T H E S I S

A N E C O N O M I C S T U D Y O F F E E D E R S H E E P P A R T N E R S H I P S

Submitted by

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GRADUATE WORK

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I HEREBY RECOMMEND THAT THE THESIS PREPARED UNDER MY SUPERVISION BY Edna Bigelow

ENTITLED AN ECONOMIC STUDY OF FEEDER SHEEP PARTNERSHIPS

BE ACCEPTED AS FULFILLING THIS PART OF THE REQUIREMENTS FOR THE DEGREE OF Master of Science

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INTRODUCTION

Sheep and cattle feeding on irrigated farms in Northern Colorado has become an economic necessity due to the system of farming which has developed in the area. Well-balanced systems have been built around staple enterprises adapted to the area. Crops and livestock have been selected which fitted well together and contributed to each other. Under this program the operator is given an opportunity to use his labor and his equipments effectively. The most important livestock enterprise is the feeding of sheep and cattle which provides the best means for the utilization of the non-marketable feeds. Since these feeding operations require considerable financial resources, two or more persons very frequently enter into a partnership for the undertaking. These persons are usually the tenant and the landlord.

What problems are to be solved in an economic study of these feeding partnerships? Some of the partnership records showed that the financial returns received by the tenant and landlord were not in proportion to the risks they had assumed. What are the reasons for these variations in risks between the partners? Is this obvious difference in risks due to the kind of feeder contract

used? What form of contract will give to each partner a share of the returns in direct proportion to his assumed risks? What are the assumed risks? It is always a question as to whether or not there will be sufficient returns from the feeding enterprise to pay for the wages of labor, for the interest on the capital employed, and for the wages of management. These are the financial risks involved. This thesis attempts to provide a scientific basis for answering some of these questions.

The solution of these problems involves two vital questions: (1) How efficiently is the feeder stock prepared for the market with regard to the technological details which govern the physical relations of quantity of labor used and materials consumed? (2) What is the relative importance of the several factors affecting livestock feeding and what is their combined effect upon the resulting financial returns?

Question one can be answered independently of prevailing economic conditions for there are certain standards of care, feeding, and flock management which are practiced regardless of current economic conditions. This phase of the problem does not enter into the study.

The answer to question two will be influenced somewhat by rising and falling prices. Changes in economic conditions frequently bring wide fluctuations in the values of the cost factors and in the value of the product. Cheap feed costs materially affect the financial returns

as well as do favorable purchase and sale prices for the livestock. The wide variations in lamb prices often make the feeder hesitant about feeding lambs and may cause him to shift to cattle feeding. If prospective prices for both cattle and sheep seem good, the feeder may feed both so as to use up more of the non-salable feed by-products on the farm. Thus, there are always economic adjustments taking place in the farming system and in the feeding practices. These are all primarily economic factors. Some of them will be analyzed in order to have a better foundation upon which to judge the merits of the different feeder contracts and to determine which of them is the fairest to its contracting parties.

DATA USED

Source

The data for this investigation were obtained from farmers in Northern Colorado during the years 1922, 1923, 1924, 1925, and 1926. The farms studied are located chiefly in Weld County. The records were taken from the farmers by the detailed cost route method. By this method the farms were visited at regular intervals each year and the farmers were assisted in keeping complete and accurate records of all their farming operations. The data gathered show the man labor, the horse work, the seed, the fertilizer and the other materials in growing crops and the feed, the man labor, the horse work and the miscellaneous cash costs in producing livestock and livestock products. The data also show the yield of each crop, the quantity sold, and the disposition of the balance and the sales of the livestock and livestock products.

The major crops of this area are alfalfa hay, potatoes, sugar beets and grain which includes, wheat, barley, and oats. The most important livestock enterprise is the fattening of sheep and cattle for the market. In this system the non-marketable products of the crops grown such as the straw, the beet tops, and the pasturage are well utilized.

The sheep and cattle feeding enterprises on these farms were selected for particular analysis. For this study there were available 14 partnership feeder cattle records, 21 partnership feeder sheep records, and 33 independent feeder sheep records. These records are representative of 7 different farms for the feeder cattle, 10 different farms for the partnership feeder sheep, and 11 different farms for the independent sheep feeders, or those who do not feed in partnership.

