Summary of Reports . . .

1974 Sheep and Wool Days

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The cover photo was taken in 1915 at the Butte Creek Land and Livestock Company, Fossil, Oregon.

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ANIMAL HEALTH PROGRAMS IN SHEEP PRODUCTION

R. C. Schock D.V.M.

Today's sheep industry is on the threshold of vast changes that can make it a competitive producer of red meat. By selecting for productivity, effectively utilizing crossbreeds, exploring exotics such as Finnsheep with their high lambing rate, desirable breeding programs can be established. Through the breeding of ewe lambs, early pregnancy diagnosis, rearing of lambs artifically, multiple lambing at any time of the year, and effective complete animal health programs, unrealized potentials of sheep production are attainable.

For years the sheep industry recognized it could produce meat and wool on forage alone making maximum use of the rumen. Feed resources of low quality and animal wastes are now being evaluated in production programs. With sheep going through an entire production cycle in six months with little added maintenance cost between breedings, and the ewe capable of having multiple lambs each year the industry is in an enviable position.

Let's diverge momentarily and look at world sheep numbers[1] in which the United States ranked eighth in 1973 with 17.7 million head. Australia of course was first with a total of 148 million head. Their per capita consumption of mutton and lamb in 1972 was 99 pounds whereas their beef and veal intake was only 86 pounds. In the last few years, the United States per capita beef consumption was over 100 pounds annually so there is ample opportunity for the sheep industry (less than three pounds per person) to increase its market.

As part of any successful sheep operation disease problems must be minimized or eliminated. Recognized animal health programs must be effectively established in the Ewe and Ram, Newborn and Growing Lamb, and Fattening Lamb to prevent and control costly disease problems.

In looking at the overall loss to the sheep industry probably the number one animal health problem is that of predators. Estimates of a $50,000,000.00 annual loss has been reported by personnel of the United States Department of Agriculture[2,3]. In 1950, 100 ewes had 92 lambs with five of these lost to predators and ten to other causes. In 1972, 100 ewes had 106 lambs, but twelve were lost to predators and ten to other causes. With coyote numbers increasing since 1964 when poisoning was restricted, predator losses have increased. The sheep industry must make a concerted effort to bring pressure to reverse this alarming loss to coyotes. Also abortions, early lamb mortality, internal and external parasites, infectious and metabolic diseases, poisonous plants, etc. add to the total dollars the industry accepts as part of its production overhead.

Intensive management practices utilizing complete animal health programs can help reduce disease problems essential to the success of the sheep industry.

Specific flock recommendations by consulting with your Veterinarian can materially assist you in implementing a successful program.

EWE AND RAM PROGRAM

General animal health recommendations in the ewe and ram are as follows:

EWE PROGRAM

Disease	Program	Method	When	Remarks
Vibriosis	Prevention	Vaccination	Prior to rams introduced Repeat in 3 to 4 weeks	Implement program in enxemic areas
	Treatment	Feed 80 mg Chlorotetracycline per head per day	During pregnancy	Also effective in EAE control
Enzootic Ovine Abortion (EAE)	Treatment	Feed 80 mg of Chlorotetracycline per head per day	During pregnancy	Extent of disease unknown
Tetanus	Prevention	Vaccination	Prior to lambing and shearing (30 days)	Only in endemic areas
Blackleg-Malignant Edema	Prevention	Vaccination	Prior to breeding	Only in endemic areas
Bluetongue	Prevention	Vaccination	Before insect season and one month prior to breeding	Disease widespread with many carriers
Enterotoxemia	Prevention	Vaccination Type C&D Bacterin Repeat in 14 to 30 days	Prior to lambing	Feed 25 to 35 mg Tetracycline per day
Internal Parasites	Treatment	Injectable or Oral Anthelmintic	Prior to Lambing (14 to 30 days)	Prevent pasture contamination and minimize lamb exposure
External Parasites[4] See page 21 for specific instructions				

Check ewes for breeding soundness culling those complicated with chronic lung conditions, poor udders, foot rot and general health liabilities. Ewes should be sheared and tagged before lambing since filthy wool is a reservoir of disease. Provide protection for newly shorn ewes from weather stress.

RAM PROGRAM

Disease	Program	Method	When	Remarks
Epididymitis	Prevention	Vaccination	At 4 to 6 months of age. Repeat in 30 days	Palpate testicles and epididymitis for lesions and cull if unsound
Tetanus	Prevention	Vaccination	Prior to breeding (30 days)	Only in endemic areas
Blackleg-Malignant Edema	Prevention	Vaccination	Prior to breeding	Only in endemic areas
Enterotoxemia	Prevention	Vaccination Type C&D Repeat in 14 to 30 days	Prior to breeding	
Bluetongue	Prevention	Vaccination	Before insect season and one month prior to breeding	Isolate new rams for 30 days after arrival
Internal Parasites	Treatment	Injectable or Oral Anthelmintic	Prior to lambing season (14 to 30 days)	Total flock dewormed to minimize pasture contamination
External Parasites	See page 21 for specific instructions			

Check rams for breeding soundness including general health, culling those with sheath rot, poor feet, ulcerative dermatoses, and epididymitis before placing with ewes. Observe replacement rams for thirty days before placing with flock.

NEWBORN AND GROWING LAMBS

Disease	Program	Method	When	Remarks
Navel ill	Prevention	Dip entire navel in 7% Iodine after birth. Give Pen-Strep injection if infected	Immediately after birth or first opportunity	Lamb in clean bedded pens or dust free pasture

NEWBORN AND GROWING LAMBS (continued)

Disease	Program	Method	When	Remarks
Week Lambs	Treatment	Check ewe teats to see if open and lamb nursing. If not give lamb 1 to $1\frac{1}{2}$ oz cow colostrum milk and follow later with Lamb Milk Replacer adding 1 part of formalin to 800 parts milk.	Within 12 hours after birth or in first week	Nursing care will save many. Provide heat lamp. Give 1 tablespoonful Karo syrup orally. May prefer 50 cc of 5% Dextrose subcutaneously. Give 50 mg Tetracycline orally or Pen-Strep injection ($\frac{1}{4}$ cc)
Scours	Treatment	Give sulfa/antibiotic orally and antibiotic injection if needed.	First symptoms treat-usually during first 2 weeks	Repeat treatments usually necessary. Give Dextrose subcutaneously
White Muscle Disease	Treatment	Check navel and disinfect again if needed. If okay give Vitamin E-Selenium injection. Give tetracycline orally 40 to 100 mg	First symptoms treat-usually in first 3 weeks	Repeat if necessary Give 1 mg/per 2 week old lamb or 1 mg/per 40 lbs if older lamb
Entertoxemia	Prevention	Vaccination with Type D Bacterin. Types A, B, C may also be problem.	2 to 4 weeks of age	Largest healthiest lambs often involved. If tapeworms found deworm with Lead Arsenate .5 to 1 gm/per head if needed.
	Treatment	Type BCD antiserum	First symptoms	Oral antibiotic may be helpful in massive doses

NEWBORN AND GROWING LAMBS (continued)

Disease	Program	Method	When	Remarks
Tetenus	Prevention	Vaccination with toxoid	2 to 4 weeks of age	Only in endemic areas. Do not use elastrators.
	Treatment	Antiserum	First symptoms	Not too effective
Coccidiosis	Treatment	Sulfamethazine $1\frac{1}{2}$ gr/lb BW first day 3/4 gr 2-4 days	Bloody scours usually first symptoms	Provide creep feed with Tetracycline for lambs.
Internal Parasites	Treatment	Deworm Broad Spectrum Wormer	One month of age and repeat in 30 days if on same pasture	Deworm whole flock on program. Move to clean pasture after each deworming
Polyathritis	Treatment	Erysipelas caused Antiserum or Penicillin Chlamydia caused. Give Tetracycline by injection or orally 100 mg/hd	First symptoms treat	Either due to Erysipelas organism or Chlamydia agent
External Parasites	See page 21 for specific instructions			

FATTENING LAMBS

Essentially we are talking about lambs that are placed in a feedlot at 75 pounds and finished as a fat animal.

Disease	Program	Method	When	Remarks
Enterotoxemia	Prevention	Vaccination with Type D. Type C may be problem.	After arrival in first week	Feed 25-35 mg of Tetracycline hd/day
Internal Parasites	Treatment	Deworm with Broad Spectrum Anthelmintic	After arrival	Deworm immediately after receipt
Polioencephalomalacia	Treatment	Give thiamine hydrochloride 4.5-7 mgm per lb body weight	If symptoms observed	Repeat if needed

FATTENING LAMBS (continued)

Disease	Program	Method	When	Remarks
Pneumonia	Treatment	Give injectable Tetracycline or Combiotic or Sulfamethazine in feed or water	First symptoms	Repeat as needed

Now let's look at some of the major animal health problems in detail.

ABORTIONS

In order for the sheep industry to take full advantage of multiple lamb births, improved breeding management practices including adequate nutrition, and effective disease (abortion) control programs are imperative. Specific diseases in a flock contribute to reduced number of lamb births and weak lambs.

VIBRIOSIS

This is a bacterial infection caused by the Vibrio fetus intestinalis organism. Abortion in endemic areas of 25-30% is usual although it may be as low as 5% or as high as 70%. These occur in the last thirty days of pregnancy although some ewes carry to term, lambing weak unthrifty young. This disease is apparently transmitted by a few carrier ewes or from contaminated ground where previous abortions occurred. Also magpies, crows, and rodents have been implicated as carriers of this disease. An effective vaccine is commercially available with two injections recommended prior to the introduction of the rams.

Of interest seldom does an outbreak occur in the same flock two consecutive years. If such should occur, however, only the unexposed replacement ewes will abort. In experimental work at the Idaho Experiment Station Caldwell, Ida. ewes given V. fetus serotype I in the last half of gestation while on 80 mg of Chlorotetracycline per head daily were immune to challenge by this same serotype I during the next gestation. Their work indicated even though a portion of the ewes in a flock might abort, immunity to the infection would be established throughout the flock, and this could be persistent for at least two years. So efforts of immunization in positive flocks should be directed toward a program in replacement ewes only. The use of Chlorotetracycline has also been established to be effective in prevention of this disease if fed at the rate of 80 mg/hd/day[5].

Results of Antibiotic Administration in Ewes Infected with V. Fetus

Lot No.	Medication	No. Pregnant Ewes	Lambed	Aborted	Abortion (%)	Vibrio Fetus Isolated
1	None	21	6	15	71.0	15
2	Pen-Strep* injections 5th and 6th days post challenge plus 80 mg Chlorotetracycline in feed continuously from 5th day	18	14	2	12.5	2
3	80 mg Chlorotetracycline in feed continuously	20	17*	3	15.0	2
4	None (Previously challenged and fed 80 mg/hd/day of Chlorotetracycline)	23	20	3	13.0	1

*800,000 units Penicillin and 1 gm Dihydrostreptomycin

ENZOOTIC OVINE ABORTION

Also known as EAE this disease is quite widespread through western United States with a usual abortion rate of one to two per cent, although some outbreaks create a 30 per cent loss. Often this disease is confused with Vibriosis since it causes abortion in late pregnancy and it too can result in weak lambs. Non-pregnant ewes can become exposed to this disease and become infected eventually aborting when they become pregnant.

Control procedures should be directed toward bunk feeding of hay avoiding ground feeding entirely. A water source free of any contamination is also desirable to minimize exposure. Any aborting ewes should be isolated from the flock and a diagnosis established before they are reintroduced into the flock. If EAE should be present in a flock the early exposure of ewe lambs to the older ewes might offer enough exposure to the infectious agent and immunity could develop. With no vaccine commercially available in this country the use of Chlorotetracycline at 80 mg/hd/day has been found effective in preventing this disease[6].

Abortion has also been reported following Salmonella dublin infection in ewes. In addition Listeria monocytogenes has been reported to cause occasional abortions. The feeding of silage is the apparent source of the latter organism which produces a septicemia, encephalitis, and abortion. Again the use of Chlorotetracycline in the ration has been found effective in preventing this disease.

SUMMARY

Early detection of abortions within a flock of sheep is essential to establishing an effective program. Diagnosis of the cause of these abortions will determine the specific program to follow. Management practices of feeding off the ground and contaminated water supply should be eliminated from the breeding operation. An effective vaccination program should be instituted in Vibriosis positive flocks. The use of Chlorotetracycline at 80 mg/hd/day will also prevent the further spread of Vibriosis within a flock and will also minimize additional abortions associated with EAE and Listerellosis.

FOOT ROT

This is a highly contagious disease of sheep that involves the horny portion of the hoof and soft tissue. The bacterial organism Fusiformis nodosus initiates the infection and many secondary bacteria further complicate the diseased area.

It is first recognized as an inflammation of the skin at the hoof junction with a progressive deep layer infection involving the sensitive laminae of the foot. The horny hoof is invaded without abscessation and a foul smelling discharge is found.

The organism will only survive two weeks in the soil yet it will live in crevices of the hoof for over a year. Foot rot is not to be confused with foot abscess which infects the soft tissue above the horny portion and is due to several extraneous contributing factors.

Use of an Australian developed foot rot vaccine shows considerable promise in minimizing and lessening the severity of foot rot but it is still experimental at this time[7]. A flock program of managing infected sheep is still needed.

PROGRAM

Examine all sheep in the flock separating foot rot free animals from those with hoof deformities and inflammations in the hoof area.

FOOT ROT FREE SHEEP

1. Clean sheep must have hoofs trimmed and passed through disinfectant bath prior to being placed on ground that has been without any sheep for at least two weeks.
2. Further contact with any infected sheep should be avoided at all costs.

FOOT ROT INFECTED SHEEP

1. Carefully trim hoofs removing all pockets, crevices and disease tissue.

2. Immerse feet in disinfectant using stiff brush on hoof.

   Disinfectants recommended
   a. 20% Copper Sulfate
   b. 5-10% Formalin
   c. 12% Alcoholic Solution of Chloromycetin
   d. Iodiphor Concentrate 2 oz/gallon

3. Foot bathe all sheep forcing them to stand in bath four minutes (wooden trough 12" high, 12' long, 6' wide.) Disinfectant should be 4" deep.

