April 1987

A.E.Res. 87-12

A COMPARATIVE ECONOMIC ANALYSIS of the STAR ACCELERATED and ANNUAL LAMBING SYSTEMS

Darwin P. Snyder

Robert A. Milligan

Department of Agricultural Economics
Cornell University Agricultural Experiment Station
New York State College of Agriculture and Life Sciences
A Statutory College of the State University
Cornell University, Ithaca, New York 14853

A Comparative Economic Analysis of the
STAR Accelerated and Annual Lambing Systems

CONTENTS

ACKNOWLEDGMENTS

The authors appreciate and recognize the assistance provided by Dr. D. E. Hogue and B. H. Magee in matters of sheep husbandry used in this study. In addition, helpful comments and review by Dr. B. F. Stanton and Dr. G. L. Casler, Department of Agricultural Economics, were greatly appreciated.

A Comparative Economic Analysis of the Star Accelerated and Annual Lambing Systems

Darwin P. Snyder and Robert A. Milligan

Introduction

During the recent past the sheep industry in the United States has experienced a steady decline in numbers. The January 1, 1986 inventory of all sheep and lambs was only 77 percent of the 1981 inventory. In the Northeast during the same period, numbers were 92 percent of the 1981 inventory (Crop Reporting Board, Sheep and Goats). However, in the past year, the U.S. inventory of all sheep and lambs increased by three percent while the 11 Northeast states inventory increased by 14 percent. The increase, particularly in the Northeast, appears to be in response to strong lamb prices and low feed prices as well as to the demand created by the new slaughter facility which began operating in Virginia in 1985.

The decrease in size of the national sheep flock reflects the relatively poor economic health of the industry. With a stable per capita consumption of lamb and reduced supplies, prices have improved and continue to be strong for the producer. The traditional annual lambing systems, however, have limited the potential for gains in productivity and, therefore, profits for sheep and lamb producers.

Traditionally, lamb production has been based on the natural tendency of ewes to lamb annually. In an effort to improve the productivity of the ewe flock and producer profits, work has been done to accelerate lambing schedules. This has involved breed selection, improved management practices, and various innovations.

Objectives

This study examines the economics of the STAR lambing program in the context of resources that otherwise could be used to raise market lambs under the traditional Annual lambing system. It is designed to compare three productivity levels under the STAR system with results the same operator could expect under an Annual system. The same basic real estate, equipment, and management resources are assumed for each system.

The purpose of the study is to present results a good operator may expect under each system. It is intended that the results will provide guidance to researchers, extension personnel, and producers about the economic merits of the STAR system relative to an Annual program. It will add an economic dimension to the growing body of literature on accelerated lambing systems.

Review of Literature

Much of the research on the economics of sheep production has dealt with comparisons of management practices, flock size, and levels of labor and capital intensity (Harrison, 1986; and Epplin, Doye, and Ward, 1983). Other research explores not only existing systems but also alternative management systems used for sheep enterprises (Gee and Madsen, 1982). These studies generally measure results in terms of return to various factors on a total farm or per ewe basis. Research done on accelerated lambing systems has

generally been limited to the husbandry aspects of the system rather than the economics of the concept.

Hogue and Hall (1971) published a series of sheep budgets including some involving accelerated lambing. Work was done by Harrison (1980) that described some of the techniques used to improve lambing rates. This work also included budgets for different levels of management for a given size ewe flock.

More recently, work at Cornell by Hogue and Magee (19844) has described a combination of management practices they have called the STAR accelerated lambing system. It is a package of practices designed to improve the efficiency and profitability of a sheep enterprise. The program will allow a ewe to lamb a maximum of five times in three years instead of the traditional annual event. This major feature, plus an increase in the incidence of multiple births, can substantially increase the number of lambs produced per ewe per year.

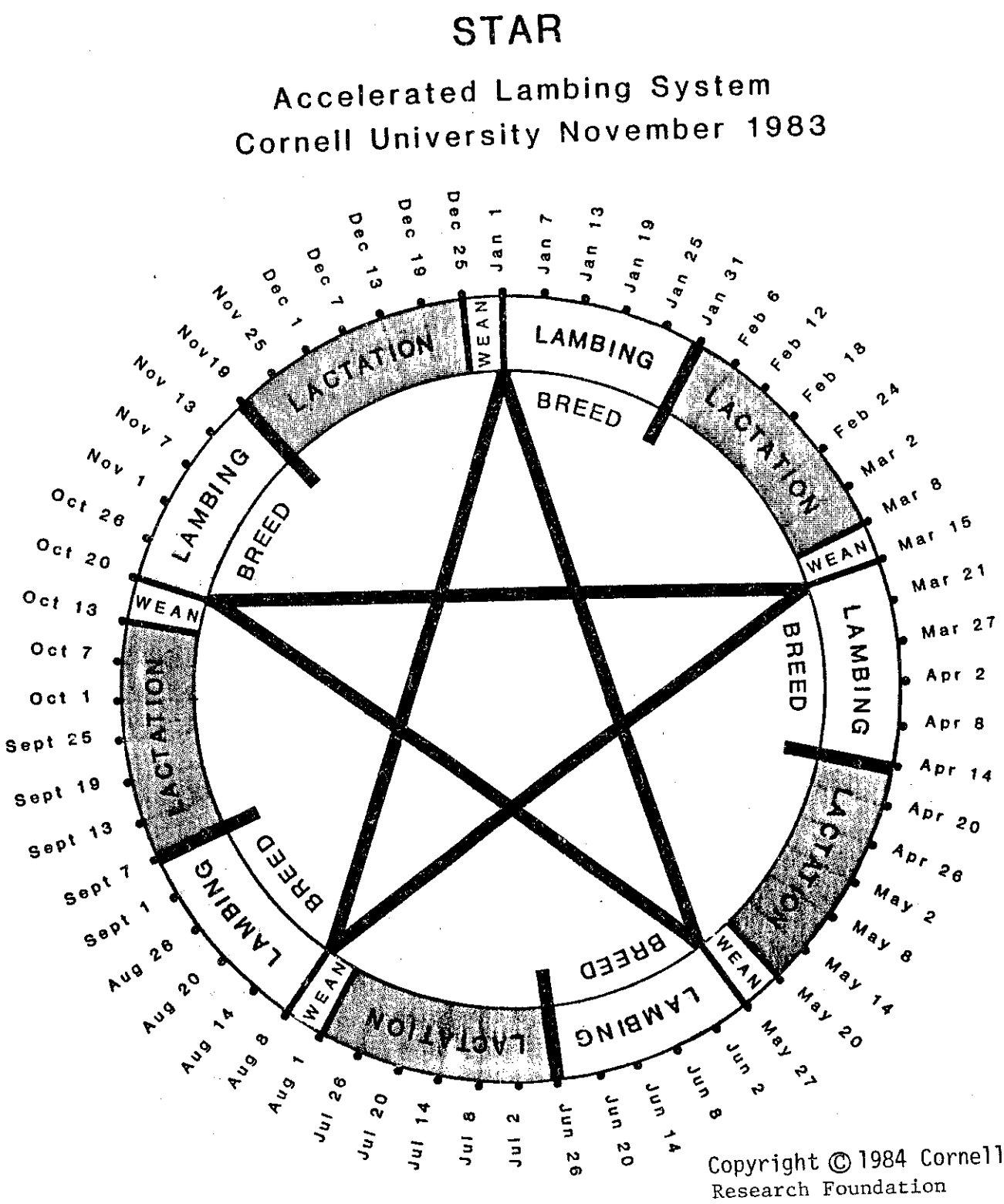
The STAR System

The STAR system of lamb production is based on the 146 day gestation period of a ewe. One-half pregnancy equals 73 days which is exactly one-fifth of a year. By dividing the calendar into five 73 day periods, the flock can be managed in a way that allows a significant increase in the efficiency of the use of farm resources. Each of the five periods begins with a 30 day lambing and breeding period (Figure 1). While the group of open ewes is exposed to a ram, another group of ewes is lambing. During the last week of the period, lambs born earlier in the period are weaned and moved to the feeder operation. The next group of ewes to lamb is moved to the lambing barn, open ewes are selected for breeding and another management period begins.

These characteristics of the STAR system are described in more detail in Hogue and Magee (1984) and Magee (1984). They found that, by emphasizing aseasonal breeding tendencies, the system matches sheep biology to the calendar year in a way that improves production efficiency and resource use.

Since facility and other resource uses are spread throughout the year and used more frequently, more ewes and lambs can be handled in the same space. The resulting increased use of fixed resources should improve production efficiency and reduce costs per unit. It should also introduce more stability and uniformity to the production and marketing of lambs. At the same time, the producer's cash flow throughout the year would be more regular than with traditional annual lambing programs. Because of the larger flock size and the need to follow a well defined schedule, success with the STAR system requires more intensive management.

