates livestock and infective parasite larva onto the same small area. To control the flush of early season grass, MIG practices routinely employ stocking densities in excess of 100 ewe units per acre. Furthermore, ten-day to twenty-day early season paddock rotations often parallel life cycles of clinically important internal parasites. Thus, scheduled rotational returns to contaminated paddocks may occur when these previously grazed (10 to 20 days earlier) paddocks contain significant numbers of infective parasite larva. Regrazing highly-contaminated, early-season pastures may "set the stage" for clinical disease for the remainder of the grazing season.

Spring lambing systems also contribute to parasite losses due to: 1) the logistics of the system and 2) the type of animals being grazed. In typical spring lambing systems, lambing (April and May) and early lactation (May and June) parallel the onset of lush, nutrient rich pasture. Midwestern producers utilize either a drop-lot lambing system or pasture lamb their flock. Following lambing, ewes and their newborn lambs are released to pasture and grazed until fall. In spring lambing systems (unlike winter-lambing systems) the *periparturient egg rise* (associated with lambing stress and the onset of lambing) and the *spring egg rise* (associated with spring weather that is conducive to worm survival) occur in the ewe at roughly the same time. When spring arrives early (as in 1998) the spring egg rise may actually occur before ewes begin lambing - thus prolonging the parasite season and contaminating pasture very early in

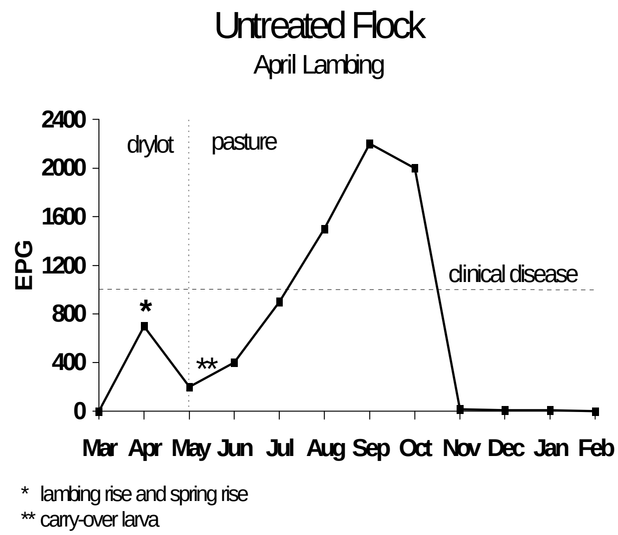

Figure 1 illustrates the contribution of early season pasture contamination to the development of clinical disease. In this example, notice that the *periparturient egg rise* (lambing egg rise), the *spring egg rise* (same time) and *carry-over larva* combine to create a triple threat for early season pasture contamination that leads to clinical disease. Production losses and clinical disease generally occur any time fecal strongyle *EPG* (eggs per gram of manure) counts exceed the 1,000 to 1,500 EPG level. To put this in perspective, one gram of manure is roughly equal to two manure pellets. High EPG counts early in the grazing season exponentially explode into clinical disease as the grazing season progresses. Strategic deworming programs strive to reduce these three sources of early season pasture contamination. This helps to reduce the number of highly infected generations of parasites that are allowed to cycle through the animal - before normal fall egg production ceases (Oct. to Nov.).

Furthermore, as animals age and are exposed to parasites, those that survive the initial insult do develop some immunity. For this reason, parasite control in lambs is much more critical than in older ewes. However, older ewes are the initial source of pasture reinfection each spring. In addition, animals that are stressed are more likely to develop parasite problems. Thus age, stress related to lambing and nutritional stresses associated with seasonal fluctuations in available forage all influence the severity of parasite problems in MI spring lambing systems. Summer droughts and the usual "summer slump" in grass production also impact the parasite equation by placing added nutritional stress on the lambs due to decreased milk production in the ewe flock.

the spring. The periparturient egg rise and the spring egg rise result from re-activated dormant worm larva that winter within the intestinal wall of the ewe. During the spring and periparturient egg rise, egg production often exceeds 10,000 eggs per adult worm per day! The importance of preventing massive pasture contamination early in the grazing season should be obvious (see Fig.1). ***Deworming prior to lambing is an important management tool for controlling both the periparturient and the spring egg rise***.

Additionally, "*carry-over larva*"(or "*over-wintering larva*") infect lambs and ewes as they begin each grazing season. Carry-over larva develop from worm eggs deposited onto pasture during the previous fall grazing season. As spring arrives, carry-over larva (dormant in the soil during the cold winter months) develop into infective larva. Winter survival of carry-over larva is dependent upon snow cover and winter temperatures. Generally, internal parasite problems are much more common in grazing seasons that follow extremely mild winters (1998 was a good example). Producers should not consider winter-idled pastures as "clean" (parasite free), unless they were ungrazed by sheep during the previous fall. Each spring, over-wintering larva found on contaminated pastures are capable of infecting sheep for about 3 to 6 weeks into the new grazing season. Preventing early season pasture contamination from: 1) the spring egg rise, 2) the periparturient egg rise and 3) carry-over larva, should avert establishment of new generations of parasites and is the basic function of strategic deworming programs. If left unchecked, early season pasture contamination, coupled with moist humid weather conducive to 17 to 20 day parasite generational turn-over time, can lead to clinical disease and lamb mortality by late June or early July (see Fig.1).

Grazing clean pastures and strategic deworming - grossly under-utilized parasite management tools!!!! Management decisions regarding grazing rotations for “clean” (worm free) and “dirty” (worm infected) pastures and deworming programs greatly impact parasite losses. While many Midwestern producers understand the importance of: 1) early season strategic deworming and of, 2) grazing "clean pastures" early in the spring, most fail to utilize these important, yet rather basic strategies. Due to labor demands, early season strategic deworming is usually postponed at the expense of spring field work and first cutting hay. Spring lambing flocks also postpone initial deworming to allow newborn lambs to grow and bond with their mothers. In larger flocks, processing (drenching) ewes and very young lambs through a working chute is often counter productive - as mismothering and traumatic losses often occur. This is especially true in larger production units. Due to field labor constraints and mismothering losses in very young lambs, initial deworming is typically postponed until early July (8-10 weeks into the grazing season). Delaying initial deworming until July allows three to four generations of parasites (5 or 6 generations in a year when spring comes early as in 1998) to cycle through the ewes and lambs - heavily contaminating pastures *before* the first deworming occurs. Lambs confronted with this type of massive early season pasture contamination exhibit clinical signs of parasitism early in the summer, often requiring anthelminthic treatment at 3 to 4 week intervals throughout the grazing season - just to prevent death and production losses. Once 3 or 4 generations of parasites become established on pasture and in the intestine of the animal, deworming and returning the flock to the same heavily contaminated pasture does little to prevent losses.