4. Recommended to pass sheep through series of clean water troughs before disinfectant trough to minimize dirt in latter.

5. Sheep should be kept on clean dry surface for 15 minutes before returning to pasture.

6. Reexamine treated sheep in 10 to 14 days retreating those individually needing same. Again give four minute disinfectant foot bath and place on ground free of sheep at least two weeks previous.

7. Repeat treatment every two weeks for three or four treatments.

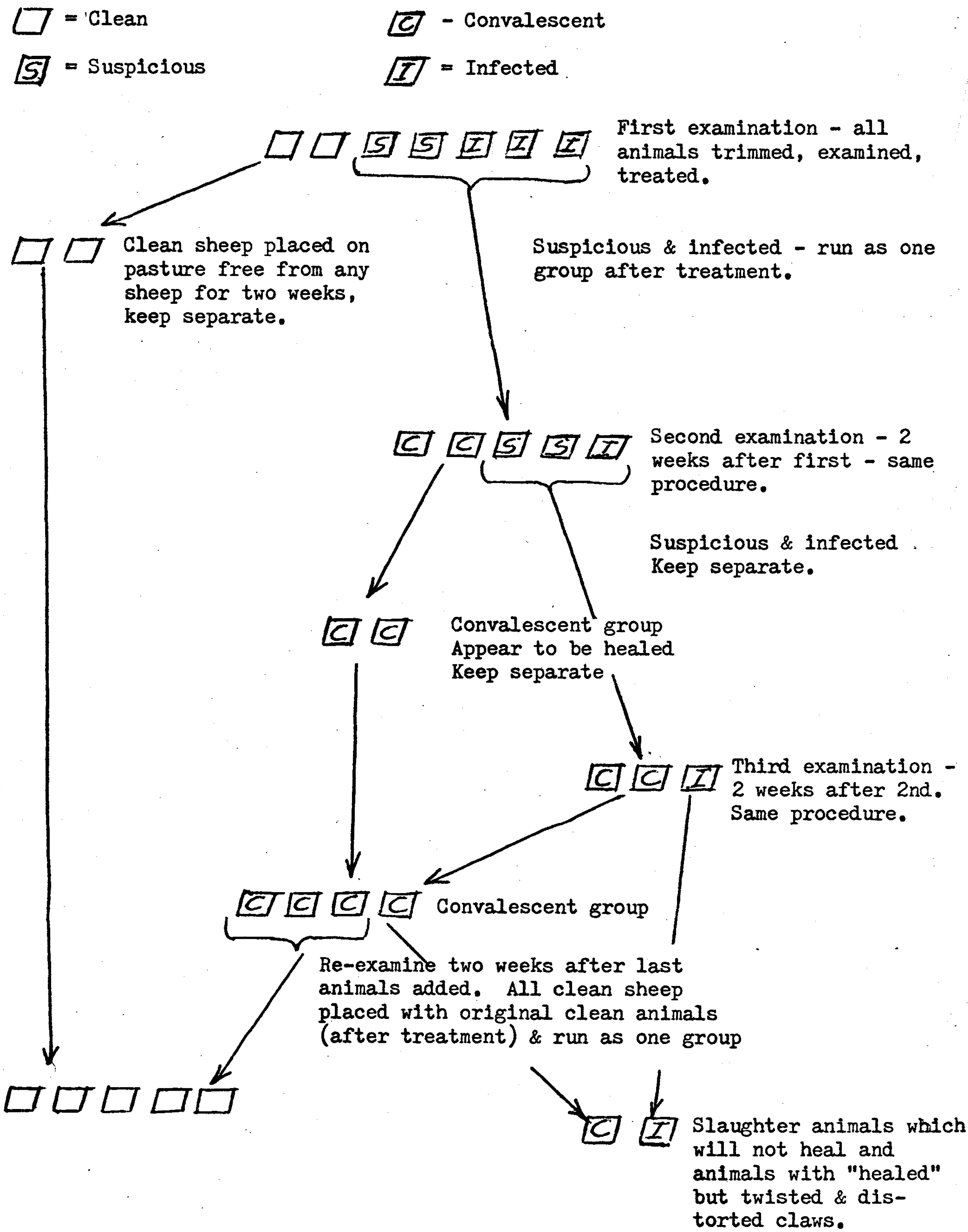
8. Cull all carrier sheep such as

   1. Animals with remaining lesions
   2. Distorted hoofs of lame sheep

9. Carefully examine all new additions to flock and pass through disinfectant bath before placing with flock.

10. Twice a year foot inspection is recommended trimming hoofs at this time. Pass animals through foot bath before returning to pasture.

Treatment Diagram for Infected Flock[8]



SUMMARY

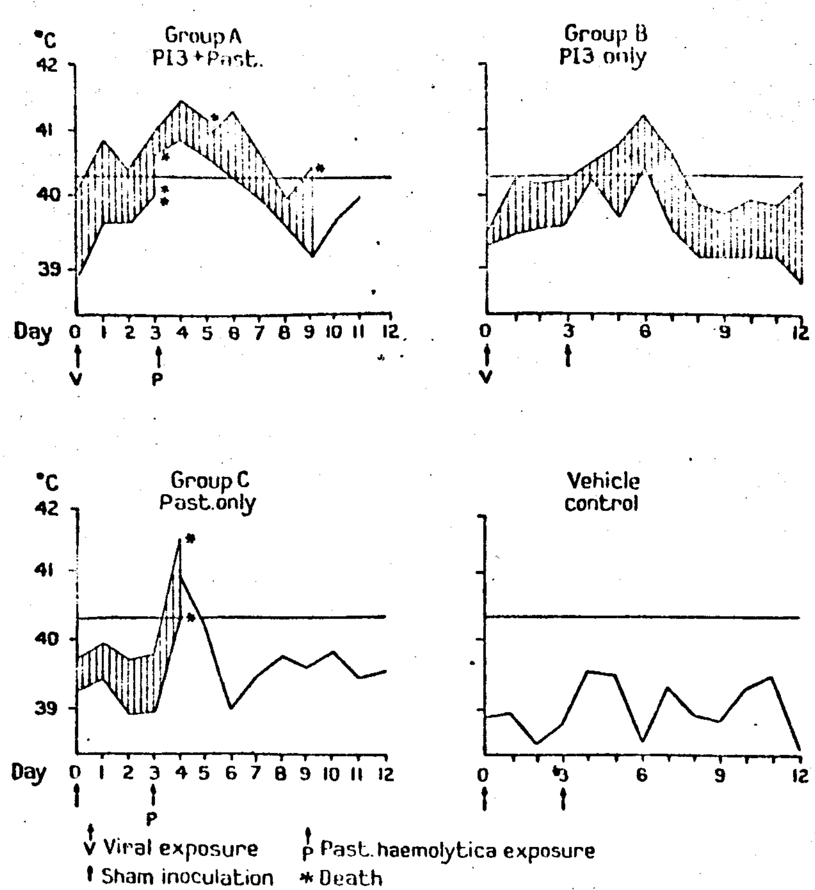
Foot rot control in a flock of sheep can only be accomplished by a complete program of conscientious effort. Any slight deviation from a thorough approach results in failure.

PNEUMONIA

Pneumonia of sheep can be caused by a number of different organisms bacterial, rickettsial viral, or parasistic. Oftentimes combinations of these agents produce a complicated pneumonia with a high mortality resulting. Sudden temperature changes, exposure to dust, shipping, prolonged periods of feed withdrawal can further complicate these pneumonias.

In work by Biberstein et al[9] the effects of a dual infection Parainflenza Three Virus (Pl_3) and Pasteurella Bacteria is illustrated in temperature patterns. Although Pl_3 virus has not been isolated from flocks in the United States, it has been confirmed in Scotland. Further work needs to be done in this country since the Pl_3 virus is commonly found in cattle here.

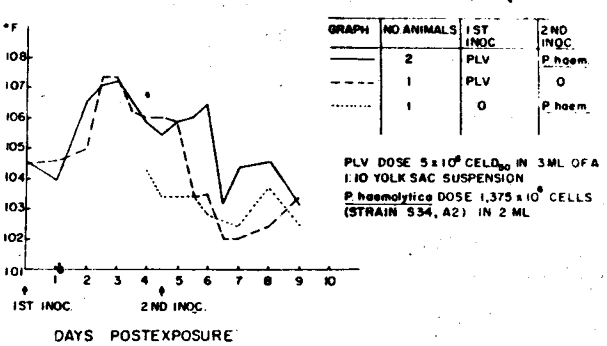
EXPERIMENTAL PNEUMONIA OF SHEEP: DUAL INFECTION



Sheep receiving a Pl_3 virus plus Pasteurella organisms had an elevated temperature for eight days whereas the Pl_3 infection alone gave only a four day temperature response. Even though Pasteurella alone only gave a two day temperature elevation the sheep were clinically severely depressed and they had a poor appetite, difficulty in breathing, coughing, nasal discharge, and then collapsed. Likewise sheep receiving the Pl_3 virus plus Pasteurella showed similar symptoms whereas the Pl_3 virus alone had only minor outward symptoms with the temperature rise.[3]

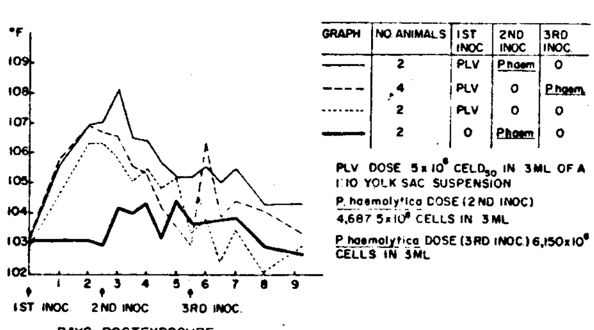
Of interest, Pleuro-Pneumonia like organisms can be readily isolated from the lungs of pneumonic sheep but their significance is not understood. Also, a large virus agent Chlamydia[10] has been implicated with Pasteurella in producing an extensive lobar pneumonia in California sheep. In the following work by Biberstein[11] the temperature response is illustrated when a PLV (Chlamydia) agent is given with Pasteurella.

FIG 1 TEMPERATURE RESPONSE OF SHEEP INOCULATED WITH PLV AGENT, P. haemolytica, TYPE A, OR BOTH
SERIES 1.



Temperature response of sheep inoculated with PLV agent, *P. haemolytica*, type A or both. Note. CELD stands for chick embryo lethal dose.

FIG. 2 AVERAGE TEMPERATURE RESPONSE OF SHEEP INOCULATED WITH PLV AGENT, P. haemolytica, TYPE T, OR BOTH
SERIES 2.



Average temperature response of sheep inoculated with PLV agent, *P. haemolytica*, type T, or both.

Unfortunately experimental infections do not duplicate what is commonly seen in the field as an acute lobar pneumonia with extensive fibrin in the lung cavity. Instead experimental infections reveal only a limited pneumonia in the fore portions of the lung. Obviously additional research is needed to unlock the mysteries of lamb pneumonia.

Although elevated temperatures in sheep are typical of early respiratory infection later chronic disease may not reveal a high temperature (maybe near normal or subnormal.) The use of temperature taking devices, nevertheless, such as the GAL Electronic Thermometer, is recommended in evaluating disease in a flock. If the lungs are already consolidated with complicated pneumonic lesions the use of a stethoscope will also readily detect abnormal lung sounds. The normal temperature in sheep incidentally is 102.3; however, excitement and air temperature might cause some variation. A range of 100.9 to 103.8 is therefore acceptable. If temperatures of 104.5 and higher are found an infection is present and treatment should be initiated.

CONTROL

In recognizing the importance of Pasteurella in the respiratory complex of sheep the use of sulfonamides should be given major consideration in a treatment program. Water and feed medication with sulfamethazine has been found to be highly effective against complicated sheep pneumonias. New Food and Drug recommendations of $1\frac{1}{2}$ grain per pound body weight the first day and 3/4 grain per pound body weight the next three days has been recently approved. This can be given in the feed or water.

Earlier reports indicate the successful use of sulfamethazine soluble powder at 45 pounds per ton of feed using one half pound of the medicated feed per animal for five days as highly effective in treating pneumonias and enteritis. Of course, in any program any sick sheep not eating or drinking should be given individual medication such as injectable Tetracycline or Penicillin-Streptomycin or Sulfalthamine by drench or injection.

Also, in any pneumonia control program the importance of sheep lungworm must not be overlooked. They can produce a primary or secondary respiratory condition reducing the effectiveness of any treatment program. Therefore, the presence of parasitism should be established and eliminated by using a broad spectrum anthelmintic (Levamisole) thus hastening the effectiveness of the sulfonamide or antibiotic.

INTERNAL PARASITES

Considerable losses (estimated $45,000,000) occur to the sheep industry each year from heavy burdens of internal parasites. In looking at the variety of potential worm loads in sheep it is quite understandable why these losses occur.

Protozoa - Coccidiosis
Flatworms - Liver Flukes
Tapeworms
Roundworms -

Abomasum	Small Intestine	Large Intestine	Lungs
Trichostrongyles	Trichostrongyles	Oesophogostomum	Dictyocaulus
Ostertagia	Cooperia	Chabertia	
Haemonchus	Nematodirus		
	Busostomum		

Although all parasitic infestations are not necessarily detrimental to the sheep too often a severe burden results. To modify this infection cycle the use of drugs along with management practices can be most helpful. In applying this to the aforementioned parasitic infections some understanding of the specific life cycle is needed.

COCCIDIOSIS[12]

Although there are nine to ten species of coccidia found in lambs only three are considered pathogenic. Mild infections in lambs are common so a control program is designed to combat the most pathogenic. For instance some species require 1,000,000 oocysts to produce damage whereas others produce symptoms with as little as 50,000 oocysts.

LIFE CYCLE

Oocysts or eggs are passed in the feces of the host contaminating the ground. These microscopic oocysts consist of a wall surrounding a single cell (zygote). These must undergo further development in the ground before they are infective. Four small bodies develop from the original nucleus and each of these contain two sporozoites. At this time the host ingests the oocyst and its cell wall disintegrates allowing the sporozoite to enter the intestinal mucosa or submucosa. The sporozoite can now further divide in the host cell with numerous merizoites being formed. These merizoites are released from the cell and are capable of reinvading another host intestinal cell. Then the merizoites form a male and female cell which unite into a zygote and the sexual stage of reproduction is completed.