Figure 1


STAR
Accelerated Lambing System
Cornell University November 1983
LAMBING
BREED
LACTATION
WEAN
Jan 1
Jan 7
Jan 13
Jan 19
Jan 25
Jan 31
Feb 6
Feb 12
Feb 18
Feb 24
Mar 2
Mar 8
Mar 15
Mar 21
Mar 27
Apr 2
Apr 8
Apr 14
Apr 20
Apr 26
May 2
May 8
May 14
May 20
May 27
Jun 2
Jun 8
Jun 14
Jun 20
Jun 26
Jul 2
Jul 8
Jul 14
Jul 20
Jul 26
Aug 1
Aug 8
Aug 14
Aug 20
Aug 26
Sept 1
Sept 7
Sept 13
Sept 19
Sept 25
Oct 1
Oct 7
Oct 13
Oct 20
Oct 26
Nov 1
Nov 7
Nov 13
Nov 19
Nov 25
Dec 1
Dec 7
Dec 13
Dec 19
Dec 25
Copyright © 1984 Cornell
Research Foundation

Procedure

The study develops economic engineering budgets to examine the economics of the STAR system used on a farm representative of those commonly found in many parts of the Northeast. The intent is to utilize modified existing buildings and land more suited to forage than cash crop production. The representative ewe flock and lamb feeding operation requires a part-time operator and is small enough to be combined with other income producing activities and the use of family labor.

The STAR system is budgeted for three production levels expressed in terms of lambs raised per ewe per year. A budget for the Annual lambing system is also constructed, using the same resources, for comparison purposes.

Two situations for each of these budgets are developed. In one case, the operator owns field equipment to harvest his own hay; in the other situation the operator owns no field equipment and uses a share arrangement to harvest his forage and clean the barns.

Results of the budgets for the two situations are compared on the basis of the farm net cash income and several measures of profitability. Since the farm activities are limited to a ewe flock and lamb feeding operation, the "whole farm" method is used to calculate the cost of producing a pound of lamb and compared for each budget. In addition, a sensitivity analysis is made to show the effects of changes in market lamb and feed prices on the study results.

Representative Farm and the Two Lamb Production Systems

The representative farm has a former two story dairy barn which has been remodeled to provide lambing facilities for a 150 ewe flock under the Annual System and adequate space for the lamb feeding activities. Storage space for hay and equipment is provided on the second floor of the dairy barn and in other farm buildings as appropriate. The land resource includes 150 acres with 70 acres of tillable land and 50 acres of fenced permanent pasture. The hay crop averages 2.3 tons of hay per acre and an estimated 2.0 tons of hay equivalent is produced per acre of pasture (Crop Reporting Board, New York Agricultural Statistics). The location and soil resources are suited more to hay and pasture production than to more intensive types of agriculture.

The field equipment complement is not new, but is in serviceable condition for the anticipated hay crop production. Barn equipment includes a grain bin for feed and adequate feeders and waterers for the ewe flock and market lambs. Permanent and portable fence is used in the pasture and grazing program for the ewe flock. Labor and management is provided by the operator and his/her family with hired help as needed for hay harvest.

These resources are adequate to meet the needs of a 150 ewe flock using the Annual lambing system with a lamb feeding operation. The land resource is more than adequate to raise all forage for the ewe flock sizes assumed for either the Annual or the STAR system. In existing operations, intensifying to the STAR system may result in a need to purchase hay or to improve or purchase land to meet forage needs. In this study, excess forage, expected with the annual system, is sold as hay. The general practice is to purchase rams for breeding and to raise replacement ewes along with the market lambs. Cull ewes and rams are sold.

Because of the improved efficiency of resource use with the STAR system, the same buildings, with some additional remodeling, houses a 300 ewe flock and the resulting lambs. The operation involves raising all lambs for market, retaining only those ewes needed for replacements. The larger ewe flock consumes most of the hay produced with a small quantity available for sale.

Capital investments were determined by consulting with extension agents and animal scientists (Table 1). The value of the residence is omitted from the analysis because it is not part of the business production unit.[1] The higher investment for the fences and buildings for the STAR system reflects more fencing and more extensive remodeling. With adequate cropland to produce enough hay for the larger STAR ewe flock, the field equipment investment is the same for both systems. Barn equipment and movable fence requirements are greater for the STAR system because of the larger flock. Ewes for both systems are valued at $100 each. Rams are valued somewhat higher and fewer are needed for the STAR system (Hogue and Magee, 1984).

TABLE 1. Estimated Capital Investments for the STAR and Annual Lambing Systems, New York, 1986

FARM DESCRIPTION		Value	Investment STAR	Investment Annual
		$	$	$
Bldgs -	Residence	35,000	0	0
	Remodelled barns		20,000	15,000
Fences -	High tensile		3,000	1,500
Land -	70 ac cropland @ $450	31,500		
	50 ac perm pasture @ $250	12,500		
	30 ac woods, etc.	3,000		
	150 ac Total		47,000	47,000
Eqpt -	Field:		20,000	20,000
	2 Tractors (1 w/ldr)			
	Mower-conditioner			
	Rake, baler, elevator			
	2 bale wagons			
	Rotary mower, spreader			
	Barn:		2,000	1,200
	Grain bin			
	Hay & grain feeders			
	Movable fence		1,000	650
Lvstock-	Ewes - @ 100 ea			
	Rams - STAR @ $250; Annual @ $200 ea			
	Total		30,750	15,800
	TOTAL INVESTMENT		123,750	101,150

[1]The omission of the personal residence, while not common in farm management analysis, has no effect on the systems comparison but does improve profitability compared to an analysis which includes the residence.

Estimates for the annual costs for the capital investments are in Table 2. Depreciation is based on a 20 year life for the buildings and a 10 year life for the equipment. Straight line depreciation is used with no salvage value. Depreciation of the breeding flock is covered by the cost of raising replacement ewes. A real interest rate of five percent reflects capital costs. Repairs, fuel, taxes, and insurance are estimates based on research results from Snyder (1984) and current price series from the New York Crop and Livestock Report (New York Agricultural Statistics Service, current issues).

TABLE 2. Estimated Annual Costs for Capital Items for the STAR and Annual Lambing Systems, New York, 1986

STAR System - 300 ewes :

Item	Land	Fen/Bldg*	Equip	Lvstock	Total
	$	$	$	$	$
Invstmt	47,000	23,000	23,000	30,750	123,750
Depr	0	1,150	2,300	0	3,450
Int @ 5%	2,350	1,150	1,150	1,538	6,188
Rep/Fuel	0	460	2,300	0	2,760
Tax @2.5%	1,175	575	0	0	1,750
Ins @0.5%	0	115	115	154	384
TOTAL	3,525	3,450	5,865	1,691	14,531

Annual System - 150 ewes :

Item	Land	Fen/Bldg*	Equip	Lvstock	Total
	$	$	$	$	$
Invstmt	47,000	16,500	21,850	15,800	101,150
Depr	0	825	2,185	0	3,010
Int @ 5%	2,350	825	1,093	790	5,058
Rep/Fuel	0	330	2,185	0	2,515
Tax @2.5%	1,175	413	0	0	1,588
Ins @0.5%	0	83	109	79	271
TOTAL	3,525	2,475	5,572	869	12,441

* Excludes residence

** Repairs and fuel are variable expenses; all other costs are fixed.

Lambing information for the three production levels for the STAR system and the Annual system is based on the recent experience of Hogue and Magee (1984) at Cornell (Table 3). As indicated in the description of Figure 1, each ewe has the potential of lambing a maximum of five times in a three year cycle. This would be a maximum of 1.67 times per year. However, every ewe in the STAR system will not reach this potential and every ewe in the Annual System will not lamb each year. The lambing frequencies of 1.4 and 0.95 per year for the two systems respectively are considered reasonable by Hogue and Magee (1984) for good management.

The three levels of production chosen for the STAR system are related to the productivity of the ewe flock as well as the lambing frequency. Dorset ewes and rams are used for the two lower production levels. Dorset sheep have been found to be responsive to aseasonal breeding and produce excellent quality carcasses with an annual lamb crop of over 200 percent under the STAR system. Finn sheep are even more prolific and produce annual lamb crops commonly over 400 percent (Hogue and Magee, 1984). However, because of somewhat lower Finn carcass quality, Finn-Dorset ewes and Dorset rams are used for the highest STAR production level to produce lamb carcasses of acceptable quality. With these assumptions, the ewe flock under the STAR system produces about two, two and one-half, and three lambs per ewe per year respectively for the three production levels (Table 3).

TABLE 3. Lambing Information for the STAR and Annual Lambing Systems

ITEM	STAR - 300 Ewes			Annual 150
	Low	Med	High	
Lambs rsd/ewe/yr	1.73	2.22	2.72	1.34
Lambings/ewe/yr	1.4	1.4	1.4	0.95
Lambs/ewe/lambing	1.4	1.8	2.2	1.6
Lambs/ewe/yr	1.96	2.52	3.08	1.52
Lambs weaned*:				
Per ewe/yr	1.76	2.27	2.77	1.37
Total/yr	529	680	832	205
Lambs raised*:				
Per ewe/yr	1.73	2.22	2.72	1.34
Total/yr	519	667	815	201
Repl ewes rsd/yr	60	60	60	30
Cull ewes sold	54	54	54	27
Ewe deaths @ 2%	6	6	6	3
Lambs sold/yr	459	607	755	171

* Ten percent loss prior to weaning; two percent loss after weaning.

Under the Annual system, a multiple birth rate of 1.6 lambs per ewe per lambing is used for Dorset ewes (Hogue and Magee, 1984). With a 95 percent annual lambing frequency for the ewe flock, the Annual system will produce about one and one-half lambs per ewe per year.

Lamb losses from birth to weaning average about 10 percent for both systems. Another two percent of the lambs born are lost after weaning. Twenty percent of the ewes are replaced each year because of culling and a two percent death loss. Both systems raise their own replacement ewes. One ram is replaced by purchase each year for each system.