Clean pasture for early season grazing and for post-anthelminthic treatment turn-out is a cheap, efficient, yet seldom utilized practice. Most producers do not have sufficient pasture acreage to allow grazing of clean pastures early in the spring. Yearly stocking densities on sustainable MIG farms typically run 3 to 8 ewe units per acre - with year-round grazing. Additionally, many grazing flocks purchase hay and no longer produce row crops or graze cattle. Hay fields, row crop residue acreage and cattle pastures are all options for clean pasture during the grazing season. Clean pastures prevent initial carry-over infection early in the grazing season and prevent reinfection immediately following a mid-season deworming.

What strategic deworming practices are we using that are helpful?: Currently, most Midwestern producers deworm ewes prior to lambing to reduce the impact of the *periparturient* and the *spring egg rise*. This pre-lambing deworming treatment helps reduce two of the three sources of new parasite infection each spring. If routine pre-lambing anthelminthic treatment is practiced, spring lambing ewes and their lambs should be relatively parasite free when released to pasture each May. *If clean pastures could be designated and grazed during the first three to six weeks of the grazing season, risk of new infection from over-wintering larva could be reduced. Strategically grazing clean pastures early in the spring would address the third source of new parasite infection (carry-over larva). However, clean pastures are seldom planned for or available.*

Strategic Deworming: A Two-year (1996 & 1997) Deworming Trial Utilizing Fenbendazole-Medicated Salt Blocks

To facilitate timely strategic deworming of larger, pasture-based commercial ewe flocks, a self-medicating deworming system is needed for use early in the grazing season (May & June). Spring lambing flocks routinely deworm ewes in the lambing pens, or as a group - just prior to lambing. However, most producers find it difficult to deworm animals at three and six weeks into the spring grazing season. As mentioned earlier, this is due to labor constraints from field work and perinatal mortality issues associated with working large groups of ewes and their newborn lambs. *Strategic deworming at exactly three and six weeks into the grazing season is important, if, over-wintering larva are to be prevented from maturing and producing the eggs which restart pasture contamination each spring*. While a medicated feed-type anthelminthic would appear to address the issue, spring lambing ewes consume pasture and receive no supplemental grain. Therefore, a self-medicating, non-feed-based system that prevents disruption of maternal bonding is required. Medicating via a free-choice salt mix system appears to be the only reasonable choice. While salt consumption by newborn lambs is erratic, ewes consume about ½ oz of salt per day, on a regular basis. Additionally, early in the grazing season the ewe should be the target animal for strategic anthelminthic treatment - as newborn lambs consume very little forage. The rationale here is that during the first three to six weeks of the grazing season ewes grazing "dirty" pasture consume an enormous quantity of carry-over larva infected pasture. Ultimately, the ewe, not her lambs, probably restarts pasture contamination each spring.

Free-choice salt preparations are merely the vehicle used to carry anthelminthic medication to the ewe flock. However, we also need a safe and effective anthelminthic. Fenbendazole (FBZ) appears to be a logical choice. Fenbendazole is a unique dewormer that functions well in a self- medication system. While not approved for use in sheep in this country, FBZ is approved for use in most species of domestic animals and is commonly used in most sheep producing countries throughout the world. Many sheep producers are familiar with a 10% FBZ suspension cattle drench marketed under the trade names of Panacur or Safeguard. This product is commonly used to deworm sheep and cattle at a drench dose rate of 2.27 mg of FBZ/lb of body weight. It is safe for pregnant ewes, effective for most common internal parasites and has a huge margin of safety. Additionally, a unique and useful property of this anthelminthic is that *lower doses of FBZ - administered for 3 continuous days - are as effective as a single larger drench dose of the product.* Thus, a daily .76 mg fenbendazole/lb of body weight dose - ingested over 3 continuous days - is equivalent in effect to the one-time drench dose listed above. Fenbendazole's unique 3-day dosing feature, safety, and spectrum of activity make FBZ an ideal product for administration to animals via a free-choice salt mix. Salt is both the carrier of the medication and is also used to control intake. However, when medicated salt mixes are used, producers should remember to remove all other sources of salt during the treatment phase.

There are numerous commercial FBZ-medicated salt/mineral products designed to treat cattle. Free-choice FBZ-medicated cattle products include loose salt/mineral mixes, molasses flavored salt blocks and salt/protein/mineral blocks. However, all are designed for cattle. Our two-year clinical trial involved the use of the Safe-Guard En-Pro-AL

Deworming Block (Hoechest-Roussel). This product was chosen for the following reasons: 1) it is molasses flavored (palatability), 2) it contains 750 mg of fenbendazole per pound of product and, 3) it is 18% salt. On a daily basis, if each ewe consumes ½ ounce of salt per day, this block supplies a dose of .83 mg of FBZ/lb of body weight. Thus, three consecutive daily doses of the medicated block (based on daily intake of ½ oz of salt/ewe) provided a total dose of 2.5 mg of fenbendazole/lb of body weight - very similar to the recommended 2.27 mg FBZ/lb of body weight total dose rate. Additionally, each 25 lb block provides a 3-day continuous FBZ dose for fifty 150 pound ewes.

This particular deworming block is designed for cattle and contains 67 ppm copper. Generally, copper levels in the total diet in excess of 15 to 20 ppm can create copper toxicity problems in sheep. While 67 ppm copper appears to be rather high, remember that this product is not the entire diet of the ewe and is only to be used for several days during the grazing season. Copper levels in the product are similar to those found in cattle trace mineral salt. *Clinically, copper was not an issue during the two-year trial and palatability of the block was at the expected level*.

Economics was also a consideration. However, on a per ewe basis, FBZ-medicated blocks were similar in cost to equivalent drench doses of fenbendazole. Over the two-year period, costs for either the FBZ drench or FBZ blocks ranged from $0.50 to $0.70 per ewe. Labor for drenching was not included in these figures and could be considered a savings related to FBZ block administration.

1996 & 1997 Field Investigation: During the 1996 and 1997 grazing seasons, five larger (200 to 700 ewes) grazing-based operations were selected to evaluate the feasibility of using FBZ-medicated salt blocks to strategically deworm the flock at three weeks and six weeks into the grazing season. We believed this practice would reduce early season pasture contamination and lessen the effect of over-wintering larva. Three farms (designated farms J,G & H) were selected to deworm with FBZ-medicated salt blocks during the May 20th though May 24th period each year (the 3-week deworming) and again from June 17th through June 21st (the 6-week strategic deworming) each year. The other two farms (designated farms W & T) were instructed to use FBZ drench for their first two deworming treatments each season. No specific three or six-week strategic treatments were requested on the FBZ drench farms. Instead, producers were instructed to drench with FBZ drench when they chose. Four of the five (J,H,T & W)) farms practiced varying degrees of rotational to intensive grazing practices. One farm (G) functioned with a continuous grazing system. All farms had experienced parasite losses during the previous (1995) grazing season.