CONTROL

Sheep do develop an immunity against coccidiosis however, if severe oocyst exposure occurs and the animal is susceptible infection results; therefore, this is usually a disease of lambs. Greatest damage to the intestinal tract occurs 14 to 20 days after infection but if there is only mild exposure to the oocyst immunity will develop in ten days. If clinical symptoms should appear the use of sulfa drugs to control infection is recommended; however, management practices should be corrected to prevent undue fecel exposure. The cleaning of water troughs daily is recommended and any dust in the feed area should be controlled.

Although coccidiosis may occur in lambs at any time it is often seen at one to four months of age. Overgrazing of pasture will also create a greater exposure to the oocyst since it is a surface soil contaminant. Any additional feeding of hay or supplement should be done in a bunker or trough and not on the ground. If ground feeding is necessary the site of the feeding should be changed daily.

FLATWORMS[13]

FLUKES

Liver flukes may cause acute death in sheep or result in a high liver condemnation at the packer. Also they are implicated in Black's Disease which results from a high destruction of liver tissue.

LIFE CYCLE

Fasciola hepatica is found in the bile duct of sheep and measures three-quarter to one inch in length and one half inch wide. Its life cycle is not direct, therefore an intermediate host is needed to complete its development. Eggs are passed in the feces of sheep and a free swimming form develops known as miracidium. Adequate water is needed so that an appropriate snail species Lymnae can be found for further development. Several different species of Lymnae serve as the intermediate host in which the miracidium penetrates the body wall and forms a cyst like body called the cercariae. From a few to several hundred cercariae develop in this cyst in a thirty day period. These will then leave the snail's body if water is present and after swimming about will find some vegetation on which to encyst. Sheep will ingest the vegetation and in 24 to 48 hours the young fluke is released in the gut and it penetrates the intestinal wall entering into the abdominal cavity. The young fluke will wander through the cavity four to six days finally penetrating the liver capsule entering into the liver. These young flukes are one-twentieth of an inch in length at this time migrating through the liver tissue forming hemorrhagic tracts. With a good environment the fluke grows rapidly and in five to six weeks they enter the bile ducts. Some eight weeks are required after the sheep is infected before eggs are found in the feces.

CONTROL

Regarding management it is noted in the life cycle water is needed (well aerated) which is found around springs, seeps, marshes and meadows. Irrigation fields incidentally, with good drainage are not conducive to cycling the fluke. If temperatures are below 50° F there is no hatching or egg development although they remain viable for five months. With ideal temperatures of 78° to 81° eggs can hatch in nine days or slightly longer. Areas where there is standing water should be fenced off or drained to interupt the life cycle.

Further in the life cycle it is observed the miracidium must find a suitable snail (Lymnae) in 24 to 48 hours or it will perish. So again a method of treating water or eliminating water are keys in breaking the life cycle. Copper sulfate if applied to water at the rate of one part in 100,000 will kill snails in eight hours while one part in 1,000,000 is lethal in 24 hours.

A more recent development, Calcium Cyanamide at the rate of one part per 1,000,000 is effective in destroying the free swimming form. In the following chart[14] the effectiveness of 1PPM Calcium Cyanamide water treatment is illustrated in snails.

	Snail Samples*		
Count Dates	5/26 fresh water	5/26 sump water	5/27 sump water
5/27	11 dead 10 morbid	19 dead 2 morbid	20 dead 10 morbid
5/28	18 dead 3 morbid	20 dead	30 dead
5/29	21 dead	20 dead	30 dead

*Note: All arthropods dead upon 5/29 examination

Also 200 pounds per acre of Calcium Cyanamide will kill emerging snails (Lymnae) in the soil thus breaking the liver fluke cycle. To eliminate the adult fluke Carbon Tetrachloride, Hexachlorethane, and Hexachlorephene are used. Unfortunately, there is no compound in this country that can be used to control the damaging fluke's larvae stages (first four to five weeks of development.)

TAPEWORMS

Although awesome in appearance tapeworms are not considered to be lethal or of great economic importance per se to the sheep industry. I might add however, tapeworms are thought to be a triggering influence on Clostridium perfringens organisms causing Enterotoxemia in lambs. The use of Lead Arsenate in a deworming program can be considered.

ROUNDWORMS[15]

Stomach and intestinal parasites as well as lungworms are of major economic importance in sheep. Flock control of sheep roundworm parasitism is most essential for best performance. A total of nine species are found in the stomach and intestinal tract and one in the lungs. (Refer to page 14)

LIFE CYCLE

Adult male and female roundworms located in the digestive tract mate and the female lays fertile eggs in the excrement which passes from the body. After development in the egg the first stage larva hatches, moults, eventually repeating this process twice. At the third stage the larva becomes infective and are ingested by a suitable sheep host and a fourth and fifth stage larva develop into adults. Haemonchus contortus the large stomach worm is primarily a blood sucking parasite. Infection with 3,000 to 5,000 adults will kill a lamb. Each female produces 5,000 to 10,000 eggs per day. In contrast the Brown Stomach Worm Ostertagia spp which does not suck blood would need 10,000 to 30,000 adult worms to produce serious disease. This species lays 100 to 400 eggs/day/adult female. Further in looking at ideal requirements for development H. contortus desires a temperature of 58° to 98° F while O circumcincta is more suited to a 40° to 70° F temperature. Both species require a 2" monthly rainfall for maximum development. Similar considerations must be given to the other gastro-intestinal species in sheep.

The life cycle of lungworms is also direct with major emphasis for development being dependent on lower temperatures than roundworms. With temperatures as low as 41° F infectivity is reached in twenty days while at 77° F only five days is required. However, with temperatures over 78.8° F all larva cycling will cease. The optimum temperature for lungworm larvae appears to be 58° F. This is a late spring or summer disease in Oregon although it has also been seen in the fall dependent on weather conditions.

CONTROL

Using these considerations one can begin to appreciate the importance of life cycle control of parasitism in sheep. Deworming in the spring of the year to prevent pasture contamination is advised. A repeat deworming in thirty days in heavier parasitized sheep is needed minimizing an internal parasitic worm burden. A broad spectrum completely effective anthelmintic such as levamisole is recommended.

Summary of the Efficacy of dl-Tetramisole and Levamisole Against Adult Dictyocaulus filaria Infections[16]

Researcher	Type Infection	Isomer Used[a]	Dosage	No. of Sheep Control	No. of Sheep Treated	Av. No. of Worms Recovered at Necropsy Control	Av. No. of Worms Recovered at Necropsy Treated	% Efficacy
Walley (25)	N	dl	15	58	297	95	-	96
Forsyth (6)	N	dl	15	-	-	11	0	100
Pretorius (15)	E	dl	15	6	7	169	6	99
Shone & Philip (18)	E	dl	15	7	5	369	8	99
Presidente & Worley (14)	E	l	8	10	10	489[b]	4.8	99

[a] dl = dl-tetramisole; l = l-tetramisole or levamisole

[b] Mixed infections of mature and immature worms.

Summary of the Efficacy of 8 mg./kg. Levamisole Against Adult Gastrointestinal Neumatodes in Sheep[16]

Researcher	H.c.[a]	O.c.	T.a.	T.spp.	C.spp.	N.spp.	Ch.o.	Oes.spp.
				% Efficacy				
DRENCH								
Drudge (P.C.)[b]	99	-	98	100	100	100	100	100
Bradley (P.C.)	99	-	-	100	100	-	-	100
Smith & Bell (20)	89	88	83	100	100	98	-	-
Marble (P.C.)	98	100	-	-	-	82	-	-
Average	95.8	94.0	90.5	100	100	93.3	100	100
BOLUS								
Drudge (P.C.)	98	-	85	99	100	90	100	100
Bradley (P.C.)	99	-	-	100	100	-	-	100
Smith & Bell (20)	90	88	90	100	89	96	-	-
Marble (P.C.)	99	94	-	-	-	77	-	-
Average	95.7	91.0	87.5	99.9	96.3	87.6	100	100

[a] H.c. = Haemonchus contortus; O.c. = Ostertagia circumcincta; T.a. = Trichostrongylus axei; T. spp. = Trichostrongylus spp.; C.spp. = Cooperia spp.; N. spp. = Nematodirus spp; Ch.o. = Chabertia ovina; Oes. spp. = Oesophagostomum spp.

[b] P.C. = personal communication - see section following literature cited.

SUMMARY

Life cycle control of parasitism is recommended to effectively minimize worm loads. A ewe, ram, and lamb program is advised as a complete approach to worm control.

Emphasis of management considerations such as pasture rotation, use of feed bunks, elimination of water trough fecal contamination, and a broad spectrum anthelmintic are the essential tools.

BLUETONGUE

Although Bluetongue (BT) was first confirmed in 1953 in California sheep it was recognized clinically in 1948 in Texas[17]. Later in 1959 it was diagnosed in Oregon cattle. Cattle therefore can be carriers of this disease in which at least one severe outbreak in sheep was detected. Symptoms are temperatures of 104-107 F, panting, ulcers on lip and mouth, swollen tongue with ulcers, mucopurulent exudate in nasal cavity, excessive thick saliva, sloughing skin of muzzle, severe laminitis and muscular weakness.

BT is commonly transmitted by a biting midge Culicoides varipennis, or less so by the sheep ked Melophagus ovinus, or the short nosed cattle louse Haematopinus eurysternus, and more recently reported by lice. It is also found in white tailed deer, elk, antelope and rodents as well as other wild ruminants. So the reservoir for maintaining this virus is there. Of interest a pneumonia can occur with BT infection. If such is found this is usually due to aspiration of rumen contents into the lungs which produces a broncho-pneumonia and death[18]. The importance of a vaccination program in sheep must be emphasized since this disease has become quite common throughout the United States. Of interest a variety of organisms were isolated from sheep experimentally innoculated with BT virus. Under field conditions it is quite logical the disease can be obscured or it can manifest itself with complications.

Aerobic Bacteria Isolated from Tissues of 33 Sheep Inoculated with Bluetongue Virus*

Tissue	Bacteria	Isolations No.
Lung	Pasteurella	22
	Micrococcus	10
	Pseudomonas	3
	Escherichia coli	1
	Corynebacterium	1
	Klebsiella	1
	Streptococcus	1
	Actinomyces	1
Spleen	Pasteurella	12
	Corynebacterium	2
	Klebsiella	1
	Micrococcus	1
Retropharyngeal lymph node	Pasteurella	8
	Micrococcus	4
	Carynebacterium	1
	Klebsiella	1

*Tissues were negative for bacteria in 1 sheep.

Vaccination of sheep with BT vaccine will usually abort these complicated BT disease problems. The use of supportive treatment may also be needed to speed recovery of a flock.

Concerning strains of virus there are fifteen known types in the world. Within the United States there are six strains (probably of same immunological type.) Presently the Bluetongue vaccine commercially available has only one immunological strain present.

SUMMARY

Vaccination is strongly urged to prevent Bluetongue which can decimate a flock of sheep. The vaccine by the way will produce mild transitory symptoms which is not a serious liability.

EXTERNAL PARASITE CONTROL

Refer to pages 21-24.

SUMMARY

Complete animal health programs emphasing good management practices, including disease prevention and treatment specific to your area and flock will minimize losses making you a member of a most important animal industry. Consult specialists in management and animal health programs such as University personnel, farm advisors, and your Veterinarian to assist you in developing an effective program specific to your operation.

PARASITE CONTROL ON SHEEP

Chemical Formulation and Concentration			Application Method	Amount	Days Between Treatment and Slaughter	Remarks
■ SHEEP KED (Treat in the spring, following shearing.)						
coumaphos (Co-Ral®)	WP	25%	Spray ‡	8 lb./100 gal. water (0.25%)	15	Do not treat animals under 3 months old. Lightly spray animals 3 to 6 months old. Do not use with pyrethrins, allethrin, or synergist. Do not spray animals for 10 days before or after shipping, weaning, or after exposure to disease. Do not apply within 14 days of phenothiazine treatment.
diazinon	WP	50%	Spray ½ to 1 gal./ animal	½ lb./100 gal. water (0.03%)	14	
dioxathion (Delnav®)	EC	30% (2 lb./gal.)	Dip or spray	½ gal./100 gal. water (0.15%)	0	Do not apply more than once every 2 weeks. Do not dip animals under 3 months old.
malathion	EC	55% (5 lb./gal.)	Spray thoroughly	7 pt./100 gal. water (0.5%)	0	Do not use on animals less than 1 month old or on sick animals.
	WP	25%		16 lb./100 gal. water (0.5%)	0	
ronnel (Korlan®)	EC	25% (2 lb./gal.)	Spray ‡	2 gal./100 gal. water (0.5%)	28	Do not reapply within 2 weeks.
toxaphene[2]	EC	72% (8 lb./gal.)	Dip or spray‡	½ gal./100 gal. water (0.5%)	28	

Parasite Control on Sheep – continued

Chemical Formulation and Concentration			Application Method	Amount	Days Between Treatment and Slaughter	Remarks
■ SPINOSE EAR TICK (Treat as needed.)						
coumaphos (Co-Ral®)	dust	5%			0	Inject into ears from squeeze-bottle duster as prepared by manufacturer.
dichlorvos (Vapona®)	EC	20–24% (2 lb./gal.)	Oil can	½ oz./2 qt. mineral oil (0.25%)	0	Apply ½ oz./ear by means of spring-bottom oil can with rubber-tipped spout.
■ SCAB MITES (Treat when observed.)						
Report infestation to Bureau of Animal Health, California Department of Agriculture. Treatment and movement of mange- or scab-infested animals are subject to regulation. Animals should be treated twice in an approved dip at 10- to 14-day intervals.						
lime sulfur	Proprietary solutions		Vat dip for 2 to 3 minutes		0	Temperature of dip to be held at 95° to 105° F.
toxaphene[2]	EC	72% (8 lb./gal.)	Dip not less than 1 minute	½ gal./100 gal. water (0.5%)	30	Same as for beef cattle.
■ LICE (Treat in fall or after spring shearing.)						
Ciovap®	EC	10%* (1 lb./gal.)	Spray 1 pt./animal	8⅓ gal./100 gal. water (1%)	0	Repeat spray in 2 weeks but not more than once a week.
coumaphos (Co-Ral®)	WP	25%	Spray	8 lb./100 gal. water (0.25%)	15	Repeat at 2- to 3-week intervals if needed.