Research with the STAR system has been conducted under natural light and without hormones (Magee, 1984). Table 3 outlines realistic levels of production under farm conditions for both systems for use in the budgets that follow.

Neither system, at the assumed size, requires a full-time operator. Other activities must be used to provide full or additional part-time employment for the operator. The suggested flock sizes depend on family involvement as well as part-time local hired labor for hay harvest.

Labor estimates for the sheep enterprises, including the lamb feeding operations, are based on experience with the Cornell flock and adjusted (Magee, 1984) for commercial production (Table 4). Labor requirements for hay enterprises have averaged about seven hours per acre over a recent five year period for dairy farm operations (Snyder, 1984a). Therefore, a labor requirement of seven hours per acre is used for hay production for these sheep enterprises.

TABLE 4. Annual Labor Required for the STAR and Annual Lambing Systems

ITEM	STAR – 300 Ewes			Annual 150
	Low	Med	High	
Lambs rsd/ewe/yr	1.73	2.22	2.72	1.34
Labor for Sheep:				
Operator, hr	600	700	800	310
Family, hr	300	350	475	100
Hired, hr	0	0	0	0
Hours/ewe	3.0	3.5	4.3	2.7
Hours/lamb rsd	1.7	1.6	1.6	2.0
Labor for Crops:				
Operator, hr	100	100	100	100
Family, hr	170	170	170	170
Hired, hr	220	220	220	220

Under both systems, the 70 acres of cropland are maintained for hay production. With a four year life, one-fourth of the hay acreage is reseeded each year. One or two cuttings are harvested in the seeding year. At least two cuttings per year are harvested from established seedings. Aftermath growth, if any, is used for pasture. Labor, outside the family, is hired to assure the timely harvest of the hay crop. Labor for the sheep activities is provided by the operator and family.

Both the STAR and the Annual systems make maximum use of available pasture and cropland to meet the forage needs of the ewe flock. For farms likely to be considered for lamb production, a pasture season from about May 10 through November is reasonable for New York State. Other forage needs are met by the hay crop grown on the farm.

Pregnant ewes are confined for a 70 day prelambing-through-weaning period. During this period, grain is fed, in addition to hay, to maintain body condition and lactating ability. Ewes in each system and for each productivity level require different amounts of grain because of differing lambing rates and frequencies. Both quantity and cost of grain required for the ewe flock each year are calculated in Table 5.

TABLE 5. Annual Grain Requirements for the Breeding Flock for the STAR and Annual Lambing Systems*

ITEM	STAR - 300 Ewes			Annual 150
	Low	Med	High	
Lambs rsd/ewe/yr	1.73	2.22	2.72	1.34
Days fed/lambing**	70	70	70	70
Lambings/yr	1.40	1.40	1.40	0.95
Days fed/ewe, avg	98	98	98	67
Grain fed/day, lb	1.4	1.8	2.2	1.6
Totl grain/ewe, lb	137	176	216	106
Ewes, no	300	300	300	150
Total feed, tons	20.6	26.5	32.3	8.0
Total cost, $	3,704	4,763	5,821	1,436

* Data are based on experience and judgment of Cornell researchers. See Hogue and Magee (1984). Feed cost of $180 per ton is based on current volume purchases adjusted upward because of current abnormally low ingredient prices.

** Prelambing-through-weaning.

Pasture and hay produced on the farm are consumed by the breeding flock only. Table 6 outlines the hay and pasture requirements for the two lambing systems for various stages of the production cycle during the year.

There are three distinct feeding periods during the production cycle. Availability of pasture for the breeding flock affects the length of time hay is fed during the nonlactating part of the cycle. During the prelambing-through-weaning period, grain and about five pounds of hay per day are fed to meet body requirements of the pregnant or lactating ewe.

TABLE 6. Annual Hay and Pasture Requirements for the Breeding Flock for the STAR and Annual Lambing Systems*

ITEM	System	
	STAR	Annual
Prelambing-thru-weaning		
Days fed/ewe/lambing	70	70
Lambings/ewe/yr	1.40	0.95
Days fed /ewe, avg	98	67
Hay fed/day, lb	5	5
Ewes and rams, no	303	154
Total hay, tons	74	26
Pasture		
Days pastured/ewe, avg	172	200
Total hay, tons	0	0
Non-lactating, Not-pastured		
Days fed/ewe, avg	95	98
Hay fed/day, lb	3.9	3.9
Ewes and rams, no	303	154
Total hay, tons	56	29
Total hay fed/yr, tons	130	55

* Data are based on experience and judgment of Cornell researchers. See Hogue and Magee (1984).

The pasture season is about 200 days in length - from May 10 through November. Each ewe in the Annual system utilizes the full season because lambings occur from winter to early spring. However, the STAR system involves aseasonal lambings. About 40 percent of the ewes lamb and lactate during the seven month pasture season (Magee, 1984). Since they are confined during that period, they are fed hay and grain instead of pasture. This reduces the average pasture season for STAR ewes to 172 days (Table 6).

During the period when ewes are neither pastured nor lactating, they require an average of 3.9 pounds of hay to maintain body condition during pregnancy. No grain is fed during this period or the pasture season.

Market lambs are fed in confinement. Lambs are fed and managed the same for either lambing system. Young lambs are creep fed until weaning at an average of 45 days of age. Weaning weights average about 40 pounds. A complete ration is then fed for 105 days. This feeding program produces a weight gain of 70 pounds for a market weight of 110 pounds per lamb at 150 days of age (Table 7).

TABLE 7. Annual Feed Requirements for Market Lambs for the STAR and Annual Lambing Systems*

ITEM	Both Systems
Creep feed	
Days on feed	45
Total feed	28 lb/lamb weaned
Complete ration	
Days on feed	105
Weight gain	70 lb/lamb, avg
Feed/lb of gain	4.0 lb, avg
Total feed	280 lb/lamb rsd
Cost of both feeds	180 $/ton
Cost per lamb	
Creep feed	$2.52
Complete ration	$25.20

* Data are based on experience and judgment of Cornell researchers. See Hogue and Magee (1984).

During the feeding period, lambs raised under both systems consume 28 pounds of creep feed and 280 pounds of complete ration per lamb. At a cost of $180 per ton for both feeds, total feed costs are $27.72 per lamb.

Success with the lamb feeding program is achieved only with the use of a well balanced complete ration designed for good feed efficiency. With proper management, lambs will gain 70 pounds in 105 days. Average daily gains of 0.7 pound and feed conversions of four pounds of feed per pound of gain are within reason (Magee, 1984).

Lambing System Budgets and Analysis

In developing a budget, any number of circumstances and assumptions can affect the results. This analysis of the STAR lambing system assumes an above average level of management ability on the part of the operator. Only good management practices and reasonable estimates realistically illustrate the relative potential of the STAR lambing system. The same quality of management is used for the Annual system for the sake of a fair comparison.

The ability to follow timely and appropriate practices is necessary for the profitable production of market lambs for sale. Just as good feeding practices are critical to cost control, so are good marketing practices critical to good lamb prices. Both are essential to any profitable operation. Since lamb sales are the major source of income, developing good, dependable markets is required to obtain attractive prices. The lamb producer must produce a timely, quality product that is in demand at each step of the marketing chain.

The following budgets and analyses are developed for two situations related to the harvesting of the 70 acres of hay crops. Situation 1, represented by Tables 8 through 12, assumes the operator owns the field equipment indicated in Table 1. He harvests the hay crop and sells the excess not needed for the ewe flock.

Situation 2, represented by Tables 13 through 17, differs from Situation 1 in that no field equipment is owned to harvest hay or spread manure. Manure removal is accomplished by custom hire. Hay is harvested on shares with a neighbor having the necessary equipment. This will result in the need for some purchased hay for the STAR system.

The budgets reflect the effects of these differing circumstances. The analyses that follow each budget measure the farm cash position and profitability for an annual period. An analysis is also made of the cash costs as well as the total costs of producing lamb for market.

Situation 1 - Field Equipment Owned

As indicated earlier, land resources are used to produce forage in the form of pasture and hay crops. Table 8 summarizes the production and use of these crops on the representative farm for the ewe flocks for the two lambing systems when the field equipment is owned. Under the STAR system, only a small quantity of excess hay is available for sale and the available pasture meets the requirements for the ewe flock. With the same acreage, the smaller flock for the Annual system releases 100 tons of hay to be sold and 20 acres of excess pasture to be rented out. In both systems, additional pasture may be available from aftermath grazing of hay fields, if needed.

TABLE 8. Annual Land Use to Meet Forage Requirements for the STAR and Annual Lambing Systems When Field Equipment is Owned

ITEM	Hay Equivalent	
	Available	Required
	tons	
Cropland: 70 ac hay		
Prod: 2.3 t/a -4% stg loss	155	
STAR System:		
Available from farm		155
Total Required (T6)		130 *
Available to sell		24
Annual System:		
Available from farm		155
Total required (T6)		55 *
Available to sell		100
Pasture - 50 acres		
Avg hay equiv - 2.0 t/a	100	
STAR 172 days/ewe @ 3.9 lb HE/day		100 *
Annual 200 days/ewe @ 3.9 lb HE/day		59 *
20 acres excess pasture to rent		41
Produced		100

* Forage requirements allow for feeding losses

Most of the labor to harvest the hay crop is provided by the operator and his family (Table 4); however, 220 hours of hired labor is used to help harvest the hay crop in a timely manner. This part-time labor costs an average of $4 per hour (Table 9) including employer nonwage costs according

York farm records (Snyder, 1984a). Labor to clip pastures and manage movable pasture fencing is included with labor to care for the ewe flock during the pasture season.