Combined pastured animal units on the three FBZ-medicated block treatment farms included about 1,300 ewes and 1,800 lambs. The two FBZ drench farms involved about 750 ewes and 500 lambs. Discrepancies in ewe and lamb numbers resulted from other groups of winter-lambing ewes that were pastured along with the spring-lambing group. Due to the cumbersome logistics of grazing additional animal groups (multiple groups increase requirements for multiple paddocks), this is a common practice in our area. Additionally, all producers dewormed ewes two to four weeks prior to lambing (or in the lambing pens) with producer selected products. Pre-lambing anthelminthic treatments included levamisole (drench or injectable), albendazole (drench), fenbendazole (drench) and ivermectin (drench or injectable). Parasite load in each flock was monitored from April through November of 1996 and 1997 on a regular 4-week interval. Fifty ewes from each farm were sampled during the same two-day period each month, and sampling occurred during the week prior to any scheduled FBZ-medicated block deworming. Fresh manure samples from fifty ewes from each farm were analyzed using standard fecal flotation methods. Fecal strongyle-type egg per gram (EPG) counts were performed on each fecal sample and the data recorded.

Results of the 1996 - 1997 strategic deworming trials - pooled group data

As occurs in most on-farm anthelminthic trials involving producer flocks, there are many variables that impact both individual farm and group data. Unlike controlled research conditions, these events (weather, labor, nutrition, informational inputs, etc.) dynamically occur under normal production practices and as such, are an integral part of parasite issues and epidemiology. Removing management variables from the system produces "neater" science, but often masks the reality of production systems. We will first discuss results on a pooled data basis (all farms) and then discuss individual farm variations and possible relationships to management issues.

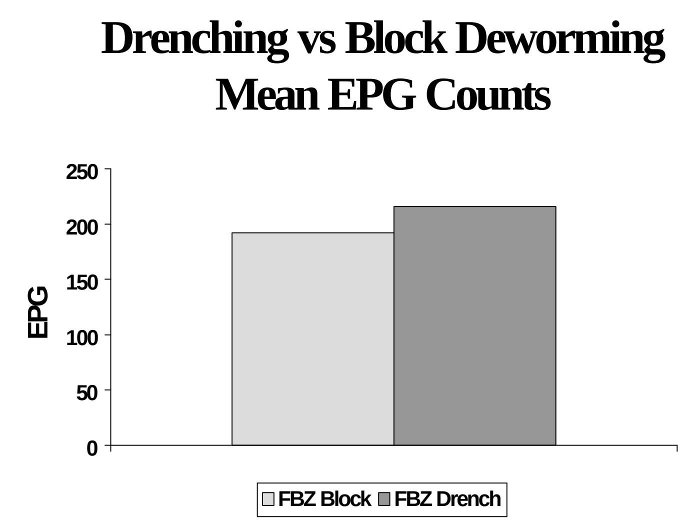

Figure 2: Combined 1996 & 1997 grazing season mean strongyle-type fecal egg per gram count for the two FBZ drench farms compared to the three FBZ medicated salt block treatment farms.

Figure 2 compares the mean strongyle EPG counts for the combined 1996 and 1997 grazing season for flocks that strategically dewormed (three and six weeks into the grazing season) with FBZ-medicated salt blocks and those that used FBZ drench for their first two anthelminthic treatments. It would appear that over a two-year period the medicated blocks performed similarly to the drench preparations. If one looks more closely at the over-all data it is interesting to note that (*Figure 3*) this trend occurred in 1996 and 1997. Furthermore, *Figure 3* suggests a general reduction in EPG counts occurred between 1996 & 1997 - regardless of deworming method. This is probably best explained by increased producer awareness of a strategic parasite deworming program and the regular reports they received during the grazing season. Several management changes occurred between 1996 and 1997 that may have influenced decline in mean EPG counts. In 1997, producers on the drench program concentrated on deworming the ewe flock at the same time that medicated blocks were administered early in the grazing season. Drench and medicated-block designated producers also became more aware of the need to deworm all ewes closer to lambing to facilitate anthelmintic efficacy on recently activated larva in the intestinal wall. In 1997, producers that drop-lot lambed dewormed ewes in the lambing pens before release to pasture. Those that pasture lambed, dewormed ewes during the week before lambing, instead of 4 weeks prior to scheduled lambing. Additionally, in 1996 one of the drench group producers failed to deworm all ewes prior to lambing, this was corrected in 1997.

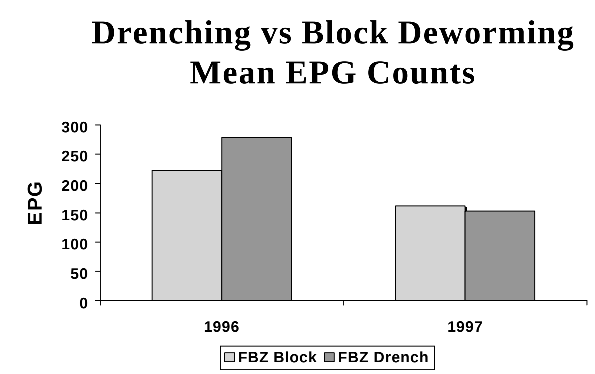

Figure 3: Combined results of strongyle EPG counts for FBZ drench farms vs FBZ-medicated block farms by year. Note the general reduction in 1997 EPG levels on all five farms.

Figures 4 & 5 graphically illustrate the relationship of fecal EPG counts to the progression of the combined 1996 & 1997 grazing seasons. We believe this graph illustrates ***three important points*** for all sheep producers that pasture

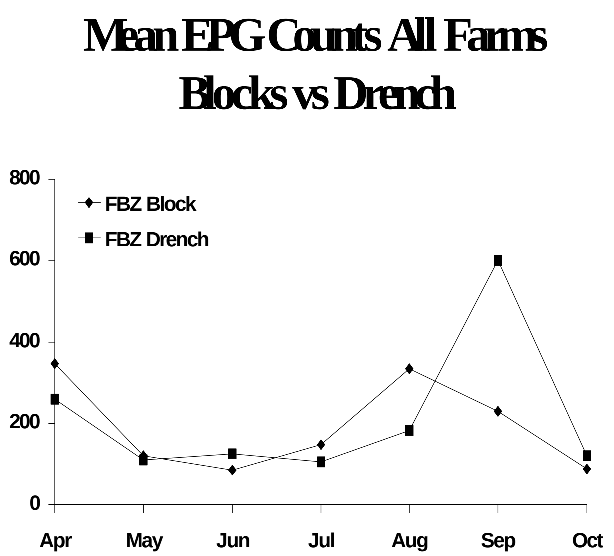

Figure 4: Combined 1996 & 1997 grazing season FBZ drench farm and FBZ-medicated block farm monthly comparisons of strongyle EPG counts.