■ WOOL MAGGOTS (Fleece worms) (Treat during warm, humid weather in areas having history of wool maggot problem.)

coumaphos (Co-Ral®)	WP	25%	Spray	8 lb./100 gal. water (0.25%)	15	Safety precautions as given for sheep ked (sheep tick).
dioxathion (Delnav®)	EC	30% (2 lb./gal.)	Dip or spray	½ gal./100 gal. water (0.15%)	0	Do not apply more than once every 2 weeks. Do not dip animals less than 3 months old.
ronnel (Korlan®)	EC	24%	Spray	2 gal./100 gal. water (0.5%)	28	Do not reapply within 2 weeks.

■ TICKS (Wood ticks) (Treat as needed.)

coumaphos (Co-Ral®)	WP	25%	Spray‡	8 lb./100 gal. water (0.25%)	15	Safety precautions as given for sheep ked (sheep tick).
dioxathion (Delnav®)	EC	30% (2 lb./gal.)	Dip or spray	½ gal./100 gal. water (0.15%)	0	Do not apply more than once every 2 weeks. Do not dip animals less than 3 months old.
malathion	EC	55% (5 lb./gal.)	Spray thoroughly	7 pt./100 gal. water (0.5%)	0	Do not use on animals less than 1 month old or on sick animals.
	WP	25%		16 lb./100 gal. water (0.5%)	0	
ronnel (Korlan®)	EC	24% (2 lb./gal.)	Spray	2 gal./100 gal. water (0.5%)	28	Do not reapply within 2 weeks.
toxaphene[2]	EC	72% (8 lb./gal.)	Dip or spray ‡	½ gal./100 gal. water (0.5%)	28	

[2] Formulations of toxaphene may contain mixtures of dichlorvos (Vapona®), dioxathion (Delnav®), or lindane, all of which are registered for use and appear under different brand names. Toxaphene and lindane are restricted materials. A permit is required to purchase, apply, and possess them.

‡ Repeat at 2- to 3-week intervals if needed.

methoxychlor	WP	50%	Dip ‡	4 lb./100 gal. water (0.25%)	0	Do not dip animals less than 3 months old. Do not use on sick animals.
			Spray	8 lb./100 gal. water (0.5%)	0	
ronnel (Korlan®)	EC	24% (2 lb./gal.)	Spray	1 gal./100 gal. water (0.25%)	28	Do not reapply within 2 weeks.
toxaphene[2]	EC	72% (8 lb./gal.)	Dip or spray ‡	½ gal./100 gal. water (0.5%)	30	Same as for beef cattle.

■ SHEEP BOT FLY (Nasal Bot)

No safe and effective treatment.

■ SCREWWORMS (Treat during spring, summer, and early fall.)

coumaphos (Co-Ral®)	WP	25%	Spray as needed to wet animal.	8 lb./100 gal. water (0.25%)	15	Safety precautions as given for sheep ked (sheep tick).
	dust	5%	Dust wound thoroughly.	Direct application.	0	
	spray	3%	Pressurized spray to wounds and surrounding area.		14	
ronnel (Korlan®)	EC	24% (2 lb./gal.)	Spray as needed to wet animal.	2 gal./100 gal. water (0.5%)	28	Do not reapply within 2 weeks.
	smear	5%	Brush or smear on wounds.	Up to 3 ts	0	Treat wound and surrounding area twice first week and then weekly until healed.

[2] Formulations of toxaphene may contain mixtures of dichlorvos (Vapona®), dioxathion (Delnav®), or lindane, all of which are registered for use and appear under different brand names. Toxaphene and lindane are restricted materials. A permit is required to purchase, apply, and possess them.

* Contains 0.25% dichlorvos (Vapona®) and amount to mix in water is based on content of 10% Ciodrin® alone (1 lb./gal.).

‡ Repeat at 2- to 3-week intervals if needed.

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SUMMER DECLINE IN FEEDLOT LAMBS

William Hohenboken and T. P. Kistner

Lamb feeders and grazers in the Northwest have identified poor performance of feeder lambs during summer months as a major production problem. Poor and inefficient gains and difficuty in putting on sufficient external fat cover to grade choice are typical complaints of this "summer decline" syndrome. Generally there is not a high level of mortality. The Departments of Animal Science and Veterinary Medicine at Oregon State University are engaged in joint research to identify causes and provide economical solutions to the problem. This article reports on the first phase of that work.

We reasoned that poor performance could be due to some combination of respiratory infection, internal parasites and heat stress. Further, we felt that treatment of lambs prior to weaning and shipping to a feedlot could influence both respiratory and parasite problems. Also shearing could influence heat stress. Accordingly, our initial study was designed to monitor each of the three potential problem areas and to study the effects of preconditioning and shearing on lamb performance. We measured feed and water consumption, weight gain, wool growth, body temperature, respiration rate, internal parasite burden, lung damage at slaughter and carcass external fat thickness.

Experimental Protocal. Normally feeder lambs undergo considerable stress from the time that they are weaned until they are safely on feed. This stress can include several sortings and handlings, a variable time off feed and water, exposure to dust, parasites, disease, and ammonia fumes, and introduction into an alien environment. We simulated this stress by gathering and sorting lambs off pasture and hauling them to Cleve Dumdi's feedlot at Junction City, Oregon. They remained there overnight without feed and water. The next morning, they were sheared, vaccinated and medicated as called for by the experimental design, and returned to our simulated feedlot in Corvallis.

The trial lasted from July 12 to September 17, 1973. Fifty-six crossbred Suffolk feeder lambs from three university flocks were involved. Average initial shrunk weight was 71 lb. All the lambs were group-fed. Space allocations per lamb averaged 22 sq. ft. of lot area, two inches of self-feeder and 1 3/4 inches of water trough. A complete pelleted ration of 60% chopped rye grass straw plus barley, wheat millrun, alfalfa, molasses, urea and chlorotetracycline was provided.

There were two kinds of experimental treatments. The first was shearing. Sixteen lambs were sheared close, 16 were sheared with a rake attachment that left about 3/8 inch of wool stubble, and 24 lambs were not sheared at all. Comparison of these three groups allowed us to compare shearing treatment effects on the ability of the lambs to cope with heat stress.

The second treatment was the timing of vaccinations and medications. Twenty-four lambs were preconditioned a week before weaning time and 24 were conditioned at the time of weaning and "shipment" to the feedlot. In both cases, exactly the same treatments were given. They are listed in table 1. The only differences was in timing. The preconditioned group was treated before anticipated stress and exposure to the conditions they were being protected against. Within each of these groups of 24 lambs, eight were not sheared, eight were rake sheared and eight were close sheared.

A final group of eight lambs was neither sheared nor given any of the treatments in table 1. These lambs served as a negative control to which other groups could be compared.

Table 1. Preconditioning and Conditioning Treatments

Deworming	
Roundworms	Thiabendazole
Tapeworms	Diphenthane 70
Coccidia	Sulfa drench
Vaccinations	
Pneumonia	Mixed bacterin
Enterotoxemia	Type C and D toxoid
Soremouth	

Results and Discussion

Weather observations. Air temperature and % relative humidty were recorded continuously for the first eight weeks of the trial. Daily maximum temperature averaged 81^{o}F and was generally reached between 2 and 5 p.m. (daylight time). Humidity then ranged from 10 to 30%. Daily minimum temperature averaged 51^{o}F and was generally reached between 4 and 6 a.m. Humidity then was generally between 85 and 100%. Daily average temperature was 67^{o}, but the average daily temperature range (the difference between daily high and low) was 30^{o}.

The thermo-neutral temperature range for lambs is about 62-78^{o}. Within this zone, lambs are comfortable. They do not seek to dissipate or to conserve body heat. Most days of the trial, there were several hours both above and below this thermo-neutral zone. At temperatures higher than 78^{o}, lambs attempted to cool themselves by seeking shade and increasing their respiration rate. At temperatures below 62^{o}, lambs sought to conserve or gain heat by slower breathing, gathering closer to companions and seeking sunshine and protection from wind.

Thus the lambs were stressed not only by heat but also by the large daily temperature range. Most days, they had to employ both heat conservation and heat dissipation strategies.

Water and feed consumption. As all lambs were lot fed together, it was not possible to determine the effects of shearing or time of conditioning on feed and water consumption. We could, however, relate water intake to temperature changes and to time.

Lambs weren't drinking too well early in the feeding period. For the first three weeks of the trial, intake averaged 4.6 quarts per lamb per day. During this time, average daily water consumption per lamb increased about a third of a pint each day. Lower initial intake of water may have been a result of low feed intake, but it may also have been caused by reluctance to drink from an unfamiliar water source. For the next five weeks, consumption was fairly stable at 7.3 qt. per lamb per day. Hotter weather did increase intake. A 5^{o} increase in average temperature increased water intake by 3/4 pint per lamb.

Daily feed intake per lamb averaged 1.3, 3.3, 4.2 and 4.0 pounds for the first through fourth weeks, respectively. Thereafter, it averaged about 4.8 pounds for the remainder of the trial.

Weight gain. Weight change during the first two weeks and total weight gain were studied in detail. Shearing treatment had no effect on any of the gains. No advantage could be shown for either close shearing or rake shearing under the management and environmental conditions of the trial. This finding was against both tradition and expectation. Shearing generally has been reported to increase rate of gain as well as feed efficiency.

Whether lambs were conditioned at weaning, preconditioned or not conditioned at all did influence weight change, however. The effect on performance soon after the lambs entered the lot is shown in figure 1. Preconditioned lambs lost less weight initially and began gaining weight more rapidly than did the lambs conditioned at weaning time. The fact that the eight lambs not conditioned at all lost the least weight and gained the most by day 14 indicates that handling stress is detrimental to early performance. This does not mean, of course, that lambs shouldn't be dewormed, vaccinated or medicated. At the end of the trial, preconditioned and conditioned lambs had equal total weight gain, but the nontreated lambs had gained some two pounds less.

Wool growth. Wool growth was measured as an additional barometer of the nutritional and physical well-being of the lambs. There were no differences from shearing treatments or from preconditioning *vs.* conditioning. Non-treated lambs, however, had less wool growth. They averaged 0.4 in. compared to 0.5 in. for the average of all treated groups, additional evidence of the beneficial effects of the conditioning treatments.

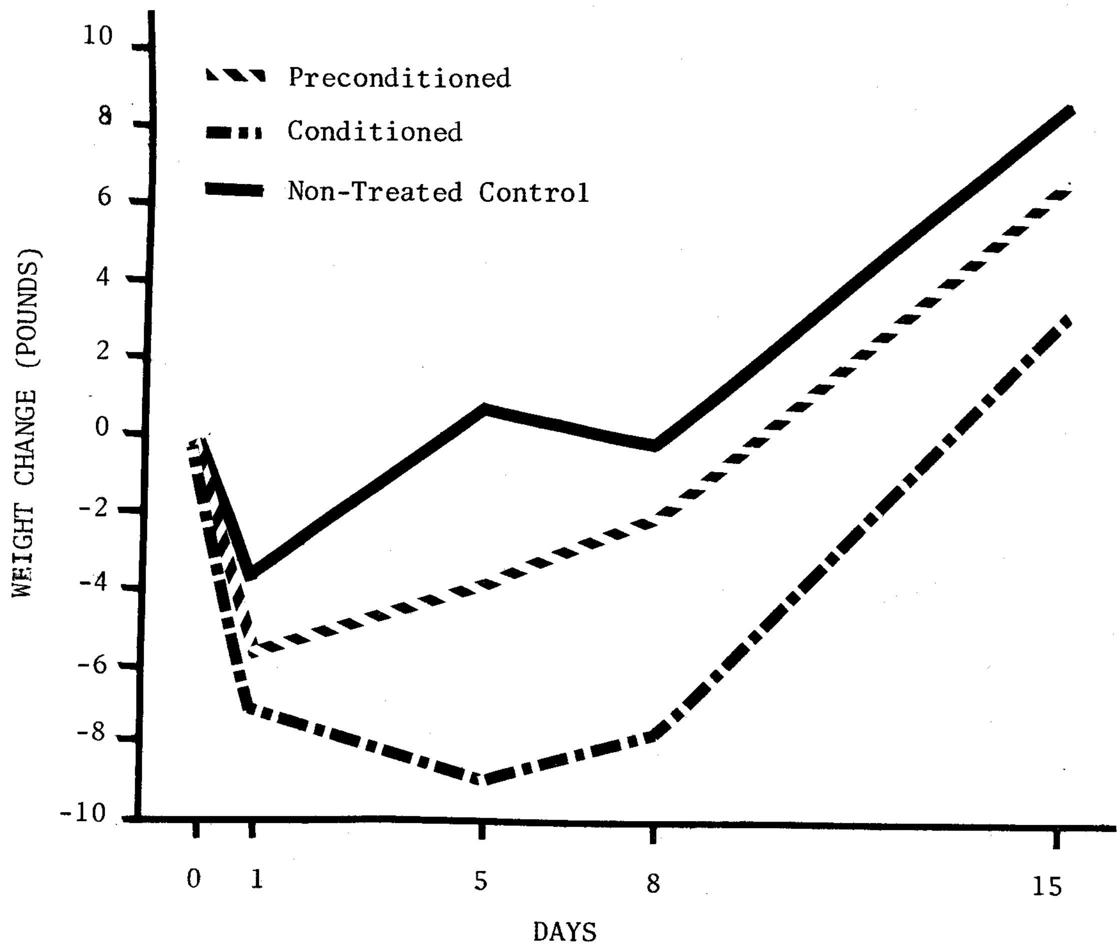


Figure 1. The effect of preconditioning *vs*. conditioning at weaning *vs*. no treatment on early weight gains.

Body temperature and respiration rate. One wether lamb and one ewe lamb per treatment group were chosen at random for observation of body temperature and respiration rate. Morning and early afternoon rectal temperatures and early afternoon respiration rates were recorded several days per week. Lambs that were rake sheared were more successful in maintaining a stable body temperature than were close sheared or not sheared lambs. Their afternoon body temperature was 0.5^{o}F less. There were no differences in body temperature between preconditioned, conditioned or not conditioned lambs.