TABLE 9. Annual Operating Costs for Hay and Pasture for the STAR and Annual Lambing Systems When Field Eqpt is Owned*

ITEM	Unit	Hay - 70 ac Average Rate/unit	Hay - 70 ac Both Systems	Pasture - 50 ac Average Rate/unit	Pasture - 50 ac Both Systems	Total Crop Expenses
		$	$	$	$	$
Labor	hour	4.00	880		0	880
Seeding	acre	25	1,750	5	250	2,000
Fertilize	acre	20	1,400	20	1,000	2,400
Lime	acre	10	700	10	500	1,200
Chemicals	acre	3	210		0	210
TOTAL						6,690

* Adapted from Snyder (1984, 1984a). Seeding cost based on four year life.

The other items in Table 9 show the average annual costs per acre to maintain the assumed yields for the hay and pasture crops under each lambing system. The crops are managed the same under each system with adequate fertilization and pest control programs. The excess 20 acres of pasture in the Annual system (Table 8) are rented out for heifer pasture at $12 per acre.

Budgets - Lamb sales are the most important receipt in the budgets (Table 10). An average lamb price of $0.70 per pound, live weight, is used. Lamb prices averaged $0.67 per pound in New York for 1985 and, generally, reported prices are stronger in 1986 (New York Agricultural Statistics Service, 1986). Sales of lamb from the Cornell flock have been above $0.70 per pound in 1986 (Magee, 1986). While historically high, $0.70 per pound is reasonable assuming continued market strength and a good marketing program.

Other sources of income include cull ewes, wool, government wool incentive receipts, and hay crop sales. The Annual system also has some income from the rental of excess pasture. Quantities and prices used in estimating returns are based on experience with the Cornell ewe flock. Animal numbers are from Table 3. The hay price and pasture rental price are adapted from reports from the New York Agricultural Statistics Service (1986) and a recent study of land rental rates in New York (Snyder, 1985).

The major expense item is purchased feed. Feed costs, in Table 10, are based on quantities, prices, and numbers of lambs calculated in Tables 3, 5, and 7. Because the crop and pasture acreages are the same for both systems, crop production costs are a larger portion of total costs for the Annual system with fewer ewes and lambs. These extra costs, however, are offset by the income from the sale of excess hay and rented pasture. Marketing charges and miscellaneous cash costs are estimated from current experience with the Cornell flock (Magee, 1984).

TABLE 10. Estimated Annual Budgets for the STAR and Annual Lambing Systems When Field Equipment is Owned

ITEM	STAR - 300 Ewes			Annual 150
	Low	Med	High	
Lambs rsd/ewe/yr	1.73	2.22	2.72	1.34
Receipts (no. from T3):	$	$	$	$
Lambs	35,313	46,723	58,133	13,174
Cull ewes	1,080	1,080	1,080	540
Wool & incentive				
Ewes	4,080	4,080	4,080	2,040
Lambs	1,763	2,267	2,771	684
Crops - hay	1,694	1,694	1,694	6,967
Pasture rent	0	0	0	246
Total cash receipts	43,930	55,844	67,757	23,651
Expenses - cash:				
Feed- ewe-grain (T5)	3,704	4,763	5,821	1,436
Lamb-creep (T5,7)	1,334	1,715	2,096	517
ration (T3,7)	13,069	16,803	20,537	5,068
Total feed	18,107	23,281	28,454	7,021
Ram - net	225	225	225	175
Crop expenses (T9)	6,690	6,690	6,690	6,690
Repairs/fuel (T2)	2,760	2,760	2,760	2,515
Taxes, insurance (T2)	2,134	2,134	2,134	1,858
Mktg chg	917	1,214	1,510	342
Misc exp*	2,334	3,001	3,667	905
Total cash expenses	33,167	39,303	45,440	19,506
Expenses- non-cash:				
Depreciation (T2)	3,450	3,450	3,450	3,010
Interest on capital (T2)	6,188	6,188	6,188	5,058
Operator value	4,900	5,600	6,300	2,870
Unpaid familly value	1,880	2,080	2,580	1,080
Total non-cash exp	16,418	17,318	18,518	12,018
Total all expenses	49,584	56,621	63,958	31,524

* Includes utilities, dip, vet, medicine, drench, interest on operating capital, etc.

Non-cash costs in the budgets include a depreciation charge from Table 2. The cost of capital is recognized by a real interest rate of five percent on the average investment in farm assets. A value of $7 per hour is used as a charge for the part-time efforts of the operator. Family labor is valued the same as hired labor at $4 per hour (Snyder, 1984).

Analysis - The results of the budgets for Situation 1 are presented in Tables 11 and 12. They include the calculation of several factors to enable a comparison between the three STAR productivity levels and the Annual system.

The cash analysis (Table 11) measures the net cash income from the farm activities in total and for each ewe. The net cash income provides an estimate of the effect the various assumptions have on the amount of cash available for purposes other than operating expenses. This income can be combined with non-farm income to meet needs for family living expenses, debt service, capital purchases, and savings. Net cash income is lower for the Annual system both in total for the farm and also per ewe. However, on the basis of lambs sold, net cash income per lamb is slightly below the Annual system for the "low" STAR budget but shows some improvement as ewe productivity improves in the other STAR budgets. This would indicate the higher farm net cash incomes for the STAR system budgets are largely the result of the increased volume of lambs sold.

The cash analysis also determines the cash cost for each lamb sold and for each pound of lamb sold. The cash cost per pound of lamb provides a break-even measure of the lamb price necessary to cover the cash costs of producing lamb. It does not include a cost for the operator's efforts, family labor or a capital charge since they are not cash expenses. Increasing productivity under the STAR system results in decreasing costs per pound of lamb. With the same crop program for the Annual system and the smaller ewe flock, hay sales and crop expenses comprise a larger portion of cash receipts and expenses than for the STAR system. This lowers the cash cost per pound of lamb to a level similar to the STAR system.

It is important to note that the cash cost per unit sold falls within a narrow range for all four budgets. This would indicate that the increasing farm net cash income for the STAR budgets results from the larger, more productive ewe flock enabling the effective spreading of fixed costs over a greater number of lambs sold. This is also shown in Table 12 where a greater range in total cost per pound of lamb sold results when fixed costs are included in the analysis.

TABLE 11. Cash Analysis for the STAR and Annual Lambing Systems When Field Equipment is Owned

ITEM	STAR – 300 Ewes			Annual 150
	Low	Med	High	
Lambs rsd/ewe/yr	1.73	2.22	2.72	1.34
Farm Net Cash Income:	$	$	$	$
Total cash receipts	43,930	55,844	67,757	23,651
Total cash expenses	33,167	39,303	45,440	19,506
Farm Net Cash Income*	10,763	16,540	22,317	4,145
Ewes, no.	300	300	300	150
Lambs sold, no.	459	607	755	171
Farm Net Cash Income:				
Per ewe	35.88	55.13	74.39	27.63
Per lamb sold	23.47	27.26	29.56	24.22
Cash Costs per Unit Produced/Sold:				
Total cash expenses	33,167	39,303	45,440	19,506
less: Marketing charge	917	1,214	1,510	342
Non-lamb receipts	6,854	6,854	6,854	9,793
Prod Costs for Lambs Rsd	25,396	31,236	37,077	9,371
Lambs raised, no.	519	667	815	201
less: repl ewes, no.	60	60	60	30
Lambs sold, no.	459	607	755	171
Prod costs per lamb sold	55.38	51.48	49.11	54.77
plus:Mktg chg/lamb sold	2.00	2.00	2.00	2.00
Cash cost/ lamb sold	57.38	53.48	51.11	56.77
Cash Cost/lb of lamb sold	0.52	0.49	0.46	0.52

* Available for family withdrawals, debt service, capital purchases and capital retention.

TABLE 12. Profitability Analysis, including Fixed Costs, for the STAR and Annual Lambing Systems When Field Equipment is Owned

ITEM	STAR - 300 Ewes			Annual 150
	Low	Med	High	
Lambs rsd/ewe/yr	1.73	2.22	2.72	1.34
Farm Returns:	$	$	$	$
Total receipts	43,930	55,844	67,757	23,651
Total expenses	49,584	56,621	63,958	31,524
Farm Profit (Loss)	(5,654)	(777)	3,799	(7,873)
Return / Dollar of Cost	0.89	0.99	1.06	0.75
Returns To Operator:				
Farm profit (loss)	(5,654)	(777)	3,799	(7,873)
plus: Operator value	4,900	5,600	6,300	2,870
Return To Operator, total	(754)	4,823	10,099	(5,003)
Operator labor, hr/yr	700	800	900	410
Return To Operator, / hr	(1.08)	6.03	11.22	(12.20)
Returns On Investment:				
Farm profit (loss)	(5,654)	(777)	3,799	(7,873)
plus: Interest on cap	6,188	6,188	6,188	5,058
Return On Investment	533	5,410	9,987	(2,815)
Average investment	123,750	123,750	123,750	101,150
Rate Of Return	0.4%	4.4%	8.1%	-2.8%
Returns Per Production Unit:				
Farm profit (loss)	(5,654)	(777)	3,799	(7,873)
Ewes, no.	300	300	300	150
Profit per Ewe	(18.85)	(2.59)	12.66	(52.49)
Total Cost Per Unit Produced/Sold:				
Total expenses	49,584	56,621	63,958	31,524
less: Marketing charge	917	1,214	1,510	342
Non-lamb receipts	6,854	6,854	6,854	9,793
Prod Cost for Lambs Rsd	41,814	48,554	55,594	21,389
Lambs raised, no.	519	667	815	201
less: repl ewes, no.	60	60	60	30
Lambs sold, no.	459	607	755	171
Prod costs / lamb sold	91.17	80.02	73.64	125.01
plus: Mktg chg/lamb	2.00	2.00	2.00	2.00
Total cost/ lamb sold	93.17	82.02	75.64	127.01
Tot1 Cost/lb of Lamb Sold	0.85	0.75	0.69	1.15

The profitability analysis (Table 12) includes measures of returns to the total farm activities, the operator, the capital invested and for each ewe as the basic production unit. When all costs of production are considered only the budget for the highest STAR level of production shows a positive return.