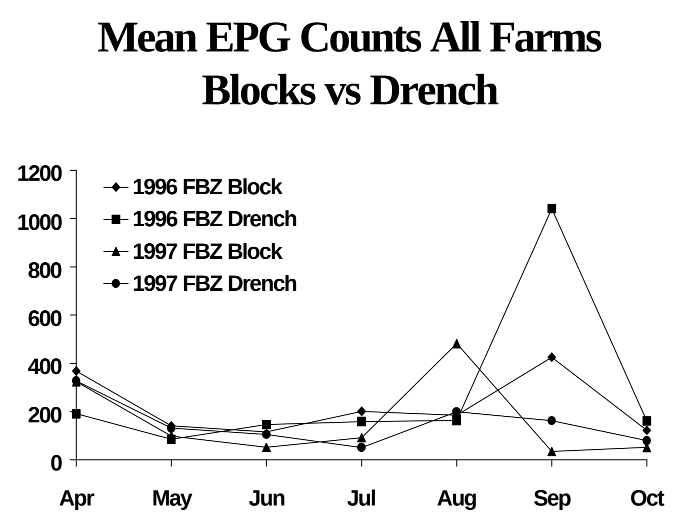

Figure 5: Mean strongyle EPG counts all FBZ block and FBZ drench farms for the individual 1996 and 199 grazing seasons.

ewes and lambs. ***First****, it should be obvious that the reduction in the April to May EPG counts occurred by deworming prior to or at lambing*. In April of 1996 not all farms were sampled prior to deworming - thus the two-year trend (as a mean) is somewhat diluted. However, the April 1997 samples were all collected prior to the lambing time deworming. The importance of the pre-lambing or lambing deworming is more apparent in the individual farm data. Reducing these counts is essential to decrease early summer pasture contamination from the ewe. ***Secondly****, it should also be obvious that EPG counts dropped off rapidly by mid-October of 1996 and 1997. This suggests that the important internal parasites affecting sheep are ceasing egg production and migrating towards dormant stages in the intestinal wall by mid to late October. Thus, fall deworming after November will have reduced affect on less active (not feeding), dormant strongyle phases.* ***Thirdly,*** *all farms, regardless of management changes or deworming methods or medications, experienced a late summer rise in EPG counts that peaked from mid-August to mid-September. Routinely deworming ewes and lambs in early August, followed by a move to clean pasture would appear to be a prudent recommendation for all grazing flocks.*

Results of the 1996 - 1997 strategic deworming trials - what did we learn from individual farms?

As *Figures* 6 & 7 illustrate, mean EPG levels varied among farms and treatment groups and between grazing seasons. While all farms exhibited reasonable mean seasonal fecal EPG counts, two of the three block medicated farms (J & H) and one of the two drench farms (W) reduced EPG counts between 1996 and 1997. In contrast, farms T (drench) and G (block) had elevated EPG counts for 1997. *To understand the management factors that may have* supported reductions or contributed to rises in EPG counts we really need to look at data from individual flocks.* Also, it is important to remember that EPG counts in the 100 - 200 EPG level are extremely low and further reductions appear difficult. This may explain the lack of obvious response (May-July) to either deworming method observed in the Figure 5 graph. Remember, the June EPG count was after the three-week May deworming block treatment and the July EPG counts occurred after the six-week June deworming treatment. To place these counts in perspective, remember that clinical disease seldom occurs until EPG counts exceed the 1,000 to 1,500 EPG range.

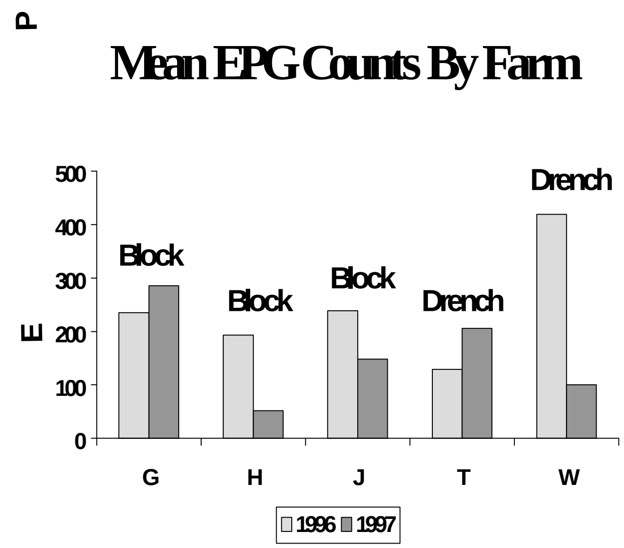

Figure 6: Mean strongyle fecal egg per gram counts for the 1996 & 1997 grazing seasons as reported by farm and for treatment group. All samples collected from April thru October.

Why did individual farms appear to have differing rates of success at maintaining EPG counts at desirable levels? (See Figure 7)

Farm J - FBZ- medicated blocks : The deworming trial appeared useful to Farm J**,** as evidenced by the obvious improvement in monthly mean EPG counts between 1996 and 1997 (*Figure 8*). Farm J lambed in a drop-lot setting and dewormed the ewe flock in 1996 and 1997 as individual ewes cycled through the lambing pens. The April 1996 and 1997 EPG counts represent EPG numbers at lambing and before the lambing pen treatment with levamisole. *Notice the elevated April 1996 & 1997 EPG counts resulting from the combined periparturient and spring egg rise. If left unchecked, these high, early season EPG counts would have contributed to massive early season pasture contamination and resulting early summer clinical disease - especially in a pasture lambing vs a dry-lot setting.* The April data illustrates the enormous potential affect of the combined periparturient and spring egg rise on pasture contamination. When parasite contamination is left behind in the dry-lot, it does not appear to be an issue for pastured ewes and lambs. However, if allowed to accumulate on pasture early in the spring, it "sets the stage" for early season parasite problems. Imagine starting the grazing season with mean EPG counts as high

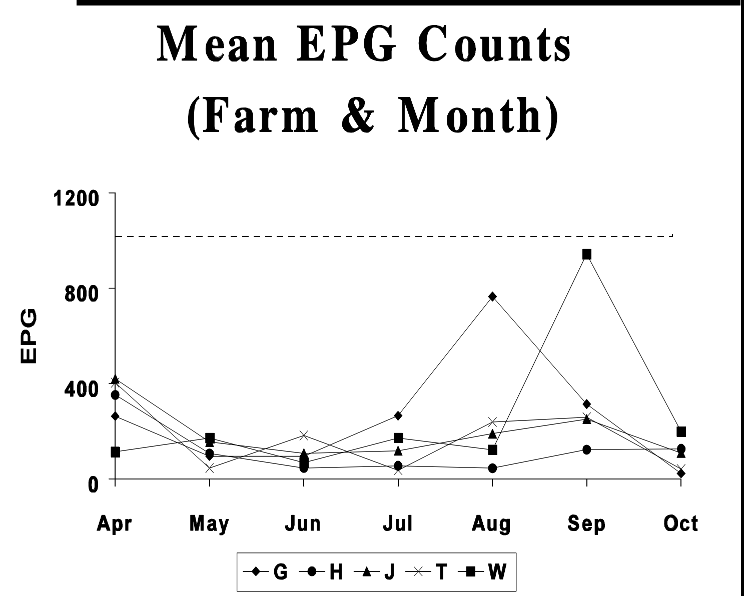

Figure 7: Two year (1996 & 1997) individual farm variations in monthly mean fecal EPG count. Farms G,H & J dewormed with FBZ medicated salt blocks while farms T and W dewormed with FBZ drench. Regardless of deworming treatment group (drench or block) there appears to be an enormous amount of individual farm variation - most likely due to differing management practices and the timing of treatments. The dashed line represents fecal EPG counts generally associated with clinical disease.

or higher than those that occurred in September of 1996!