Preconditioned lambs breathed slightly more rapidly than conditioned lambs (39 *vs*. 36 breaths per minute). Also breathing rate increased slightly from close sheared to rake sheared to not sheared lambs (35, 38 and 40 breaths, respectively). These differences were not large enough nor consistent enough to allow definite conclusions. Faster breathing probably indicates greater discomfort or heat stress. These results tentatively suggest, then, that unsheared lambs and preconditioned lambs may be under greater stress. If this is true, the preconditioning effect might be caused from two separate handlings, one for medications and one for shipping. This is an aspect of the study that merits additional investigation.

Internal parasites. Fecal examinations were conducted at the time of preconditioning or conditioning and every two weeks thereafter. The examinations included counts of gastro-intestinal nematode (roundworm) eggs, estimates of the prevalence of coccidial oocysts and determination of the presence or absence of tapeworm eggs.

Pre-experiment nematode egg counts in all groups indicated a pathogenic burden of adult worms. Hence, deworming was advisable prior to the feeding period. Egg counts seven days after preconditioning and 14 days after conditioning were near zero for the treated groups. Fecal egg counts remained near zero until day 28, and they began to rise after that. By the end of the experiment, though, counts were still well below problem levels. In the non-treated group, fecal egg counts dropped 50% from the beginning of the trial to the examination two weeks later. This probably reflected the higher level of nutrition or the ration change. They remained at this lower level throughout the study. These eggs were probably the source of reinfection of the non-treated groups.

At no time, and in none of the groups, did either coccidial oocysts or tapeworm eggs reach levels that were indicative of problems that would hamper lamb performance.

Lung damage. Of the 56 lambs, 29 showed some evidence of pneumonia lesions. Within each of the three shearing treatments, preconditioned lambs had slightly greater incidence and severity than the group conditioned at weaning. If this is a real and repeatable phenomenon, it may have been caused by the additional handling of preconditioning and later weaning and shipping.

Between shearing treatments, incidence was highest for rake sheared lambs, but severity was greatest for lambs not sheared. Negative control lambs were low in incidence but near average in severity. Several of the severely affected lambs came from the same source flock, indicating that their infection was probably present before the experiment began.

Carcass fat thickness. The overall average carcass fat thickness was only 0.2 in. None of the shearing or preconditioning vs. conditioning treatments resulted in differences in fat thickness, but non-treated lambs were slightly thinner than all treated groups. Only three lambs failed to grade choice.

Examination of lambs with inferior performance. Overall average daily gain for the trial was 0.4 lb. and feed efficiency was 10.4 lb. of feed per pound of gain. This is not superior performance, but is within a normal and acceptable range considering the ration and other circumstances. Since none of the treatments had dramatic effects on any of the traits that were measured, we next identified the ten poorest gaining lambs and attempted to pinpoint specific causes for their substandard performance.

Three of the poor doers were in the non-treated group. The remainder were about equally distributed between the three shearing treatments and the preconditioned vs. conditioned groups. Poor doers were equal to the overall average in initial weight, indicating that pre-existent conditions were not the major difficulty. They did lose more weight and did gain it back more slowly early in the trial than the overall average. Thus, poor performance did exert itself early in the feeding period. Of the ten lambs, seven had evidence of pneumonia lesions in the lungs at the time of slaughter. Respiratory infection may well have been a factor in the substandard performance of these lambs.

Summary

Effects of shearing treatment (not sheared vs. rake sheared vs. close sheared) and of preconditioning vs. conditioning at weaning time on performance of lambs during the summer were investigated. Conditioning and preconditioning treatments included vaccination for sore mouth, enterotoxemia and pneumonia and drenching for intestinal roundworms, tapeworms and coccidia. The trial included 56 lambs fed in a simulated feedlot situation for 67 days. Daily maximum and minimum air temperatures averaged 81^{o} and 51^{o} respectively, and the average daily temperature range was 30^{o}. Water intake per lamb per day increased for 24 days and thereafter remained fairly stable. Daily feed intake increased through four weeks and then stabilized at 4.8 lb. per lamb per day.

None of the shearing or preconditioning treatments affected total weight gain, but non-treated lambs did gain less than treated lambs. Preconditioned lambs and non-treated lambs lost less weight initially and gained it back more rapidly than lambs conditioned at weaning. Wool growth over the first eight weeks of the trial favored the average of all treated lambs (0.5 in.) over the negative controls (0.4 in.). Likewise carcass fat thickness was slightly greater for treated lambs. Over one half the lambs showed some evidence of pneumonia lesions in the lungs at slaughter. Preconditioned lambs were slightly higher in incidence and severity than were conditioned lambs. Between shearing treatments, incidence was highest for rake sheared lambs, but severity was greatest for lambs not sheared. Close sheared and unsheared lambs did not differ in body temperature, but rake sheared lambs averaged 0.5^{o}F less in afternoon body temperature than the remaining groups. Respiration rate was not dramatically affected by any of the treatments.

Treatment combinations did not influence internal parasite infection (as estimated from fecal egg counts) except that negative controls were higher for intestinal roundworms. Throughout the trial, neither tapeworms, intestinal roundworms nor coccidia appeared high enough to hamper performance.

When the ten poorest gaining lambs were examined, they shared the distinction of greater initial weight loss and higher incidence and severity of pneumonia than the experimental average.

INTENSIFICATION OF SHEEP PRODUCTION SYSTEMS

C. F. Parker

Man has been dependent upon sheep as an important source of nutrition (meat and milk) and clothing (wool and pelts) for many centuries. When one traces our evolving from the period of a huntsman through that of a herdsman, it is amazing to learn that sheep husbandry has been more intimately associated with man during this time than any other industry. A similar association between man and sheep was observed during the early development of this country. Contrary to a recent theme of a few, sheep are not "the most dangerous animal in America." Without exception they have been an important servant in the development of our livelihood. However, as with most enterprises, change must come as economic, ecologic and other conditions vary with time. Unfortunately the most noticeable change in the sheep industry during recent years has been the steady annual decline in total sheep numbers.

For those who question the future of sheep we sould review some of the important inherent advantages of this species. First and most significant is that an average of 89% of the food units for lamb meat and wool production comes from high fiber nutrient sources that cannot be utilized directly by man. Table 1 is presented to assess the economic importance of forages in sheep production. Applying the constant (Hodgson, 1968) to calculate forage value from the gross sales of lamb and wool in the United States during 1972, the total value for forages was 293.6 million dollars. The forage value for sheep production in the state of Oregon was equal to 7.3 million dollars ($11,697,560 x 62.3%). The high percentage of forage in the diet of sheep allows this animal to be the most efficient converter of solar energy source nutrients of all domesticated meat animal species.

TABLE 1. ESTIMATED FORAGE VALUE

	Gross Income as Feed Costs (%)	x	Feed Units as Forage (%)	=	Receipts as Forage Value (%)
Sheep	70	x	89	=	62.3
Beef	70	x	78	=	54.6

Therefore, 62.3% x Cash Receipts = Forage Value for Sheep

A second area for attention is the biological potential of sheep for further increasing net efficiency of meat and wool production. From studying Table 2, it becomes apparent that improving net efficiency of lamb meat production is highly related to reproductive rate. The average lamb crop percentage in the United States in 1973 was 95 percent, and this level has changed only slightly during the past twenty years. However, twin rearing is possible with sheep and the biological gap between the present average annual rearing rate and the potential rate provides a most promising area for increasing and improving net efficiency of lamb meat production. The genetic variability among breeds for twinning rate and for out-of-season mating provides the major source for increasing the inherent reproductive rate of sheep.

TABLE 2. RELATIONSHIP OF TOTAL FEED UTILIZATION AND ANNUAL LAMB CROP PERCENTAGE ON TDN REQUIRED PER POUND OF LAMB MARKETED

Lamb Crop Percentage	Total TDN per lb. of Lamb
100	10.2
150	7.6
180	6.8
200	6.3
220	6.1

In retrospect, the general decline in sheep number has not been related to basic utility values or to the biological potential of sheep but to a lack of intensification or increased output per unit of input, primarily for meat production, in relation to other animal species. However, it appears that sheep possess the greatest unused potential of any meat animal species and are therefore capable of improving the net efficiency of meat production from animal agriculture during the years ahead.

The relatively low capital investment in the sheep industry for specialized equipment, feeds, housing systems, drugs, compared to other livestock enterprises has not stimulated agricultural related industries to invest in the technological development of systems for intensified production. Other livestock industries have greatly substituted capital for labor and land in the production of food products and thereby have intensified production in terms of these two basic resources. This investment contrast to the sheep industry should not be used to judge the true value of the enterprise in terms of net food production potential.

The purpose of this paper is to discuss technology that can be applied to intensify the economic production of lamb meat and wool on a larger volume. It seems obvious at this time that forages will continue to provide the basis for an economically successful sheep enterprise. The general factors associated with increased forage production are: high yields and improved handling and utilization methods. Annual forage yield directly affects stocking rate and therefore allows intensified utilization of the land. Choice of forage species and fertilization practices are the two basic inputs determining total annual yield. Harvesting dates as related to plant maturity and the fertilization program are important determinants of forage quality. Forage quality needs vary according to productive stages of the sheep. Figure 1 illustrates the energy needs of the ewe during various stages of production. Energy requirements are highest and most critical during late gestation, lactation and immediately prior to and during the early portion of the breeding season. These are stages of performance when attention to forage quality is highly important for reducing the amount of supplemental feeding.

Efficient forage programs will vary widely according to soil and climatic conditions. Where corn is economically produced, corn silage deserves greater utilization in the larger sheep production systems. Corn silage yields significantly more energy per acre than any other crop. It can be economically supplemented to meet the nutrient requirements of the ewe and a large portion of the diet of the finishing lamb and can easily be adapted to automated feeding systems.

Where land is not ideally suited for cultivation, other forage systems can be developed for improving total production. One of these areas is Western Oregon where improved grass-clover pasture utilized under high stocking management has proven to be a successful forage program. Dawson and McGuire (1972) have researched this particular system in terms of the soil-plant-animal interrelationships. They report that intensive grazing and forage production can simultaneously be achieved with a symbiotic fixation of nitrogen and recycling of nitrogen and sulfur in amounts needed for top production. This program appears to exemplify an excellent balance for optimum land use intensification with sheep.

Characteristic forage growth patterns, such as the one shown in Figure 2 for tall grasses grown in Ohio, introduce the need for a carefully planned management strategy. The set stocking rate and the type of forage harvesting and utilization of the surplus growth produced during the spring months become important parts of the total forage program. The recent development and availability of large package forage harvesting equipment have provided additional handling and utilization alternatives.

Increases in forage yields and in efficiency of production, harvesting and utilization provide important improvements in the reduction of unit costs and intensification of land use by sheep. Other management practices such as utilizing electric fencing and planned parasite and disease control programs are important for the efficient use of forages.

An increase of the inherent biological potential for reproductive function seems to be the most significant change that can be made for improved efficiency of feed utilization. Table 3 is shown (Parker, 1972) to illustrate this potential for improved feed efficiency and pounds of lamb per ewe with increased lamb crop