The return to the operator is a measure of the financial reward earned by the operator for his labor and management from the enterprise for the year. The value of the operator's efforts, included as a non-cash expense to determine the farm returns, is added to the farm profit or loss to determine a residual which is the return to the operator. The Annual system and the "low" STAR budget show negative returns to the operator. Operator returns are positive for the "medium" and "high" STAR budgets and increase as productivity improves and volume increases.

In calculating return on invested capital, the interest charged for the use of capital is added to the farm profit or loss. The result is the return on the investment generated by the business for the year. Rates of return for these budgets range from 0.4 to 8.1 percent for the STAR system and are -2.8 percent for the Annual system.

Returns per ewe are also shown in Table 12. Under the Annual system, a loss of $52 per ewe is shown. Returns for the STAR budgets improve from $-19 to $13 as ewe productivity increases.

In estimating market lamb cost of production, marketing costs and the value of all non-lamb production are subtracted from the total farm expenses. This assumes the non-lamb items were produced at cost. The result is the total production cost of all lambs raised. No depreciation was charged for the breeding flock since that cost is represented by including the cost of raising replacement ewes. Total production costs per lamb sold includes the opportunity cost of all inputs provided by the operator. Both the total cost per lamb and per pound of lamb sold decrease with increasing ewe productivity. Only the highest STAR productivity level showed lamb costs below the market price of $0.70 per pound. The market price would have to equal the total cost for the producer to break even; that is, to meet all costs including a return for the operator's labor and management and a return on invested capital.

The analysis, thus far, has included an interest charge on all capital at a real rate of five percent. Any level of debt at a higher rate would have an adverse effect on the analysis factors because of the increased cost. Table 12a provides data to illustrate the effect of two levels of debt on several analysis factors. The data result from an assumed 10 percent debt interest rate and a five percent equity interest rate.

TABLE 12a. Effect of Debt on Selected Analysis Factors for the STAR and Annual Lambing Systems When Field Equipment is Owned

ITEM / Debt Level	STAR - 300 Ewes			Annual 150
	Low	Med	High	
Lambs rsd/ewe/yr	1.73	2.22	2.72	1.34
Total Capital	$123,750	$123,750	$123,750	$101,150
Farm Profit (Loss), $				
0 % Debt	(5,654)	(777)	3,799	(7,873)
25	(7,201)	(2,324)	2,253	(9,137)
50	(8,748)	(3,871)	706	(10,402)
Returns To Operator, $				
0 % Debt	(754)	4,823	10,099	(5,003)
25	(2,301)	3,276	8,553	(6,267)
50	(3,848)	1,729	7,006	(7,532)
Rate Of Return On Investment, %				
0 % Debt	0.4	4.4	8.1	-2.8
25	-2.8	2.5	7.4	-7.0
50	-9.1	-1.3	6.1	-15.6
Total Cost per Pound of Lamb Sold, $				
0 % Debt	0.85	0.75	0.69	1.15
25	0.88	0.77	0.71	1.22
50	0.91	0.79	0.72	1.29

In the event of a strong demand for ewes that respond well to the STAR system, the operator may have an alternative other than to sell all his lambs as market lambs. Ewe lambs, suitable for breeding, in excess of his own replacement needs, could be sold to other producers. With ewes valued at $100 each (Table 1), ewe lambs sold for replacements could net the producer more than if sold as market lambs for $77 each as indicated in Table 10.

Several analysis factors for the two lambing systems are shown graphically in Figures 2 through 5. The first graph shows the relationship between the four budgets for the net cash income for the farm activities for the year. The other three graphs relate the returns to the operator, rate of return on the capital investment, and the total cost to produce a pound of lamb under the assumptions used.