The apparent drop in EPG counts between the April and May samples suggests that, on this farm, levamisole was reasonably effective as a lambing treatment, successfully addressing the combined periparturient and spring egg rise. The timing (in the lambing pens vs 4 to 6 weeks before lambing) of anthelminthic treatment should have also coincided with the activation of winter-dormant larva present in the intestinal wall. The presence of active, feeding larva and adult parasites generally increases medication effectiveness. Additionally, producer awareness of the importance of the contribution of the periparturient and spring egg rise to pasture contamination may have encouraged stricter adherence to the dosage schedule in the 1997 lambing season. This may explain the dramatic drop in the April to May 1997 EPG counts as compared to the 1996 numbers.

During the 1996 and 1997 grazing seasons the late May and mid-June FBZ medicated block applications appeared to control mean EPG counts at levels similar to or below post-lambing levels. The June and July mean EPG counts probably reflect the success of the May and June strategic deworming treatments. Additionally, the medicated blocks appeared highly palatable and were consumed during the three day period at the appropriate medication rate. Due to the ease of administration of the FBZ-medicated blocks, however, Farm J decided to repeat the block medication in mid-July of 1996. The August 1996 data suggests that this deworming may not have been as effective, as mean EPG counts continued to rise into September. The increased contribution of growing lambs to pasture consumption and thus pasture contamination may have adversely influenced this third medicated block treatment. In 1996 this producer did not individually deworm lambs until 8/17/96 (albendazole) and, due to a lack of clean pasture, lambs were not weaned and moved to a clean field. Additionally, no ewes were individually dewormed until 10/21/96 - after the last sample collection (10/10/96). Therefore, the rise in the mean EPG count between the August 1996 and September 1996 samples was real, and needed to be addressed in the 1997 management program. *These late summer elevated EPG counts in the 1996 samples suggested that an early August deworming of all animals (ewes and lambs), along with a move to clean pasture (regrowth hay fields) would be a wise management decision. If clean pasture acreage was limited it should be utilized by weaned lambs, in preference to the ewe flock.* Additionally, the drop in the mean EPG counts between September and October of 1996 was unrelated to deworming the ewes and probably a response to decreased egg production related to the onset of winter dormancy status and the associated decrease in egg production. Therefore, *for late fall anthelminthic treatments to be more effective (less winter dormant parasites), treatment should probably occur before late November of each year.*

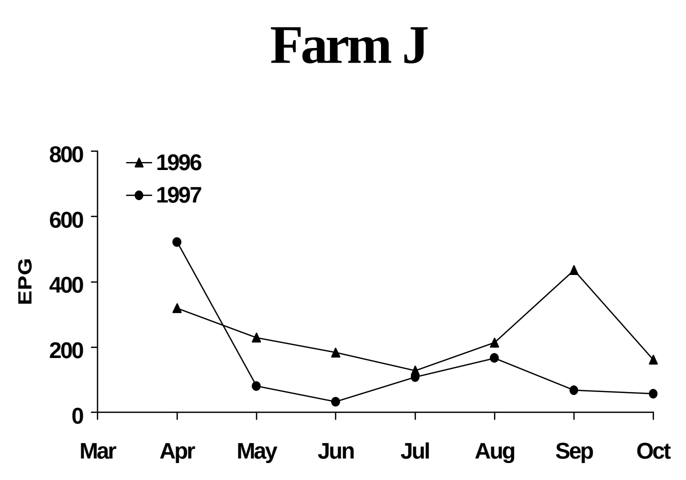

Figure 8: Monthly strongyle mean EPG counts for the 1996 & 1997 grazing seasons for Farm J.

Farm H - FBZ medicated blocks: Farm H is an interesting contrast to most of the other farms on the project. This farm is located on extremely light, sandy soil and is, therefore, susceptible to mid-summer drought. During dry years (such as 1996 and 1997) lambs are often weaned by late July and ewes are often housed in a dry-lot setting until fall rainfall restarts grass growth. Thus, *this farm provided a good look at the management affect of removing ewes from pasture to clean areas during the mid-summer grazing season*. The data additionally illustrates the reduction in internal parasite problems associated with dry-lot housing systems.

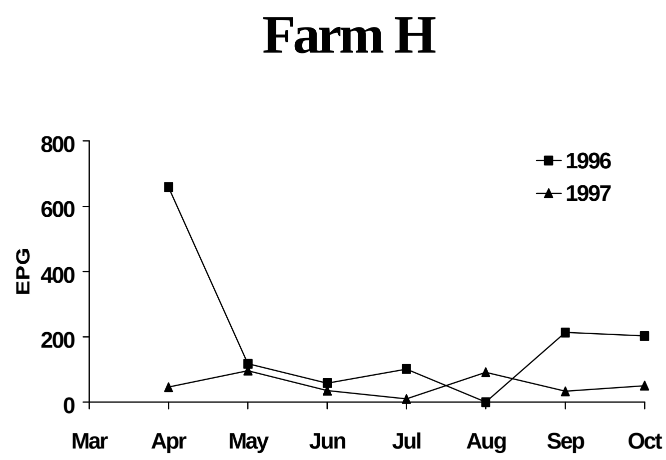

Figure 9: Mean strongyle-type EPG counts for the 1996 & 1997 grazing seasons - Farm H

Notice the dissimilarity between the April 1996 and 1997 mean EPG counts. During both years each ewe was dewormed as she cycled through the lambing pens and moved to pasture with her lambs.
Fenbendazole drench was used in the lambing pens in April of 1996 (response represented by the May counts) and ivermectin drench was utilized in April 1997. Notice the consistent periparturient and spring egg rise response in April of 1996 and the obvious response to the 1996 FBZ drench in the lambing pens - as evidenced by the reduced May 1996 mean EPG count. As occurred with Farm J, the June and July 1996 and 1997 mean EPG counts suggest that the strategic May and June FBZ block treatment helped control the parasite load at a reasonable level. However, during both years, dry weather required removal of ewes to a dry-lot setting during the last week in July. In 1996, this producer dewormed (ivermectin) all ewes and lambs when removed from pasture in late July (see obvious drop in August mean EPG in Figure 9). However, note the mean EPG increase that occurred in September of 1996 when ewes returned to pasture in late August. Interestingly, even though the flock was not dewormed when removed from pasture in late July (1997), the typical September egg rise observed in other flocks did not occur in 1997. In late August of 1997 the ewes were released to a pasture that had not been grazed since very early in the spring (May). *The lower September 1997 counts following dry-lot housing and return to relatively clean pasture, may support the generalized need for a mid to late summer clean pasture break in the grazing rotation.*

In addition, the ewe flock was dewormed with ivermectin on November 1, 1996. The low April 1997 mean EPG count (even before the lambing pen deworming) suggests that the November 1996 deworming (ivermectin) may have had a similar management affect to deworming in the lambing pens. During April of 1997, dormant larva from active 1996 fall infections were probably absent in the intestinal wall (April of 1997) and thus unable to initiate the typical spring or periparturient egg rise. *Deworming in late October or early November, timed with a move to clean pasture or corn stalks, etc., may be an alternative to deworming in the lambing pens. Fall deworming might also help eliminate the need to decide when the spring or periparturient egg rise will occur each spring (removes weather variability). Fall deworming, coupled with removal to clean pastures, might also be a better choice for preventing reinfection each spring in pasture lambing flocks that are never housed in dry-lots (i.e. no pasture break at lambing).* Also, the 1997 deworming that occurred in the lambing pens may not have been cost effective following the response to the November 1, 1996 ivermectin drench.