FIGURE 1

DAILY DIGESTIBLE ENERGY (D.E.) REQUIREMENTS OF 160 LB. BREEDING EWES

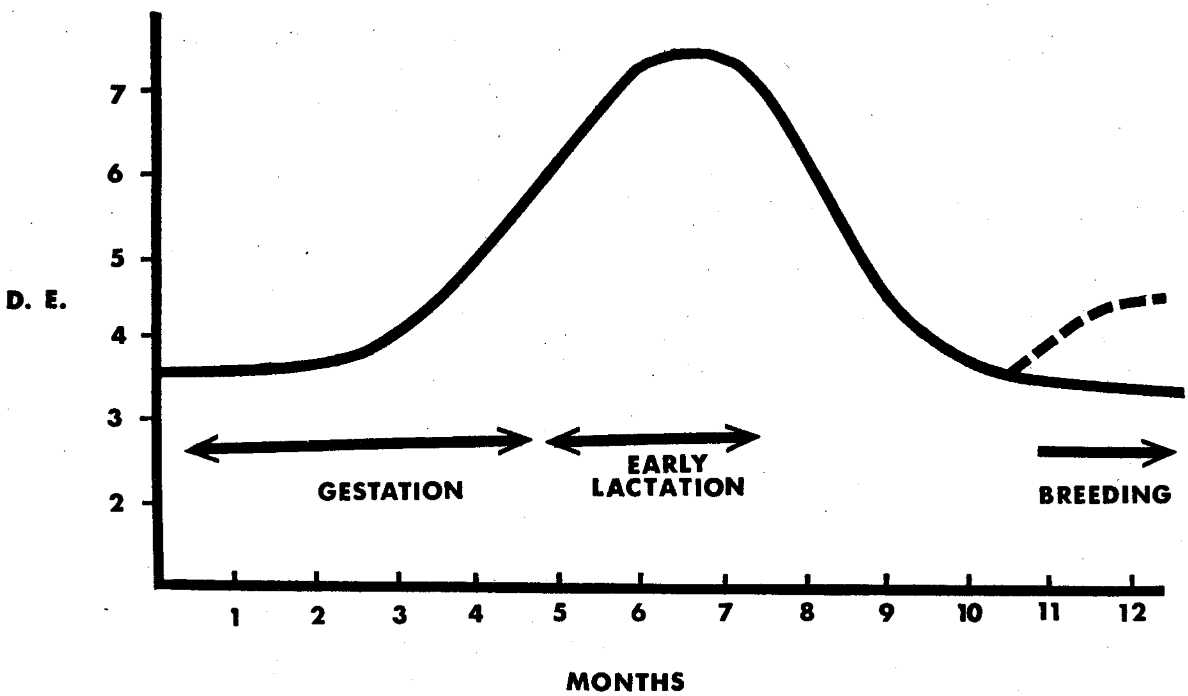


FIGURE 2

TALL GRASS GROWTH PATTERN

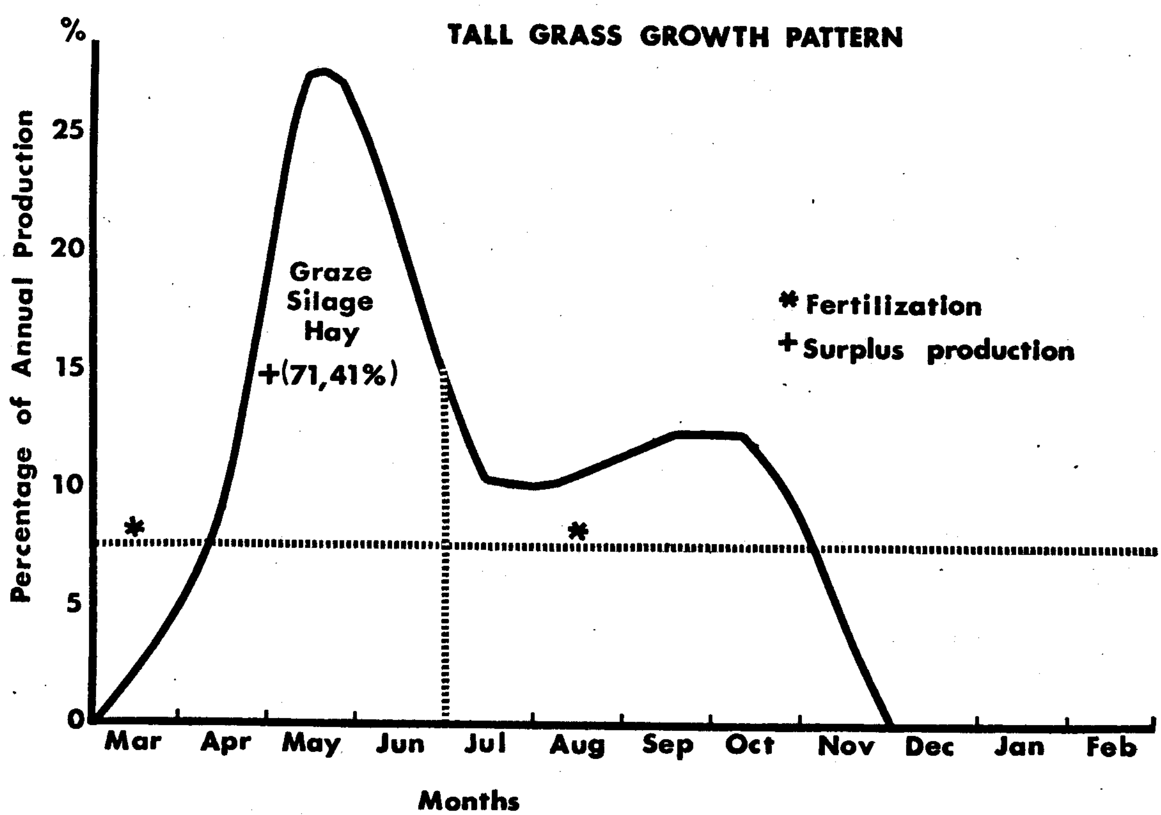
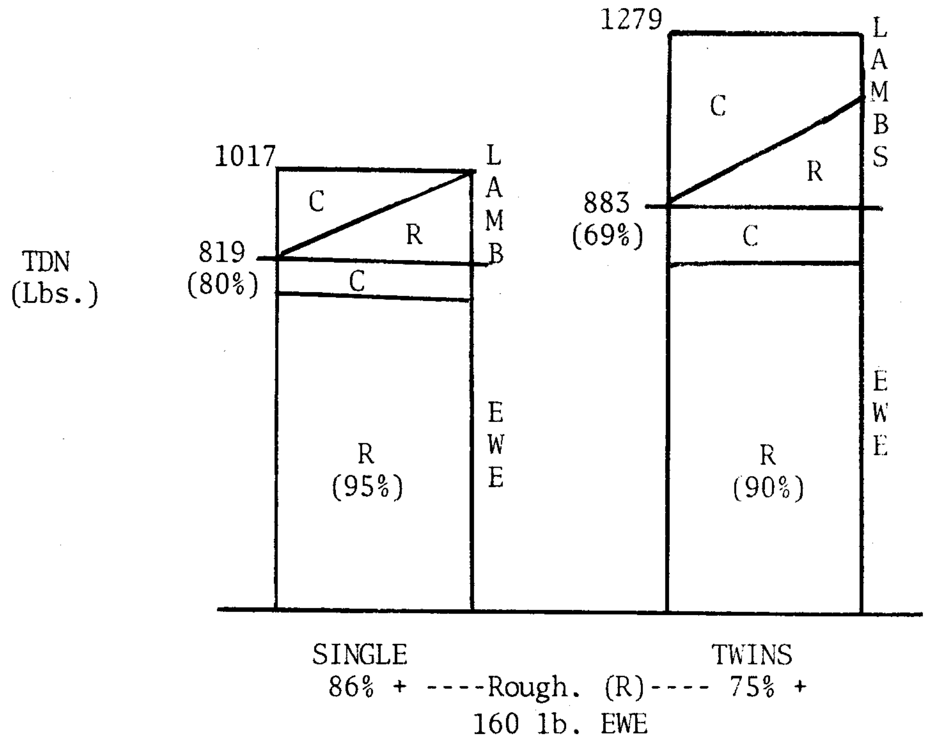


FIGURE 3

TOTAL TDN REQUIREMENT



percentage. The total feed (both ewe and lamb) required per unit of gain for a single lamb to slaughter is 60% greater than that required by twin lambs. However, it is estimated that a larger percent of the total feed required by the ewe and her twin lambs will be concentrate than for the ewe with a single (25% vs 14%).

TABLE 3. RELATIONSHIP OF LAMB CROP PERCENTAGE AND OPTIMUM WEIGHT ON POUNDS OF LAMB PRODUCED AND TDN (Ewe and Lamb) PER POUND OF LAMB

	Potential Weight of Breeding Animals at 12 to 18 Months		
Ram	220	240	260
Ewe	120	140	160
Optimum slaughter weight for lamb	90	100	110

Lamb Crop Percentage	Total lbs. lamb Produced			Total TDN Per lb. Lamb Gain
100	90	100	110	10.2
150	135	150	165	7.6
180	162	180	198	6.8
200	180	200	220	6.3
220	198	220	242	6.1

Figure 3 presents the estimated quantities of TDN (total digestible nutrients) used in this comparison. Identification of the critical management conditions (nutrition of the ewes and lambs, care at lambing, etc...) necessary for the production of high annual lamb crop percentages requires further study. It seems likely that breed-type performance for lamb meat production may differ among varying management and environmental conditions. Perhaps certain specific genetic combinations for production traits will be more efficient under particular management conditions. Wilson (1973) suggests that improvement in reproduction of sheep could double protein conversion percentage by 1985. The use of a terminal sire breed with high fertility and proper genetic potential for growth can further contribute to the intensification of lamb meat production.

Table 4 is presented to summarize the combined effect of increased stocking rate and lamb crop percentage on the meat producing ability of sheep. Intensification of forage production systems with increased annual lamb crop percentage appear to be the two variables of greatest importance for improving the profitability of sheep production.

TABLE 4. LAMB PRODUCTION POTENTIAL PER ACRE[1]

Lamb Crop (%)	Ewe Stocking Rate/A. 2	6	8	12
100	2.0	6.0	8.0	12.0
140	2.8	8.4	11.2	16.8
180	3.6	10.8	14.4	21.6
220	4.4	13.2	17.6	26.4
400	8.0	24.0	32.0	48.0

[1] Stocking rate based on land required for ewes only.

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NEW CONCEPTS IN FARM FLOCK SHEEP PRODUCTION

M. Vavra, W.D. Hohenboken, M.M. Wing, and R.L. Phillips

Introduction

Increasing productivity of farm flock sheep has great potential because the ewes are kept under rather confined and hence controllable conditions. Current high prices for land, feed and machinery make increased efficiency of operations a must for producers. Presently, meat packers, wholesalers and retailers are somewhat reluctant to handle lamb because of limited supplies and seasonal changes in availability. Increasing the number of lambs going to market and marketing lambs throughout the year should help strengthen the market as well as increase returns to producers.

Studies are currently underway at the Eastern Oregon Experiment Station in Union to increase the number of lambings per year, to increase the number of lambs born per lambing, and to increase growth rate, feed efficiency and survival rate of all lambs born. By applying the results of this work, the sheep producer will be able to use existing facilities more efficiently. The ewe herself will become more efficient through more frequent lambing and producing more lambs per lambing.

Increasing the number of lambings. For some time exogenous hormones have been used to induce estrous and ovulation in anestral ewes. Past work at the Eastern Oregon Experiment Station has shown that hormones can be used effectively to produce a crop of lambs every 8-1/2 months. In that study sixty ewes were divided into 3 equal groups. The experiment utilized yearling crossbred ewes which were the progeny of Columbia or Targhee ewes and Hampshire rams. Group 1 served as controls and received no hormones; Group 2 ewes received an intravaginal pessary[a] impregnated with a synthetic progesterone-like compound for 16 days; and Group 3 ewes received similar pessaries for 16 days, then went 8 days with no treatment and again each received a pessary treatment for 9 more days. Pessary treatment was synchronized so that final removal occurred on the same day for both groups. Following pessary removal ewes in both groups were injected with 750 I.U. of Pregnant Mare's Serum Gonadotropin (PMSG), and rams were turned in with the ewes. The breeding season lasted 35 days.

Providing progesterone or progesterone-like substances to ewes prevents them from showing heat and ovulating. Withdrawal of the

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[a] Pessaries were impregnated with cronolone (flurogestone acetate), a product of G.D. Searle and Company, Skokie, Illinois, and were provided by them.

chemical allows estrous cycling to begin and thus synchronizes heat for the ewes so treated. PMSG is a hormone that increases ovulation rate.

Data obtained from this experiment are listed in Table 1. The normal estrous season for ewes in northeastern Oregon occurs from late August through February, with the peak occurring in October. Therefore, in this study the ewes were bred only once (April 15) when the ewes could be considered anestral for the entire 35 day breeding season. Hormone treatment showed a definite positive effect on the number of lambs born to treated ewes that were bred in April. Ewes were probably anestral during the first part of the August 1 breeding. Slightly more lambs were born to treated ewes lambing from this breeding. Lambing percents among groups were quite similar for the January 1 and September 18 breedings. These breedings occurred during the normal estrous season and no difference was expected. The percent of ewes lambing was higher in the hormone treated groups over the entire experiment. The number of lambs weaned per ewe was slightly more than from control ewes indicating an increase in prolificacy. The increase occurred during the anestral breedings.

Table 1. SUMMARY OF INITIAL HORMONE USE STUDY.

Breeding and lambing dates	Grp.	No. of ewes	No. of ewes lambing	% of ewes lambing	No. of lambs born	No. of lambs weaned	Lambing %	Lambs weaned per ewe bred
8/1/66	1	20	15	75	24	20	120	1.33
12/28/67	2	19	17	89	29	27	153	1.59
	3	19	14	74	26	20	137	1.43
4/15/67	1	19	4	21	5	5	26	1.25
9/10/67	2	19	11	58	16	16	84	1.45
	3	18	10	53	19	15	106	1.50
1/1/68	1	19	17	89	32	24	168	1.41
5/29/68	2	19	19	100	32	24	168	1.26
	3	18	17	94	32	23	178	1.35
9/18/68	1	17	17	100	32	27	189	1.59
2/14/69	2	16	16	100	27	25	169	1.56
	3	17	16	94	33	27	194	1.69
	1	75	53	71	93	76	124	1.43
Total	2	73	63	86	104	92	143	1.46
	3	72	57	79	110	85	153	1.49

In April 1972, another study investigating the use of exogenous hormones was begun. Data are presented in Table 2. Columbia and Targhee ewes varying in age from 2 to 7 years were used. Sixty ewes were again allotted to 3 treatments. The results of the first study indicated that progestagin-impregnated pessaries and subsequent PMSG injection could increase the lamb crop when ewes were bred during a normally anestrous period. The double pessary treatment was discontinued because of the increased labor and cost involved. Group 1 ewes again served as controls and received no hormones. Group 2 and 3 ewes received pessaries for 16 days. When the pessaries were removed Group 2 ewes received 750 I.U. of PMSG subcutaneously and those in Group 3 received 1,000 I.U.. It was hoped that the higher PMSG level might increase fertility further. Pessaries and PMSG injection were utilized in Groups 2 and 3 only when the ewes were considered anestrous. In the previous study no effect due to hormones had been noticed during the normal breeding season and it was felt that discontinuing hormone use would reduce costs without reducing performance. Breeding schedule was trimmed one month more in this study so that ewes were lambing every 7-1/2 months. Again, rams were with the ewes for 35 days.

The first breeding period occurred in April, normally an anestrous period, so hormones were administered. Group 3 ewes produced the greatest number of lambs and Group 1 the least. Even though the ewes were exposed to rams during an anestrous period, half of the controls were cycling and fertile. However, no twins were born to the 10 control ewes that lambed. From the November 28 breeding, lambing percent was similar for all 3 groups. No hormones were used prior to this breeding because this mating occurred during the normal seasonal estrous. Lamb mortality was highest in Group 3 and resulted in fewer lambs weaned.

The July 12 breeding period was again considered an anestrous breeding even though the close of the breeding period was August 16. Group 1 ewes produced as many lambs as Group 2 ewes and slightly more than Group 3 ewes (Table 2). The use of hormones did not have a significant effect on ewes' production during this breeding. Group 3 ewes did lamb slightly earlier, and this is reflected in the slightly heavier weaning weights observed.

At this point in the study the hormone treated ewes have produced more lambs than controls. This difference was primarily due to the first breeding. Lambs from Group 2 and 3 have been slightly heavier than those from Group 1 at weaning. The hormone treatment caused the ewes to lamb earlier than the controls, so the lambs were older at weaning. However, the number of lambs weaned per ewe bred was lowest in Group 3 ewes and highest in Group 2 ewes. Group 3 ewes performed best during the first lambing but because the lambs had a higher mortality during the April, 1972 lambing the number weaned per ewe was lower.

Table 2. Summary of present hormone study.