Figure 2

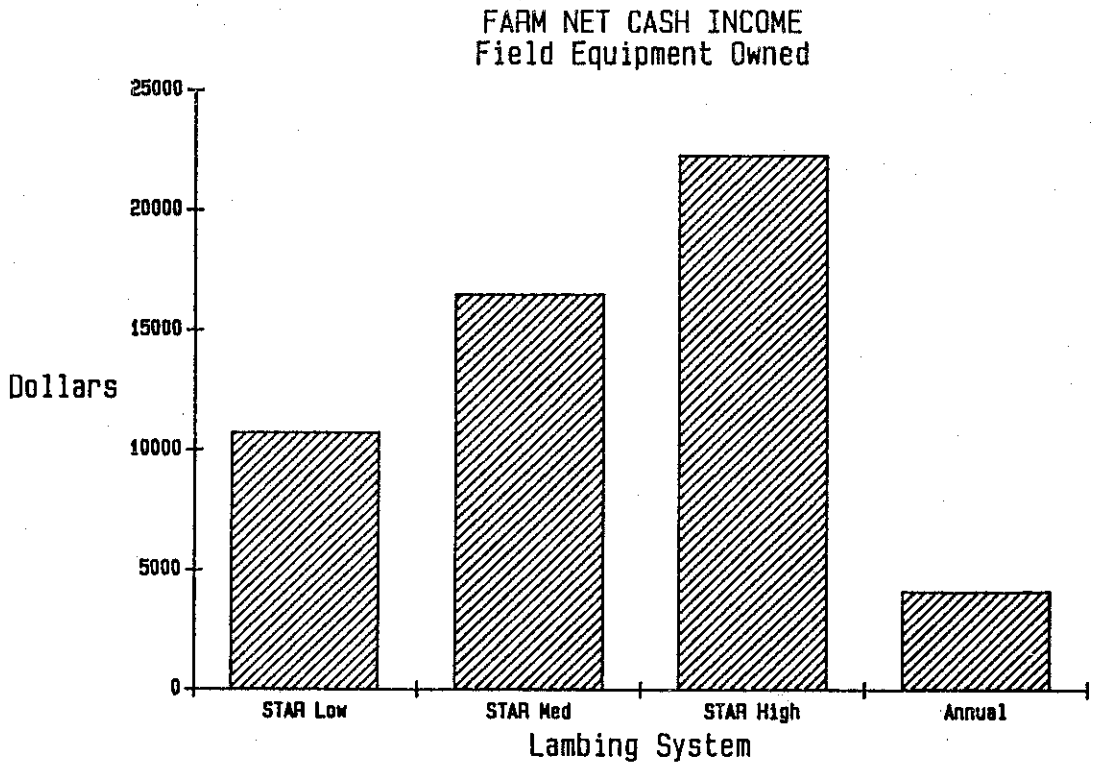


Figure 3

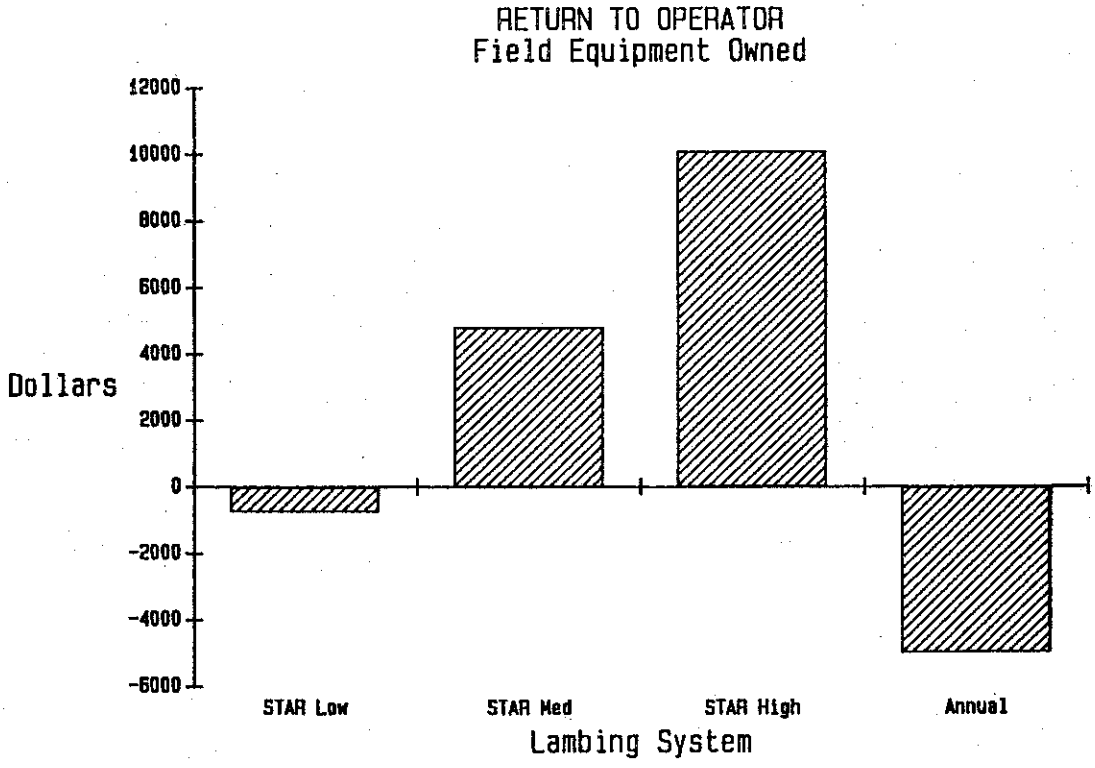


Figure 3

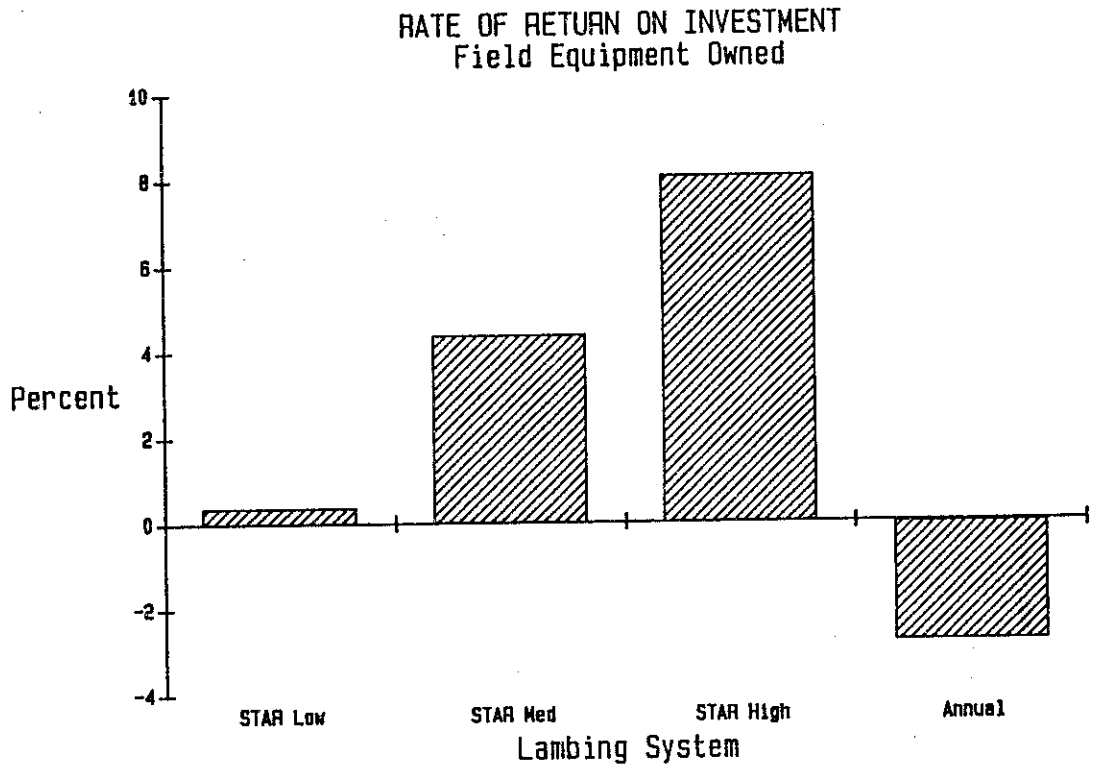
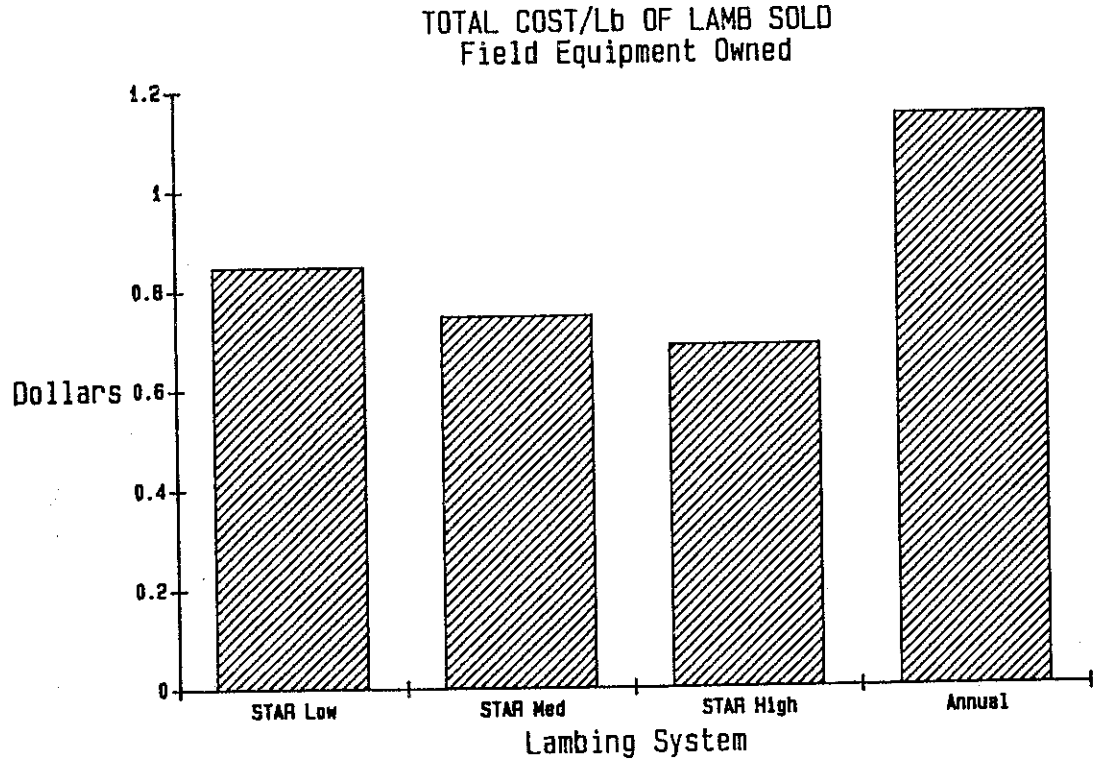


Figure 4



Situation 2 - Field Equipment Not Owned

Budgets - The budgets presented in Table 15 for Situation 2 involve many of the same assumptions as in Situation 1. The same level of good management of the sheep and lamb enterprises is assumed. The difference is in the method by which the hay crop is managed.

In Situation 1, the operator used his own resources to produce the crop. In Situation 2, the operator has a satisfactory arrangement with a local farmer to produce hay on his 70 acres of cropland on a share basis. The operator provides the land and pays the cash costs to maintain production of a satisfactory crop in exchange for half of the hay crop to be stored in his barn.

TABLE 13. Annual Land Use to Meet Hay Requirements for the STAR and Annual Lambing Systems When Field Equip is Not Owned

ITEM	Hay Equivalent Available	Hay Equivalent Req'd
	tons	
Cropland: 70 ac hay		
Prod: 2.3 t/a -4% stg loss	155	
less: neighbor's share	77	
Available from farm	77	
STAR System:		
Total required (T6)		130
Available from farm		77
Required to purchase		53
Sold		0
Annual System:		
Total required (T6)		55
Available from farm		77
Required to purchase		0
Sold		22

This arrangement results in several changes from the budget shown for Situation 1 in Table 10. The amount of hay produced on the farm remains the same but only half of the production is available to the operator (Table 13). Thus, under the STAR system, the operator has to purchase 53 tons of hay to meet the needs of the ewe flock. Production exceeds requirements for the Annual system leaving 22 tons of hay available for sale. The pasture program for both systems remains the same as for Situation 1 (Table 8).

Because of the share arrangement for hay harvest, costs directly related to hay production are significantly reduced. Table 14 shows the annual cash costs related to the 70 acre hay crop. The costs for seeding, fertilizer, lime, and chemicals for the hay crop are unchanged but the hired labor cost is eliminated. Pasture costs for these items remains the same.

TABLE 14. Annual Operating Costs for Hay and Pasture for the STAR and Annual Lambing Systems When Field Eqpt is Not Owned*

ITEM	Unit	Hay – 70 ac Average Rate/unit	Hay – 70 ac Both Systems	Pasture – 50 ac Average Rate/unit	Pasture – 50 ac Both Systems	Total Crop Expenses
		$	$	$	$	$
Labor	hour	0	0	0	0	0
Seeding	acre	25	1,750	5	250	2,000
Fertilize	acre	20	1,400	20	1,000	2,400
Lime	acre	10	700	10	500	1,200
Chemicals	acre	3	210	0	0	210
TOTAL						5,810

* Adapted from Table 9.

Several other items in the Situation 2 budgets (Table 15) are affected by the share arrangement for hay harvest. Receipts for the STAR system include no income from hay sales and hay income for the Annual system is greatly reduced. The STAR system uses more hay than the amount available from farm production. The budget shows the purchase of hay to fill the need. Also, a charge is added for custom manure removal. In addition to lower crop expenses, the share arrangement results in lower equipment costs. Since only livestock equipment is owned, field equipment costs for repairs, fuel, insurance, depreciation, and interest are eliminated (Tables 1 and 2). Elimination of the hay harvest activities results in the reduction of each of the non-cash expenses for depreciation, interest, and the value of the operator and his family.