Farm G: Fenbendazole medicated blocks

Figure 10 illustrates the same late summer (August through September) increased fecal EPG counts observed in both previously discussed farms. However, the increase is more substantial and approaches fecal EPG levels consistent with producing clinical disease. Additionally, the grazing management of Farm G can be described as continuous vs rotational type grazing. Personal observations are that *continuous grazing practices tend to overgraze and heavily contaminate areas closest the barn, loafing areas, and/or water sources. Elevated August and September fecal EPG data for Farm G appears to support this premise. Rotational grazing, with longer returns to contaminated pasture, may reduce parasite exposure.*

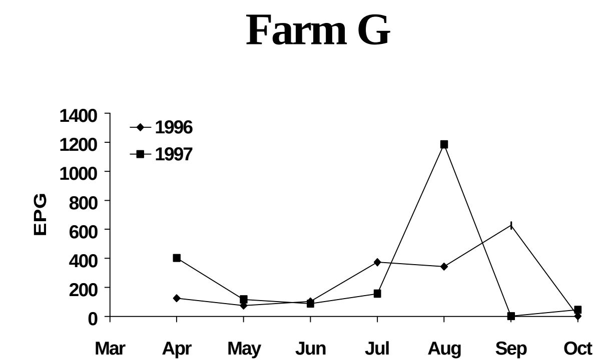

Figure 10: Mean strongyle fecal EPG counts for the 1996 and 1997 grazing seasons - Farm G

In 1996, Farm G dewormed (levamisole - 4/1/96) all ewes as a group, about four weeks prior to lambing. The flock had been dewormed the previous fall (11/7/95 - albendazole) before entering stock-piled pasture designated for winter grazing and the dry feeding period. Interestingly, the April 1996 data for Farm G is similar to April 1997 data from Farm H (Farm H had administered a drench November 1, 1996). Additionally, the April 1997 Farm G data was collected from ewes that had *not* received a 1996 fall drench. Notice the elevated (compared to April 1996 Farm G data) EPG levels in April of 1997 - prior to the lambing pen treatment with levamisole. *Farm G data appears to support the same fall deworming issues discussed for Farm H. That is, deworming in late October or early November, followed by a move to clean pasture or a dry lot, may help eliminate the effects of the spring and periparturient egg rise - diminishing the need to deworm ewes prior to or at lambing. This practice could reduce costs and labor demands during the lambing season.*

Farm G strategically dewormed with FBZ medicated blocks at the identical times as Farms J and H. However, note the higher mean EPG counts recorded in the August and September samples from both 1996 and 1997. As mentioned earlier, these increases may have been influenced by the practice of continuous vs rotational grazing. *Additionally, in 1996, Farm G chose to continue the monthly FBZ block deworming in mid July, August and again in September of 1996.* As *Figure 10* illustrates, the 1996 repetitive FBZ block deworming appeared to control fecal EPG counts below critical levels associated with clinical disease and below levels experienced during August and September of 1997. However, during 1996, the EPG count continued to slowly elevate until natural reductions in egg passage occurred in October (similar to those observed in other farms). In 1997 the flock was again strategically treated with FBZ-medicated salt blocks at three and six weeks into the grazing season. Farm G was also encouraged to deworm ewes and lambs during the first week of August 1997. This did not occur until lambs were weaned and both ewes and lambs dewormed (albendazole) on September 8, 1997 - before the September fecal egg samples were collected. Note the response to the September 8, 1997 albendazole treatment in the September samples.

Farm T: Fenbendazole drench

Farm T is a pasture lambing flock that practices rotational grazing on about 30 acres of permanent pasture. The flock was dewormed on November 11, 1995 (albendazole) and October 29, 1996 (levamisole) pastured through the winters of 1995-96 and 1996-97 on clean corn stalk and turnip acreage. During both winters the ewes were never housed or fed in confinement. The flock was dewormed prior to lambing on April 23, 1996 (ivermectin) and April 28, 1997 (ivermectin) and began lambing on permanent pasture the first week of May each year. The 1996 and 1997 April samples represent fecal EPG counts resulting from the periparturient and spring egg rises and prior to deworming with ivermectin. *Note the higher EPG counts observed on Farm T - even though a fall deworming had occurred. In this flock, unlike the previous two examples, the previous fall deworming did not eliminate the need to deworm prior to lambing.* The May 1996 and 1997 samples illustrate the great reduction in parasite ova excretion following the April deworming each year. Additional deworming with FBZ drench (at producers convenience) occurred on June 28, 1996 and 1997 and July 28, 1996 and July 29, 1997. Note the similar responses to the June 28,1996 and 1997 FBZ deworming (reduced July EPG counts) and a lesser August to September decline in ova output - probably in response to the July FBZ treatment. Additional deworming with albendazole occurred in late September of 1996 and 1997. The October EPG declines observed in 1996 and 1997 may be due to the September treatment and/or the natural decline in ova production as winter arrives. In either case, it is interesting that April counts the following season appear to rebound and initiate the annual cycle of pasture contamination. Additionally, Farm T's delayed deworming until late June illustrates the need to control early season contamination. *The FBZ block medicated farms utilizing the three and six week deworming routine appeared to maintain lower May, June and July mean EPG counts (compare Figure 11 to the graphs in Figures 8, 9 and 10) than did Farm T. This comparison suggests that strategic deworming may shorten the parasite season by shifting parasite exposure from an early to a late season orientation.*

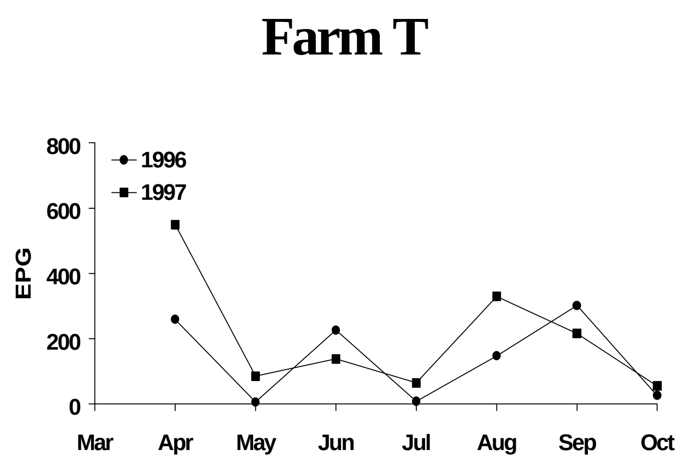

Figure 11: Mean strongyle EPG counts for the 1996 and 1997 grazing seasons - Farm T