Breeding dates	Treatment	No. of ewes	No. of lambs born [2]	Total ewes lambing	No. of lambs weaned	Pounds weaned	Average weaning weight	Lambing percent	No. of lambs weaned per ewe bred
4/15/72[1]	1	20	10	10	10	453	45.3	50	1.00
	2	20	18	13	16	822	51.4	90	1.23
	3	19	30	17	22	1006	45.7	150	1.29
11/28/72	1	18	26	16	18	669	37.2	137	1.13
	2	18	28	18	21	809	38.5	156	1.17
	3	17	26	16	15	580	38.7	144	0.94
7/12/73[1]	1	17	20	12	16	480	30.0	118	1.33
	2	20	20	13	17	511	30.1	100	1.30
	3	20	17	13	15	488	32.5	85	1.15
Sum	1		56	38	44	1602	37.5	102	1.16
	2		66	44	54	3744	40.0	115	1.23
	3		73	46	52	5818	39.0	126	1.13

1. Exogenous hormones used.

2. Includes fetuses in ewes killed by coyotes.

Cost to producers for PMSG would be $1.50 for 750 I.U. and $2.00 for 1,000 I.U., and pessaries $.50 each. The only facility needed to administer the hormones is an alley closed on either end to hold ewes. The next lambing in this study will occur in July, 1974. At that time, ewes in Groups 2 and 3 will be combined and treated similarly for the duration of the experiment. The specific treatment used will depend upon results obtained by that time.

Ewe management for more efficient production. Intensified lambing and early weaning create several new problems in ewe management. Weaning lambs at 30 to 45 days of age means drying up the ewe at the height of her milk production and therefore, at her greatest susceptibility to udder damage. Presently a system of weaning is undergoing investigation whereby milk production may be decreased just prior to weaning. Four days before weaning the ewes are put on a sub-maintenance diet. Twenty-four hours prior to weaning the ewes are taken off feed and water until the lambs are weaned. Following weaning the ewes are fed the sub-maintenance diet for an additional 10 days.

In the accelerated lambing study, ewes must then be brought back to breeding condition. Following the 10-day post-weaning period of poor feeding, the ewes are returned to a flushing ration and fed well through the breeding period. An example of the feeding schedule follows:

Physiological state	Feeding level	Time period (days)
Pregnancy	maintenance	120
Late pregnancy	maintenance + pregnancy	30
Lambing	maintenance + lactation	35
Lactation	maintenance + lactation	26 - 52
Pre-weaning	sub-maintenance	4
Post-weaning	sub-maintenance	10
Pre-breeding	flushing	10
Breeding	flushing	35
Pregnancy	maintenance	120

At this point, ewe management is the critical part of increased lambing.

Under the current feed price situation and ration composition used in the present study, early weaning of lambs may not be feasible. Perhaps future research should include an economic and feasibility analysis of breeding ewes that have lambs at their side as an alternative to early weaning.

Increasing the number of lambs born. The recent introduction of the Finnsheep or Finnish Landrace breed has caused some excitement in the sheep industry since their importation in 1968. The outstanding quality of the breed is fertility, and more specifically, the tendency for multiple births. Finn ewes regularly produce triplets and can have up to eight lambs per lambing. Another "plus" for the breed is "livability" or hardiness of the newborn lambs. The ewes are also good mothers and rate fairly high in milk production. However, wool production is quite poor, the wool being both sparse and coarse. British workers have shown that Finn lambs somehow concentrate in their blood higher levels of maternal antibodies from the colostrum. From this higher level of maternal antibody, they have greater disease resistance during early life. Through crossbreeding, it is hoped that the good qualities of the Finn and of indigenous breeds can be combined to produce a more efficient ewe that will produce more lambs that are more efficient in converting feed to gain.

Working cooperatively, the Eastern Oregon Experiment Station and the Department of Animal Science at Oregon State University, Corvallis, have begun a crossbreeding project at Union. The Finn, Hampshire and Columbia breeds are being used in a rotational cross breeding system. Each year the crossbred ewes will be bred to rams of the most distantly related ancestor breed of the three. A straight bred flock of Columbias will be maintained as a comparison. Characteristics to be measured on ewes and/or lambs include: fertility, prolificacy, wool production, maternal ability, growth rate, feed efficiency, carcass merit, health and longevity. Ewes will be kept for the duration of their productive lives.

Lamb management to enhance growth rate and survival. Increasing the lambing rate and the number of lambs born per lambing necessitates changes in lamb management. Increasing the number of lambs born per ewe requires the development of a system of handling extra lambs. The use of cold milk replacers fed free choice has come into its own in the past few years. This system allows an increased efficiency in feeding motherless lambs in large numbers. Many systems of varying designs have been produced. Most of these systems, however, are basically comprised of a container with a number of nipples and a milk storage vessel under refrigeration. Some producers just use the container with nipples and refill it two or three times a day.

A simple system that has worked well at Union is illustrated in Figure 1. A 10-gallon milk can is placed in an old refrigerator. A hole is bored in the side of the refrigerator and a plastic hose connects the milk can to the feeding bucket. Milk replacer flows by syphon. A float valve apparatus from an automatic livestock water fountain keeps milk at a constant level in the feeding bucket. Two complete sets are used so that they can be changed

Figure 1.

COLD MILK FEEDING SYSTEM

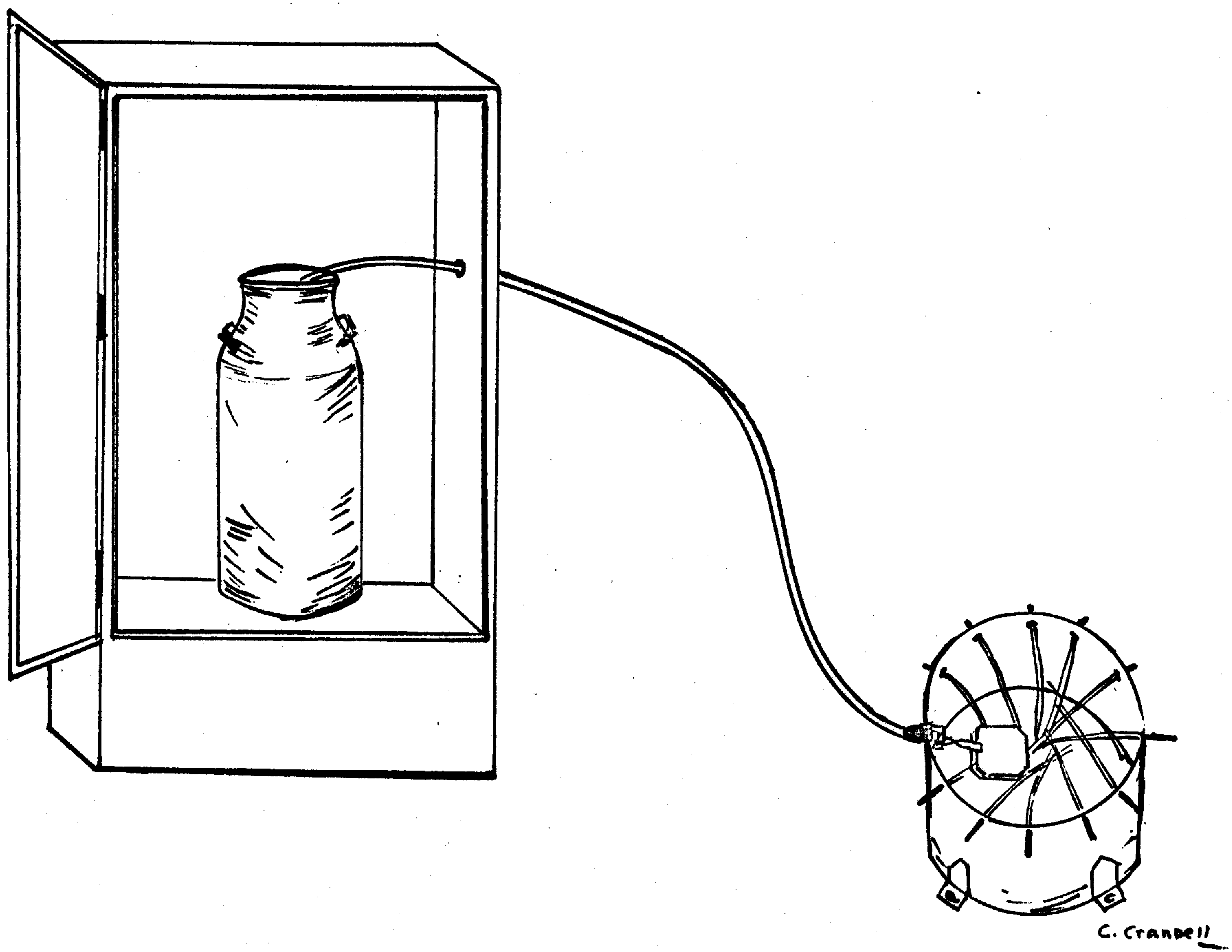

Table 3. Summary of early weaning study.

Group 1972	Weaning age	Weaning weight	Wt. at 65 (1972) or 60 days (1973) of age	Average daily gain in feedlot	Days on feed	Age at marketing	Final Weight
1	30	31.4	48.9	.66	102	132	98.3
2	45	40.8	54.4	.73	102	147	115.4
3	65	43.2	43.2	.76	81	146	104.7
1973							
1	30	31.1	45.6	.63	105	135	97.4
2	45	38.2	56.5	.63	91	136	95.3
3	60	48.1	48.1	.65	84	144	102.4

daily for cleaning and disinfecting. Cleanliness has been the key to success of a cold milk feeding system.

When mixing milk replacer in large quantities for several days use, the problem of separation of replacer components has occurred and is unsolved at this time. Formaldehyde has been added at the rate of 1 cc per gallon of milk replacer to inhibit bacterial growth. Hay and grain are made available to the suckling lambs. Lambs are weaned from this system when they weigh 30 to 35 pounds.

Weaning lambs from milk replacer and weaning those at young ages from an accelerated lambing flock has necessitated research into post-weaning management of lambs. In an ongoing experiment, lambs have been weaned averaging 30, 45, and 60 days of age. Both singles and twins were used. In the case of twins, both lambs were weaned at the same time. Data collected in 1972 and 1973 are presented in Table 3. Lambs in Group 3 in 1972 averaged slightly more than 60 days at weaning. During both years lambs weaned at 30 days gained sufficient weight so that they were marketed at the same time as later weaned lambs. In 1972 they were almost two weeks younger. Carcasses from lambs in all groups were acceptable and graded choice or prime.

A specialized feeding program is needed for lambs weaned at young ages. Rumen development is probably not well advanced in a 30-day-old suckling lamb. Young lambs also have higher protein requirements. The following feeding regime was followed based on lamb weight:

Weight	Ration
Under 45 pounds	20% protein and limited alfalfa hay
45 to 60 pounds	15% protein, hi-barley
Over 60 pounds	14% protein

Formulations of these rations are listed in Table 4. The 20% and 15% rations were developed at the USDA Sheep Station, Dubois, Idaho. Lambs have been effectively managed under this system. However, the current high prices of feeds would make weaning and feeding lambs under 45 pounds questionable using these rations. The feeding of the 15% protein, hi-barley ration to 45 pound lambs has been discontinued this winter. Feeding the 14% ration has been a less expensive alternative that has proved successful. Lamb daily gains have not been depressed. Continuing research on ration composition is necessary to evolve cheaper rations.

Summary

Management of farm flock sheep is presently undergoing drastic changes. The farm flock is being more intensively managed than in the past; there are more lambs being produced more often. Decreasing

the lambing interval enables a producer to use both facilities and sheep more efficiently because more lambs are produced per unit of time than on a once-a-year lambing program. The introduction of the Finnsheep may aid producers by increasing the number of lambs born per ewe.

New methods of handling ewes and lambs under these intensified management systems have to be developed, adopted and refined. Management of the ewe and lamb must provide for maintaining ewe fertility and milk production and acceptable feedlot performance and resulting carcass merit of the lamb. In all cases the systems developed must be economical and within the capabilities of feasible labor and facilities.

Table 4. Formulation of rations fed to early weaned lambs.

	DIETS	
Crude protein level (%)	20	15
Ingredient composition (%)		
Alfalfa meal (sun-cured)	15.0	15.0
Barley	50.0	66.0
Soybean oil meal (44%)	28.0	12.0
Blackstrap molasses	5.0	5.0
Dicalcium phosphate (deflor.)	1.9	1.9
Trace mineral pre-mix	0.1	0.1
Vitamin A and D	*	*
Chlortetracycline	.1	.1

* Vitamin A at 900 I.U. per pound
Vitamin D at 1300 I.U. per pound

14 % Ration

Alfalfa, at least 15% protein, No. 1	20 percent	
Cull peas	26 "	
Wheat flour screenings	30 "	
Dried beet pulp	18 "	
Molasses	5 "	
Salt	1 "	
Antibiotic (aureomycin or aurofac) 20 gms/ton	.1 "	(2#/ton)

FOOTROT RESEARCH AT OREGON STATE UNIVERSITY

A Progress Report - 1974

S. P. Snyder

In past reports, I have dealt mainly with the problems associated with working with the causative bacterium of footrot (Bacteroides nodosus) and our initial vaccination trials using an experimental vaccine obtained from the McMaster Laboratories in Australia. The report will concern itself with expanded studies on the characterization of the bacteria and additional vaccine studies using a commercially prepared alum-precipitated vaccine, kindly supplied by Arthur Webster Pty. Ltd., Sidney, Australia, and used with special permission of the U.S.D.A.

As I mentioned in my last report, one of the major side-effects of the original vaccine formulation was that large nodules or granulomas developed at the site of inoculation due to the oil-emulsion adjuvant in the vaccine. This problem has been largely overcome by the newer commercial formulations which use alum as the adjuvant. These alum-precipitated bacterins have as a disadvantage, though, the induction of relatively short-term immunity, somewhere in the neighborhood of 60-100 days. The objective in their use, then, is to protect the susceptible animals from footrot at the time when spread of the organism from sheep to sheep is most likely to occur, i.e., during the first fall rains or late spring. Fewer animals will contract new cases of footrot and spread will be kept to a minimum. Also, the vaccine has, in addition to the prophylactic property, the therapeutic property of curing many animals with infected feet, further reducing the spread of infection. Even in countries where the vaccine is readily available, foot-bathing in formaldehyde and foot trimming is still used extensively along with the vaccine to assure proper health of the animals' feet. Due to the relatively short immunity that develops, vaccination will probably be done yearly until all animals in a flock are completely free of infection.