Analysis Comparison - The various analysis factors for the cash and profit positions of the sheep enterprise when field equipment is not owned are shown in Tables 16 and 17. These factors are compared with those for Situation 1 in Table 18.

TABLE 15. Estimated Annual Budgets for the STAR and Annual Lambing Systems When Field Equipment is Not Owned

ITEM	STAR - 300 Ewes			Annual 150
	Low	Med	High	
Lambs rsd/ewe/yr	1.73	2.22	2.72	1.34
Receipts (no. from T3):	$	$	$	$
Lambs	35,313	46,723	58,133	13,174
Cull ewes	1,080	1,080	1,080	540
Wool & incentive				
Ewes	4,080	4,080	4,080	2,040
Lambs	1,763	2,267	2,771	684
Crops - hay	0	0	0	1,557
Pasture rent	0	0	0	246
Total cash receipts	42,237	54,150	66,063	18,241
Expenses - cash:				
Total feed (T10)	18,107	23,281	28,454	7,021
Purch hay, $/tn 70	3,716	3,716	3,716	0
Ram - net	225	225	225	175
Custom manure removal	750	750	750	400
Crop expenses (T13)	5,810	5,810	5,810	5,810
Repairs/fuel (T1,2)	760	760	760	515
Taxes, insurance (T2)	2,019	2,019	2,019	1,749
Mktg chg	917	1,214	1,510	342
Misc exp*	2,334	3,001	3,667	905
Total cash expneses	34,638	40,774	46,911	16,917
Expenses- non-cash:				
Depreciation (T1,2)	1,450	1,450	1,450	1,010
Interest on capital (T1,2	5,188	5,188	5,188	4,058
Operator value	4,200	4,900	5,600	2,170
Unpaid family value	1,200	1,400	1,900	400
Total non-cash exp	12,038	12,938	14,138	7,638
Total all expenses	46,675	53,712	61,049	24,555

* Includes utilities, dip, vet, medicine, drench, interest on operating capital, etc.

TABLE 16. Cash Analysis for the STAR and Annual Lambing Systems When Field Equipment is Not Owned

ITEM	STAR - 300 Ewes			Annual 150
	Low	Med	High	
Lambs rsd/ewe/yr	1.73	2.22	2.72	1.34
Farm Net Cash Income:	$	$	$	$
Total cash receipts	42,237	54,150	66,063	18,241
Total cash expenses	34,638	40,774	46,911	16,917
Farm Net Cash Income*	7,599	13,376	19,152	1,324
Net Cash Income per Production Unit:				
Net Cash Income	7,599	13,376	19,152	1,324
Ewes, no.	300	300	300	150
Net Cash Income per Ewe	25.33	44.59	63.84	8.83
Cash Costs per Unit Produced/Sold:				
Total cash expenses	34,638	40,774	46,911	16,917
less: Marketing charge	917	1,214	1,510	342
Non-lamb receipts	5,160	5,160	5,160	4,383
Cash Costs for Lambs Rsd	28,561	34,401	40,241	12,192
Lambs raised, no.	519	667	815	201
less: repl ewes, no.	60	60	60	30
Lambs sold, no.	459	607	755	171
Cash costs per lamb sold	62.28	56.69	53.30	71.26
plus: Mktg chg/lamb	2.00	2.00	2.00	2.00
Cash cost/ lamb sold	64.28	58.69	55.30	73.26
Cash cost/lb of lamb sold	0.58	0.53	0.50	0.67

* Available for family withdrawals, debt service, capital purchases and capital retention.

TABLE 17. Profitability Analysis, including Fixed Costs, for the STAR and Annual Lambing Systems When Field Equipment is Not Owned

ITEM	STAR - 300 Ewes			Annual 150
	Low	Med	High	
Lambs rsd/ewe/yr	1.73	2.22	2.72	1.34
Farm Returns:	$	$	$	$
Total receipts	42,237	54,150	66,063	18,241
Total expenses	46,675	53,712	61,049	24,555
Farm Profit (Loss)	(4,439)	438	5,015	(6,313)
Return / Dollar of Cost	0.90	1.01	1.08	0.74
Returns To Operator:				
Farm profit (loss)	(4,439)	438	5,015	(6,313)
plus: Operator value	4,200	4,900	5,600	2,170
Return To Operator, total	(239)	5,338	10,615	(4,143)
Operator labor, hr/yr	600	700	800	310
Return To Operator, / hr	(0.40)	7.63	13.27	(13.37)
Returns On Investment:				
Farm profit (loss)	(4,439)	438	5,015	(6,313)
plus: Interest on cap	5,188	5,188	5,188	4,058
Return On Investment	749	5,626	10,202	(2,256)
Average investment	123,750	123,750	123,750	101,150
Rate Of Return	0.6%	4.5%	8.2%	-2.2%
Returns Per Production Unit:				
Farm profit (loss)	(4,439)	438	5,015	(6,313)
Ewes, no.	300	300	300	150
Net Profit per Ewe	(14.80)	1.46	16.72	(42.09)
Total Cost Per Unit Produced/Sold:				
Total expenses	46,675	53,712	61,049	24,555
less: Marketing charge	917	1,214	1,510	342
Non-lamb receipts	5,160	5,160	5,160	4,383
Total Cost for Lambs Rsd	40,598	47,338	54,379	19,829
Lambs raised, no.	519	667	815	201
less: repl ewes, no.	60	60	60	30
Lambs sold, no.	459	607	755	171
Total costs / lamb sold	88.52	78.01	72.03	115.90
plus: Mktg chg/lamb	2.00	2.00	2.00	2.00
Total cost/ lamb sold	90.52	80.01	74.03	117.90
Totl Cost/lb of Lamb Sold	0.82	0.73	0.67	1.07

TABLE 18. Comparison of Analysis for Two Lambing Systems and Two Situations of Field Equipment Ownership

Item	Equip Owned?	STAR Low	STAR Med	STAR High	Annual
		$	$	$	$
Cash Analysis:					
Farm net cash income	Yes	10,763	16,540	22,317	4,145
	No	7,599	13,376	19,152	1,324
Net cash income per ewe	Yes	23.47	27.26	29.56	24.22
	No	25.33	44.59	63.84	8.83
Cash cost/lb of lamb sold	Yes	0.52	0.49	0.46	0.52
	No	0.58	0.53	0.50	0.67
Profitability Analysis:					
Farm profit (loss)	Yes	(5,654)	(777)	3,799	(7,873)
	No	(4,439)	438	5,015	(6,313)
Profit (loss) per ewe	Yes	(18.85)	(2.59)	12.66	(52.49)
	No	(14.80)	1.46	16.72	(42.09)
Returns to operator	Yes	(754)	4,823	10,099	(5,003)
	No	(239)	5,338	10,615	(4,143)
Rate of return on investment	Yes	0.4%	4.4%	8.1%	-2.8%
	No	0.6%	4.5%	8.2%	-2.2%
Total cost/lb of lamb	Yes	0.85	0.75	0.69	1.15
	No	0.82	0.73	0.67	1.07

From a cash analysis or short-term point of view, the operator is better off owning his own field equipment (Table 18). Net cash income for the farm and per ewe are higher when field equipment is owned and thus the operator has more cash available to meet living expenses, debt service, and capital needs. Also, the cash required to produce each pound of lamb sold is less for the operator who owns his own field equipment.

When all costs of producing lamb are included, the ownership of field equipment is a disadvantage. Non-cash costs must be considered for the long-term viability of the business. The depreciation and opportunity costs of assets including unpaid labor resources must be recognized. In Situation 2, no field equipment is owned and, therefore, non-cash costs are lower than for Situation 1. This results in higher farm profits in total and per ewe. Also, returns to the operator and on the investment are higher and total costs to produce lamb are lower.

These results for both the cash and profitability analyses of the two equipment ownership situations are based on the equipment investment assumed for Situation 1 and the share arrangement assumed for Situation 2. As equipment investment increases, equipment costs - both cash and non-cash - also increase. With higher equipment costs, the analysis factors would be

less favorable than shown in this study for both the cash and profitability analyses.

The comparisons in Table 18 illustrate the different results and perspectives that can occur when a management decision is made. Short-term cash flow benefits may cause the unwary manager to make unprofitable decisions that may become apparent only as financial problems develop in the long run. Ignoring enterprise profitability and the associated fixed costs, which considers all costs, can result in serious cash flow problems in the future especially as capital items need replacing or debt load increases.

Sensitivity Analysis

An almost infinite number of sensitivity analyses could be imagined. Since the sale of lambs and purchased feeds are the major receipt and expense items, changes in these prices have the quickest and most dramatic effect on cash flow and profitability. Also, if the rate of feed conversion to lamb changes, the quantity of feed consumed or the lamb market-weight changes. Either change has a significant effect on the economics of production.

The effects of lamb and feed price changes on various factors in the economic analysis are illustrated in Tables 19 and 20. Table 19 shows the effect of a change of five cents per pound in live lamb prices from the 70 cents per pound used in the basic analysis for each situation (Tables 11, 12, 16, and 17). For each five cent change in lamb prices for the three STAR system budgets, net cash income and operator returns change by $2,522, $3,337, and $4,152 as lamb production levels increase. The Annual system net cash income and operator returns change by $941 for each five cent change in lamb prices. These effects are the same for Situation 1 and Situation 2. Rate of return on investment responds similarly to such price changes. Lamb price changes alone have no effect on production costs.