Farm W: Fenbendazole Drench

Perhaps it is appropriate to use Farm W as our last example of what can change from year to year by incorporating management decisions and strategic deworming into a complete program for the farm. Farm W participated in the project as a FBZ drench farm and the producer was instructed to drench at producer convenience. During 1996, Farm W,

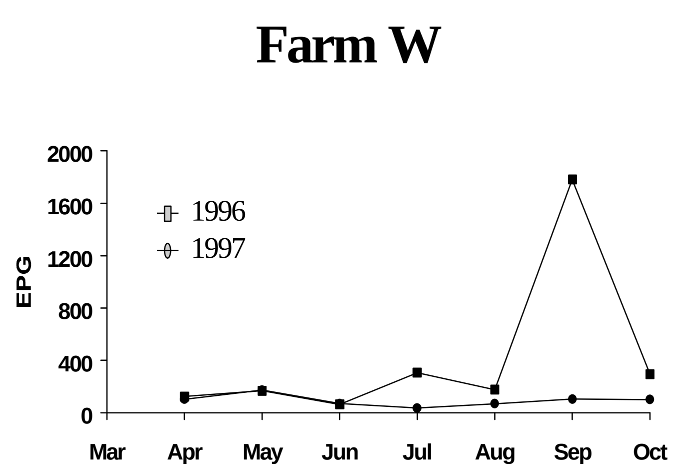

Figure 12: Mean fecal strongyle EPG counts for the 1996 and 1997 grazing seasons - Farm W

lambed the flock on pasture and utilized intensive grazing practices with typical 2 to 3 day paddock rotations throughout the grazing season. The ewes and lambs were never housed. During the 1997 grazing season the flock lambed inside and ewes and lambs were moved through lambing pens and group pens before release to pasture. The 1997 system was very similar to Farms H,J and G. Each spring, Farm W was provided with adequate FBZ drench for the first two deworming treatments of the grazing season. Following these first two deworming treatments, medication choice and frequency was up to the producer's discretion. *Figure 12* graphically illustrates the mean fecal EPG data from Farm W. *Notice the huge differences between EPG data from the 1996 and the 1997 grazing seasons.*

During 1996, Farm W dewormed (albendazole) the flock as a group during the first week of April - about two weeks before lambing. The flock had been dewormed the previous fall (11/10/95) with albendazole.
In contrast, the 1997 season involved the use of albendazole in the lambing pens. Similar to what occurred in 1996, the ewes lambing in 1997 had also been dewormed with albendazole during the fall (11/10/96) of 1996. During both 1996 and 1997 the fecal EPG counts started the grazing season at relatively low levels. This probably resulted from the combination of the fall deworming and the lambing time albendazole treatments. The EPG counts for April (1996 & 1997) were almost identical to those from the previous October samples - even though the October samples were collected before the November drench. The April samples were collected after the April pre-lambing treatment in 1996, but before the lambing pen treatments in 1997. In 1996, all ewes and lambs were dewormed with FBZ drench on June 8, 1996, and July 19th, 1996. Notice the parasite ova "explosion" that occurred during August and September. We suspect that this increased ova contamination may have been due to the establishment of new generations of parasites originating from over-wintering larva.

In contrast, during 1997, lambs and ewes were drenched with FBZ on May 23, 1997, June 20, 1997 and again on July 15, 1997. This was roughly at one, two and three months into the grazing season. Additionally, lambs were weaned and both lambs and ewes were moved to clean pasture after the July treatment. Clean pasture was created by switching cattle and sheep grazing paddocks. Notice the improvement in 1997 EPG data compared to 1996. The strategically-timed FBZ drench deworming of lambs and ewes in combination with moves to clean pasture, appeared to be quite effective and avoided problems with late summer clinical disease. The apparent effectiveness of the timing may also have involved drenching both ewes and lambs. Block medication may predominantly involve only ewes and have a limited impact on lambs. Furthermore, lambs (with minimal parasite resistance) may prove a major source of contamination as the grazing season progresses and they consume more forage. Due to palatability issues, medicated blocks may also exclude a certain percentage of the ewe flock from treatment. This portion of unmedicated ewes may continue to shed large numbers of ova.

Conclusions: Eleven Important Issues for Midwestern (Michigan) Producers

Veterinarians and producers are always looking for effective "cookbook" recommendations and easy methods to control parasites. However, in reality, they don't exist. If one looks closely at the individual farm data it is obvious that parasite control is tightly integrated with producer management decisions, weather, available acreage, livestock species, medication choices and grazing attitudes and practices - all of which impact pasture contamination and the expression of clinical disease. There are, however, some common trends regarding parasite life cycle and anthelminthic treatment that occurred on all five farms included in this two-year trial. This information should provide producers and their veterinarians with a better understanding of internal parasite behavior throughout the grazing season, and additionally, the management choices most effective in limiting production losses. What did we learn from the 1996 and 1997 data that impacts our grazing flocks?

1) Fenbendazole-medicated blocks allowed timely administration of medication during a critical phase of the early grazing season (first 3 to 6 weeks of grazing season) when pasture parasite load is often re-established from maturation of over-wintering larva. Consumption of the FBZ-medicated blocks used in this trial and the fecal strongyle EPG counts derived during this clinical study suggest that FBZ dosage was adequate and clinically effective. The FBZ medicated block was cost effective, compared to drenching, required minimal labor and was basically easy for producers to employ. ***Caution*:** Easy, however, is a term that often gets sheep producers in trouble. Several producers enjoyed the ease of administration of the blocks so much that they continued to deworm the flock with FBZ-medicated salt blocks for the remainder of the 1996 season. Continued use and over-use of any anthelminthic can lead to parasite resistance. *The use of FBZ-medicated blocks should be limited to timely strategic treatment at three and six weeks into the grazing season - when other treatment methods may be impractical. Deworming later in the season should utilize traditional drenching practices combined with a move of lambs and/or ewes to clean pasture.* Medicated deworming blocks are not for use in every production system. If possible, treat older lambs and ewes via the traditional drenching route. Additionally, FBZ is not approved for use in sheep in this country. However, it is commonly used in countries that import lamb into the U.S.A. and in most other food animal species in this country.

2) Fenbendazole drench, when administered to lambs and ewes in a strategic deworming sequence (at 4, 8 and 12 weeks into the grazing season (Farm W 1997), appeared to be more effective than did the use of FBZ-medicated salt blocks administered at three and six weeks into the grazing season. However, FBZ drench, when used for the first two deworming treatments at producer discretion, was not as effective as strategic deworming with FBZ-medicated blocks. *The two-year data suggests that the method of administration of FBZ drench is probably not as important as the timing of the treatment.* Drenching lambs and ewes at two or three strategic early season intervals appears to be more effective than delaying initial drenching until late June or early July - when several generations of parasites have already become established on pasture. When possible , strategic early season drenching of both ewes and lambs is also preferable to similarly-timed treatment (mostly ewes) with medicated blocks.