Three separate flocks of sheep in Douglas County were used to test the efficacy of the Webster Footrot Vaccine. These flocks had varying degrees of footrot problems, from very minimal in flock A to severe in flock B. The animals in flock C were all chronically infected, and were used to test the ability of the vaccine to cure sheep with this type of the disease. Vaccinations were done just prior to the onset of the fall rainy season and vaccinated and unvaccinated animals were allowed to intermingle freely to ensure maximum challenge.

Flock #	No. of Sheep	Incidence of Footrot			
		Vaccinated Animals		Control Animals	
		Initially	Terminally	Initially	Terminally
A	179	(100)* 1	0	(79) 1	2
B	135	(75) 21	20	(60) 26	25
C	83	(40) 14	3	(43) 4	5

* The numbers in parenthesis represent numbers of sheep used as vaccinates and controls in each flock.

It becomes obvious that no conclusions can be made concerning flock A due to the minimum numbers of infected animals. In flock B no significant effect was produced by vaccination. In flock C, however, vaccination was highly effective in both reducing the number of infected sheep (from 14 to 3) and in reducing the severity of the disease in those that were affected.

The results of this study strongly support my contention from the beginning that more must be known about the strains of Bacteroides nodosus we have in Oregon before we can proceed to produce a vaccine. Furthermore, our bacterial isolate from flock B (where vaccination appeared to be of no benefit) is vastly different antigenically from any other isolates we have made and from isolates we have received from either California or Australia. This isolate is extremely pathogenic and will readily reproduce the disease in susceptible sheeps' feet in our laboratory, even after prolonged passage in culture. It is reasonable to assume that the vaccine was of no help in this flock because the strain of B. nodosus involved is so different from the strains used in the formulation of the vaccine. It is imperative, then, that we determine whether other Oregon flocks also are infected with this or other antigenically unique organisms.

The results from flock C strongly suggest that this vaccine can be of major benefit in some flocks as both a therapeutic product as well as a prophylactic one. We have made several attempts to isolate the particular strain of B. nodosus from this flock, but have been so far unsuccessful. I strongly suspect that the strain involved will be antigenically similar, if not identical, to one of those employed in the formulation of the commercial vaccine. We plan to make a concentrated effort at isolating and characterizing the organism from this flock this spring.

We have expanded our efforts on characterization of the organism in several major areas. We are continually making refinements in antigenic typing of the isolates and in culture procedures. We have also made a study into the electron microscope characteristics of the organism under different culture conditions. Our preliminary studies on large-batch culturing procedures, essential to the ultimate production of vaccine, also look very good at this time. Although it would be unwise for me to predict when our findings can be turned over to a commercial vaccine laboratory for large-scale production, we are much closer to this goal than when the project began.

BREED EVALUATION PROGRESS REPORT

William D. Hohenboken

At a time when the sheep industry nationwide continues to decline, sheep production under certain management systems in Oregon has been economically viable. OSU shares the belief of many progressive sheepmen that conditions are ripe for further expansion of sheep numbers. Included in these conditions are skyrocketing costs of concentrate feeds and the growing concern of society for environmental quality. Sheep production on grasslands combines the advantages of: (1) producing a quality protein source without competing directly with humans in the food chain, (2) building soil fertility by the recycling of nitrogen, sulfur and other plant nutrients, (3) in some cases reducing dependence on objectionable cultural practices such as field burning, (4) providing biological control of a poisonous and noxious weed (tansy ragwort), and (5) being esthetically pleasing by providing landscapes for the harried city dweller.

For potential expansion to be realized, however, certain critical problems (such as predator losses) must be overcome. Also sheep production must provide a fair return to labor and capital plus a fair profit to the operator. In 1972, the Department of Animal Science at OSU started a research project designed to help the sheep industry to achieve optimum economic and production efficiency.

Objectives and Experimental Protocol

The experiment is entitled "Breed of Sire Effects on F_1 Growth, Carcass and Maternal Performance for Optimal Production Efficiency in Sheep." I am the project leader, and Drs. Walt Kennick (meats), Bill McGuire (pastures and forages) and Ken Rowe (statistics) are cooperators. The three objectives are:

(1) to characterize breeds as to their suitability as sires of F_1 crossbred ewes possessing desirable maternal traits,
(2) to characterize breeds according to the growth rate and carcass merit of their F_1 crossbred lambs, and
(3) to identify how characteristics of the ewe affect overall productivity and profitability under given sets of environmental conditions.

Phase I. The experiment is divided into two phases. In the first, four breeds of ram were crossed onto grade Suffolk and Columbia type range ewes to produced F_1 crossbred offspring. The ram breeds were chosen for their predicted merit in maternal characteristics. (We are presupposing that an optimum or near optimum breeding system for commercial lamb production is the cross of a rapid growth, meat-type ram onto crossbred ewes of two good "maternal" breeds. This project is an attempt to characterize potential "maternal" breeds, as stated earlier.) Chosen were the North Country Cheviot (for hardiness and adaptability to harsh environmental conditions), the Dorset (for carcass quality and maternal performance), the Romney (for adaptability to our wet winter conditions) and the Finnish Landrace or Finnsheep (for prolificacy).

Columbia-type range ewes were used because of their availability in the Western United States. We are not implying or recommending that they should be used commercially in western Oregon. We had, in fact, reservations about their adaptability to our incessant rains. If a range ewe cross proved to be economically beneficial, though, we assumed that commercial sheepmen could contract crossbred replacement ewes from range sheep operators. Suffolks were chosen as the other dam breed because of their general acceptance in Oregon and their excellent maternal qualities.

Phase I lasted two years, the 1972/73 and 1973/74 seasons. Four rams from each of the four breeds and 200 ewes of each type were mated each year. Each ram had about 12 whiteface and 12 Suffolk mates. Wether lambs and cull ewe lambs were or will be fed out and slaughtered to accomplish the second experimental objective.

Phase II. About 80% of the crossbred ewe lambs from phase I will be selected and retained at OSU. One half of each breed-cross group will be assigned to a conventional western Oregon hill pasture environment. The other half will be assigned to an irrigated valley floor, intensive management system. Both groups will be bred as ewe lambs to OSU Hampshire rams and will remain with these management and mating systems for the remainder of their productive lives. The following traits will be measured on as many of the ewes as feasible: age at sexual maturity, fertility, prolificacy, milk production, health, resistance to foot rot, maternal behavior, size, wool production and longevity. Breed of sire and breed of dam effects on these measures of ewe performance will be examined. Finally, the relationships among the traits will be studied with their effect on overall economic productivity.

Phase I Results

Table 1 summarizes data for ewe traits scored at lambing or weaning time. Columns are for the four sire breeds and represent the weighted averaged of four or eight rams per breed. The rows are separated for Suffolk vs. whiteface ewes for each ram breed. The last column and last group of rows show averages across breeds of sire and dam, respectively.

Fertility is the % of ewes bred which actually lambed. Our breeding season was 40 days and we had 11% dry ewes, a bit more than we would have liked. There was little difference in fertility between sire breeds. This indicates that breeds were equally capable

Table 1. Sire and dam breed effects on reproductive characteristics

Breed of Dam	Breed of Sire				
	North Country Cheviot	Dorset	Finnsheep	Romney	Averages
Suffolk:					
1. Fertility (%)[a]	89.5	88.1	83.7	88.9	87.8
2. Birth date of lambs[a]	13.2	15.5	15.3	14.4	15.0
3. Lambs born/ewe lambing[a]	1.79	1.57	1.57	1.77	1.68
4. Lamb survival to weaning (%)[b]	87.4	91.0	89.6	91.7	90.0
5. Lambs weaned/ewe bred[b]	1.28	1.29	1.23	1.55	1.35
Whiteface:					
1. Fertility[a]	88.4	90.7	94.3	86.7	90.2
2. Birth date of lambs[a]	14.5	19.4	13.2	15.7	15.9
3. Lambs born/ewe lambing[a]	1.64	1.50	1.61	1.72	1.62
4. Lamb survival to weaning (%)[b]	94.2	87.9	91.0	85.3	89.4
5. Lambs weaned/ewe bred[b]	1.17	1.24	1.27	1.31	1.25
Average:					
1. Fertility[a]	88.9	89.4	89.0	87.8	89.0
2. Birth date of lambs[a]	13.7	17.5	14.3	15.2	15.4
3. Lambs born/ewe lambing[a]	1.72	1.54	1.59	1.75	1.65
4. Lamb survival to weaning (%)[b]	90.5	89.5	90.1	88.4	89.5
5. Lambs weaned/ewe bred[b]	1.23	1.27	1.26	1.43	1.30

[a] Based on two lamb crops data
[b] Based on 1972/73 season only

in settling their ewes. There were differences between individual rams, however. The poorest individual ram performance was 60% from a Finnsheep ram lamb. Four rams, one North Country Cheviot, one Romney and two Dorsets, settled 100% of their mates. These differences indicate variation in semen quality, sex drive and/or ability to detect ewes in estrus. There was little difference in fertility between Suffolk and whiteface ewes, but whitefaces were about 2½% higher overall.

Birth date of lambs is the average day of birth of a group of lambs in the lambing season. Smaller numbers indicate quicker breeders and higher fertility. These differences, for either sire breed or dam breed, are not great, but lambs sired by Dorsets did tend to be born a bit later in the season.

The third trait is prolificacy, total lambs born per ewe lambing. Suffolks excelled whitefaces by 6%, but both were quite prolific for the commercial conditions under which they were managed. Interesting sire breed differences showed Romney and North Country Cheviot both high and nearly equal - Dorset and Finnsheep both lower and similar. Rams can influence prolificacy by the proportion of ova or eggs shed which they actually fertilize (heat detection ability, libido and semen quality) and by differences in embryonic mortality of their offspring.

The next trait, lamb survival to weaning, is based on only the first year's data. Most differences in percent lamb survival have generally been thought to be environmental rather than genetic. Never-the-less, individual sire progeny groups ranged from 76 to 100% survival. (For the purposes of these computations, lambs reared as orphans were considered to have died.) Differences between ewe breed groups were very small. Ram breed averages differed by only about 2%. There was not a close correspondence between survival of a breed's whiteface and Suffolk cross progeny.

Lambs weaned per ewe bred, the next trait, is getting down to the dollars and cents of sheep raising. It includes differences in fertility, prolificacy and lamb survival. For this trait, Suffolk ewes excelled the whiteface range ewes by 10%. For sire breeds, the Romney posted an 18% advantage over the average of the other three breeds, which were similar.

Lamb production per ewe bred is strongly influenced by prolificacy. Again, these data represent only the first year, and in that year Suffolk ewes and Romney rams excelled for prolificacy. The second year, Suffolks and whitefaces were about equal for number of lambs born. Thus the advantage of Suffolk ewes for lamb production will be lowered when the second year's data are added in. Romney rams maintained their excellent effect on lambs born per ewe lambing the second year. They are likely to retain their superiority for overall lamb production, as measured by lambs weaned per ewe bred.

The second table includes preweaning growth characteristics. Average adjusted weaning weight looks at each lamb as if he were the same age (120 days), the same sex (ewe lamb) and the same birth and rearing type (born and raised single). Adjustment factors from the Sheep Industry Development Program book were used. Lambs sired by Dorset rams excelled in weaning weight, though differences were not great. The superior cross was Dorset rams bred to Suffolk ewes. Suffolks exceeded whiteface ewes by eight pounds.

Pounds of lamb weaned per ewe lambing combined growth rate with prolificacy. Suffolks increased their advantage over whitefaced ewes to 14 pounds. Dorset and Romney sires averaged 110 and 107 pounds, respectively, while Finns and North Country Cheviots were each about 102 pounds.

The last line in the table, pounds of lamb weaned per ewe bred, comes as close as possible, at this stage of our study, to total economic efficiency. It combines fertility, prolificacy, survival and growth rate. For comparisons between ewe breeds - Suffolks and whitefaces - it does not include ewe weight, ewe survival and longevity, nor ewe wool production. Whitefaced ewes averaged 133 pounds at mating time, Suffolk ewes 147 pounds. The smaller whiteface ewe would require less feed. She would also produce more wool than the Suffolks. Thus the 13 pound deficit of whitefaces under Suffolks for this important statistic doesn't reflect the actual economic difference between the two. Later analyses will take these factors into consideration - as well as differences in feedlot gain and in carcass merit. Ram breed differences were important, ranging from 87 pounds for North Country Cheviots to 100 pounds for the Romney.

Certain precautions are in order in interpreting these results. First, they reflect only preliminary analysis of the first year's data and portions from the second year. Second, this is only part of the story - straightbred ewe and crossbred lamb performance through weaning. Feedlot and carcass performance of wethers and maternal performance of the crossbred daughters is yet to be collected and analyzed.

Table 2. Sire and dam breed effects on preweaning growth rate - 1972/73 data only

Breed of Dam	Breed of Sire				
	North Country Cheviot	Dorset	Finnsheep	Romney	Average
Suffolk:					
1. Average adjusted weaning weight	80.5	86.3	80.7	78.9	81.5
2. Pounds of lamb weaned/ewe lambing	105.3	116.3	110.4	114.7	111.8
3. Pounds of lamb weaned/ewe bred	92.7	102.9	93.1	110.2	100.3
Whiteface:					
1. Average adjusted weaning weight	75.3	74.5	72.6	71.9	73.5
2. Pounds of lamb weaned/ewe lambing	98.8	102.3	94.8	97.1	98.2
3. Pounds of lamb weaned/ewe bred	80.0	90.6	88.4	87.5	87.0
Average:					
1. Average adjusted weaning weight	78.2	80.9	76.9	75.9	77.9
2. Pounds of lamb weaned/ewe lambing	102.4	109.8	102.7	106.8	105.5
3. Pounds of lamb weaned/ewe bred	86.8	97.2	91.9	100.1	94.1