TABLE 19. Sensitivity Analysis for Two Lambing Systems with Three Lamb Price Levels and Other Factors Constant

Item	Lamb Price/lb	STAR Low	STAR Med	STAR High	Annual
	$	$	$	$	$
Situation 1 - Field Equip Owned:					
Net cash income	0.65	8,241	13,203	18,165	3,204
	0.70	10,763	16,540	22,317	4,145
	0.75	13,286	19,878	26,469	5,086
Returns to operator	0.65	(3,276)	1,485	5,947	(5,944)
	0.70	(754)	4,823	10,099	(5,003)
	0.75	1,768	8,160	14,252	(4,062)
Rate of return on investment	0.65	-1.6%	1.7%	4.7%	-3.7%
	0.70	0.4%	4.4%	8.1%	-2.8%
	0.75	2.5%	7.1%	11.4%	-1.9%
Situation 2 - Field Equip Not Owned:					
Net cash income	0.65	5,076	10,038	15,000	383
	0.70	7,599	13,376	19,152	1,324
	0.75	10,121	16,713	23,305	2,265
Returns to operator	0.65	(2,761)	2,001	6,463	(5,084)
	0.70	(239)	5,338	10,615	(4,143)
	0.75	2,284	8,675	14,767	(3,202)
Rate of return on investment	0.65	-1.4%	1.8%	4.9%	-3.2%
	0.70	0.6%	4.5%	8.2%	-2.2%
	0.75	2.6%	7.2%	11.6%	-1.3%

TABLE 20. Sensitivity Analysis for Two Lambing Systems with Three Feed Price Levels and Other Factors Constant

Item	Feed Price/tn	STAR Low	STAR Med	STAR High	Annual
	$	$	$	$	$
Situation 1 - Field Equip Owned:					
Net cash income	170	11,769	17,834	23,898	4,535
	180	10,763	16,540	22,317	4,145
	190	9,758	15,247	20,736	3,755
Returns to operator	170	252	6,116	11,680	(4,613)
	180	(754)	4,823	10,099	(5,003)
	190	(1,760)	3,529	8,519	(5,393)
Rate of return on investment	170	1.2%	5.4%	9.3%	-2.4%
	180	0.4%	4.4%	8.1%	-2.8%
	190	-0.4%	3.3%	6.8%	-3.2%
Tot cost/lb sold	170	0.83	0.73	0.67	1.13
	180	0.85	0.75	0.69	1.15
	190	0.87	0.76	0.71	1.18
Situation 2 - Field Equip Not Owned:					
Net cash income	170	8,605	14,669	20,733	1,714
	180	7,599	13,376	19,152	1,324
	190	6,593	12,082	17,572	934
Returns to operator	170	767	6,631	12,196	(3,753)
	180	(239)	5,338	10,615	(4,143)
	190	(1,245)	4,045	9,034	(4,533)
Rate of return on investment	170	1.4%	5.6%	9.5%	-1.8%
	180	0.6%	4.5%	8.2%	-2.2%
	190	-0.2%	3.5%	7.0%	-2.6%
Tot cost/lb sold	170	0.80	0.71	0.65	1.05
	180	0.82	0.73	0.67	1.07
	190	0.84	0.75	0.69	1.09

If the cost of the complete ration changes by $10 per ton, net cash income and operator returns change by $1,006, $1,293, and $1,581 respectively for the STAR budgets and $390 for the Annual system budget (Table 20). Rate of return on investment also changes as shown. Total cost of lamb sold changes by two to three cents per pound for each $10 per ton change in the feed price for both situations analyzed.

Another important factor that affects the analysis of these two lambing systems is the efficiency of converting feed to meat. In the budgets for the analyses, feed requirements of 280 pounds per lamb raised are used to achieve an average 70 pound gain from weaning weight to market weight (Table 7). Thus, an estimated four pounds of complete ration are required to produce a gain of one pound of live lamb.

If feed efficiency decreased 10 percent so that 308 pounds instead of 280 pounds of complete ration was required to produce a 70 pound gain, costs would increase by $2.52 per lamb with feed at $180 per ton. Increasing feed costs by $2.52 for each lamb raised will increase production costs by 2.6 cents per pound of lamb sold including the cost of raising replacement ewes. The reverse would be true for a 10 percent increase in feed efficiency.

Each of these factors - lamb prices, feed prices, and feed efficiency - are important to profitable market lamb production. Any change in one or more of the factors can have an important effect on the profitability of the enterprise.

Summary and Conclusions

The STAR accelerated lambing system is a recent development and involves a significant change in the management of a ewe flock for the production of market lambs. It offers significant potential gains in the number of lambs raised per ewe per year. These gains are the result of improved breeding and feeding programs that result in increased aseasonal lambing and productivity for the ewe flock.

The study presents budgets and compares business factors for three levels of lambing performance under the STAR system with those under a traditional Annual lambing program. The same real estate, equipment, and management resources are assumed for each system. The basic criteria dictating the size of the ewe flock for each system is the real estate resource. Because of the aseasonal nature of the STAR program, which permits buildings to be used more continuously throughout the year, the same facilities used for a ewe flock under the Annual system will accommodate twice as many ewes and their lambs under the STAR system. With the land base large enough to produce forage for the larger STAR flock, excess hay is available for sale under the Annual system.

The analysis is based on a 300 ewe flock under the STAR system and a 150 ewe flock under the Annual system. The enterprise size for either flock is intended to represent a size that could be operated by a part-time operator with family help. The analysis includes consideration of two methods of producing hay - by the operator and on a share crop arrangement.

The analyses indicate that all three levels of lambing performance with the STAR system provide the potential for a higher farm net cash income and returns to the operator and the investment than does the Annual system. The STAR system also results in relatively greater returns to the farm operation and lower costs per pound of lamb sold.

The Annual system results in a modest net cash income and a loss from the farm activities for the year. Returns to the operator and on the investment are negative when all costs are considered.

Under the assumptions used in this study, the STAR system shows a positive return for the overall farm operation only for the high level of ewe productivity. Total cost per pound of lamb, even at this level, is only slightly below the assumed lamb price of $0.70 per pound. While the study illustrates the economic advantages of the STAR system over the Annual system, it also illustrates the need for effective cost control and marketing efforts to achieve success with the STAR system.

The analysis indicates somewhat more attractive returns and profits and lower costs for lamb production for the operator who harvests his hay on shares (Situation 2) than when he harvests all his own hay. However, net cash income is slightly higher for the operator who harvests his own hay (Situation 1). This would mean a somewhat higher contribution to the operator's cash flow under Situation 1 than under Situation 2 with the assumptions used.

Income from lamb sales and the cost of purchased feed are the major receipt and expense items in the budgets. Therefore, the results of the analysis are very sensitive to changes in price levels for lambs and feed and to changes in feed efficiency. At the enterprise size used in this analysis, a five cent change in lamb prices results in an annual change in net cash income of $941 for the Annual system and from $2,522 to $4,152 for the STAR budgets. If feed costs change by $10 per ton, changes in net cash income for the four budgets range from $390 to $1,581. A 10 percent change in feed efficiency changes lamb production costs by 2.6 cents per pound.

The STAR system appears to be a system of lamb production that provides the potential for improved cash flow and profits and lower lamb production costs for the good manager when compared to the Annual system. Because of the sensitivity of these objectives to changes in lamb and feed prices, it is important that the lamb producer develop his marketing and production skills equally well. The STAR system of lamb production brings together production techniques that may provide more attractive opportunities for the livestock producer and an alternative use for many rural resources.

REFERENCES

Crop Reporting Board. Sheep and Goats, USDA, Washington, D.C., January releases 1982-1986.

Epplin, F.M., Doye, D.G., and Ward, C.E., 1983. A Comparison of Costs and Returns from Sheep for Alternative Management Systems, Lambing Times and Flock Sizes, Agricultural Experiment Station, Oklahoma State University, No. 842, September.

Gee, C.K. and Madsen, A.G., 1982. Sheep Production in Colorado, Colorado State University, No. 510A, March.

Harrison, V.L. Sheep Production: Intensive Systems, Innovative Techniques Boost Yields, 1980. ESCS, USDA, Agricultural Economics Report No. 452, March.

Hogue, D.E. and Hall, J.T., 1971. Model Sheep Management System Series, Sheep Industry Development Program, Inc., Denver, Colorado.

Hogue, D.E. and Magee, B.H., 1984. The Star Accelerated Lambing Program, Unpublished Mimeo, Department of Animal Science, Cornell University.

Magee, B.H., 1984. "A Bright Star in Lamb Production", The Lamb Producer's Journal.

New York Crop Reporting Service, 1985. New York Agricultural Statistics, 1984, New York State Department of Agriculture and Markets, June.

New York Agricultural Statistics Service. New York Crop and Livestock Report, New York State Department of Agriculture and Markets, monthly releases.

Snyder, D.P., 1984. Overhead Costs from Farm Cost Accounts, Department of Agricultural Economics, A.E. Res. 84-17, Cornell University, December.

Snyder, D.P., 1984a. Field Crop Costs and Returns from Farm Cost Accounts, Department of Agricultural Economics, A.E. Res. 84-19, Cornell University, December.

_____, 1985. Real Estate Rental Rates, Department of Agricultural Economics, A.E. Ext. 85-21, Cornell University, August.