3) The data indicates that all five Michigan farms sampled showed consistent seasonal fecal EPG increases at lambing time (April & May). The periparturient and spring egg rises are real! This important data indicates the need to address the periparturient and spring egg rise by anthelminthic treatment prior to lambing. In drop-lot situations, were lambing pens are utilized, this treatment should occur in the lambing pen. In pasture lambing situations this treatment should occur about two to four weeks before scheduled lambing and be accompanied by a move to clean pasture. All deworming medications utilized for this treatment (levamisole, ivermectin, fenbendazole, albendazole) appeared equally effective in reducing EPG counts. This may suggest that parasite resistance in these flocks is currently not a major issue as it is in other sheep producing countries.

4) The data indicates that all five Michigan farms sampled showed consistent seasonal fecal EPG increases during the late summer and early fall (August & September). This data suggests that strategic deworming may serve to shift the increased EPG counts from an early season issue to a late summer grazing problem for Midwestern farms. This is an important outcome, as this shift reduces early season pasture contamination and shortens the time from elevated EPG counts until reduced egg production related to winter parasite dormancy. *However, the fecal EPG count peaks observed in August and September confirm the importance of individually deworming all animals at or around August first each year, and moving the flock to a clean pasture so that recontamination does not occur.* This was done on Farm W in 1997 - compare 1996 & 1997 results in *Figure 12*.

5) The data indicates that all five Michigan farms sampled showed consistent seasonal fecal EPG decreases in the October samples. This data suggests that ova production declines during October as internal parasites become dormant in the intestinal wall. In our area, parasite winter dormancy is probably complete by late November, suggesting that for medications to be effective, fall deworming should occur during the last two weeks of October or first two weeks of November. While pasture contamination in the late fall is probably limited (the ewes are passing very few ova), fall deworming should be accompanied by a move to clean pasture. Furthermore, data from several farms suggests that a late fall deworming and a move to clean pasture or a winter dry-lot may eliminate the need for prelambing deworming the following spring. All except one (Farm T) of the farms that dewormed late in the fall had reduced EPG counts in the April samples prior to the pre-lambing treatment. The fall treatment may be especially important for pasture lambing flocks that never leave pasture, because the onset of the spring rise is probably weather dependent and difficult to accurately predict. Thus, if the spring rise occurs before the pre-lambing deworming ova will be deposited on pasture and not left behind in a dry-lot setting.

6) The importance of planning for and utilizing parasite-free "clean" pastures in a grazing system needs to be impressed upon MI producers!!! The data suggests that clean pastures could greatly reduce anthelminthic usage (reducing the risk of resistance), add to the effectiveness of a farm parasite control program, and help reduce costs. Clean pastures are also helpful to other species grazed on the same farm. Special concern for Midwestern producers would be parasite free pastures for initial turn-out each spring and clean pastures following the August deworming. Clean pastures would also be important for weaned lambs. However, limited pasture acreage, lack of fencing and maximized stocking densities appear to be the major hurdles derailing the clean pasture issue. Producers need to record fall grazed acreage and avoid grazing these fields early in the spring. Our producers also need to plan to use hay field regrowth as a clean pasture and time flock movements with appropriate deworming treatments. In the long-term, fencing expenditures may reduce deworming costs. Producers need to view fencing expenses as in investment in their deworming and feeding programs. The mid-summer pasture break to clean pasture might also be best accomplished by increased utilization of summer annuals such as rape, forage turnips, tyfon or sorghum x sudan hybrids. These spring seeded annuals would provide a clean field on which to wean lambs, along with excellent nutrition during the typical summer slump in grass production. Operations grazing multiple species should also recognize the additional clean acreage opportunity they provide.

7) Producers should also be encouraged to wean lambs (as a group) earlier in the grazing season. Currently, MI producers commonly graze ewes and lambs together until late fall. This practice is in response to the lack of multiple paddocks and the extra effort needed to run two separate groups of animals. However, lambs are much more susceptible to parasite losses than are adult ewes. Additionally, lambs are much cheaper to deworm (size) than are adult ewes. Concentrating the late summer deworming program on deworming lambs, followed by immediate removal to a clean pasture, would be appropriate for most producers. As an alternative, if grass is not abundant, lambs should be dewormed and removed to a dry-lot for feeding. Allowing the ewes and lambs to remain together on poor quality, highly contaminated pasture combines nutritional and parasite stresses on the lambs. Losses are common and should be expected.

8) The data from 1996 and 1997 suggests that fenbendazole-medicated block consumption and copper issues did not prove to be a problem for participating flocks. Flocks were allowed a five day access period to the FBZ-medicated blocks at the rate of one block per fifty ewes. Consumption on most farms was complete by day three and no appreciable weigh-back occurred. As predicted, copper toxicity issues did not appear to be a concern.

9) Recommendations: timing of strategic deworming with FBZ drench or medicated blocks. Early grazing season strategic deworming appears to be a timing issue that needs to be related to individual farm production practices and seasonal weather conditions. In southern MI, medicating the flock prior to or at lambing appears to be an important issue. If a clean flock can be released to clean pasture, strategic deworming may be a non-issue until a late summer drench. However, if clean pasture is not available, the data suggests that ewes and lambs should be dewormed in late May and in late June each year, and again around August first. Producers should concentrate on weaning lambs and an associated move to clean pasture at the August deworming. When possible, all lambs and ewes should be individually treated (drenched). FBZ-medicated blocks should only be used for the first two early season strategic treatments, when individual treatment is not possible. Medicated blocks should not be used for the suggested August treatment. Furthermore, composite fecals and fecal EPG counts should be used to monitor the deworming progra

10) Producer awareness of parasite issues related to their particular flock. Monitoring fecal egg per gram counts throughout the grazing season appears helpful to our producers. Reviewing monthly seasonal data defines management decisions that contribute to the success or failure of prevention and treatment programs. This should be obvious in the descriptive epidemiology of the five individual farms. Having a mechanism where-by producers could economically submit composite fecal samples for EPG information might be extremely helpful to their individual deworming programs. Having someone available to interpret this information would also be helpful.

11) Frequent mid-season deworming (every 3 weeks) of heavily infected lambs and ewes is " after the fact", but often necessary to maintain life. No medication is extremely effective in this situation - especially if treated animals return to infected pastures. Again, post-deworming release to clean pasture is an extremely important issue to resolve.

Research involving anthelminthic treatment recommendations often raises more questions then it answers. During 1996 and 1997 it would have been extremely useful to have collected data from a large commercial operation that never dewormed their animals. This flock would have served as a useful control - but I doubt we would have had any volunteers! We believe that the data presented above represents what occurs in typical, larger, spring lambing, grass-based production systems in our area. This is an important issue, because we no longer have to extrapolate all of our internal parasite information from some other part of the world that has different weather, different productions systems and different anthelminthic medications. We hope that Midwestern sheep producers will carefully read and digest the individual flock information and decide how some of the data compares to their specific management situations. Also, please remember that none of this information would be available without continued support funding from the Michigan Agricultural Initiative.