Existing Conditions

Extent of Sheep and Cattle Feeding in Colorado. The feeding of sheep and cattle on these irrigated farms in Weld County has grown into an extensive business. The whole irrigated area of Northern Colorado has become the leading area in the United States in the feeding of lambs. Colorado is one of the important cattle feeding markets of the country and is the leading lamb feeding state of the nation. Table I shows the number of sheep and lambs on feed in Colorado as compared with the number in the Southern and Western States and with the United States as a whole for the years 1923 to 1929 inclusive. On a seven year average Colorado fed 32 per cent of the lambs in the United States and 66 per cent of the lambs in the 13 Western and Southern States.

The feeding of cattle has continually expanded in Weld County as well as in other sections in Colorado. According to the census of 1880 there were 28,000 cattle in Weld County. These were classified mostly as beef cattle. By 1920 this number had increased to about 107,000. These numbers can be classified roughly as one-third dairy cattle and two-thirds beef cattle. In the 1925 census the number of cattle decreased to 99,058 of which about two-fifths were dairy cattle and three-fifths were beef cattle, a slight reduction from the previous period.

The trend of cattle feeding in Northern Colorado and in the state as a whole can be seen from the following figures taken from the Colorado Year Book, 1928-1929. In Northern Colorado the feeder cattle numbered 100,000 in 1926. This number advanced to 130,000 in 1927, receded to 120,000 in 1928, and remained the same for 1929. While the total number fed in the state in 1926 was 120,000. This number increased to 150,000 in 1927, decreased to 140,000 in 1928, and declined further to 136,000 in 1929. These figures give ample evidence that Northern Colorado is the leading cattle feeding area in the state.

A similar but larger development has taken place in the sheep feeding industry. The first lambs, about 1,800 in number, were fed in Colorado in 1889. This first feeding experiment carried on in Larimer County proved to be successful and yielded a good profit. The fattened lambs brought $4.50 per cwt. in Chicago. The sunny winter climate was considered a favorable factor in the experiment. This first feeding venture opened up to the farmers a profitable way for the disposal of their surplus grain and alfalfa. Three years later 30,000 lambs were marketed from Larimer County, and six years later about 125,000 were marketed from the state, while in 1901 there were 400,000 marketed from Northern Colorado. [1]This section soon became

[1] Maynard, E. J., "The Lamb Feeding Industry in Northern Colorado," published in the Fort Collins Express Courier, March 23, 1930.

Table I. Sheep and lambs on feed for the years 1923 to 1929 inclusive as of January first of each year. 1/

	1923	1924	1925	1926	1927	1928	1929
Montana	58	82	105	100	130	100	90
Wyoming	60	88	87	113	55	90	93
South Dakota	65	111	89	88	75	115	109
Colorado	1500	1400	1600	1475	770	1580	1480
New Mexico				5	20	20	10
Texas					25	73	80
Total for the six states	1683	1681	1881	1781	1075	1978	1862
Washington		13	36	34	36	25	30
Oregon	30	25	50	55	65	30	25
Idaho	205	190	80	160	109	106	100
Utah	132	176	100	160	165	105	102
Nevada	42	20	10	30	30	18	30
California	150	75	30	120	150	110	90
Arizona					30	20	10
Total for the seven states	559	499	306	559	585	414	387
Total for the thirteen states	2242	2180	2187	2340	1660	2392	2249
Total for the United States	4266	4229	4035	4601	4259	4463	4715
Per cent of total Colorado is of " of thirteen states	67	77	74	63	46	66	66
Per cent of total Colorado is of " of United States	35	33	40	32	18	35	31

1/ In thousands, that is, add 000

the leader in the lamb feeding industry and has continued to maintain this position.

To show still further the expansion of this feeder sheep business, figures were obtained from the Colorado Year Book, 1928-1929. The Northern Colorado area will be given first. In 1922 this area was feeding 760,000 lambs, or 73 per cent of the total number in the state; by 1928 this per cent increased to 80. Thus, it is seen that Northern Colorado is the most important sheep feeding center in the state.

The total number of sheep and lambs on feed in all sections of the state are now presented. About 95 per cent of the total number fed are lambs and 5 per cent sheep. In 1914 the number fed was 1,300,000 as compared with 125,000 in 1898. In the years 1919 and 1920 the numbers fell slightly below a million but advanced again until in 1923 the number was 1,500,000. It can be seen in Table I that this number advanced to 1,600,000 in 1925, declined to 770,000 in 1927, then advanced to 1,580,000 in 1928, and decreased to 1,480,000 in 1929. These figures indicated that approximately one and a half million of lambs and sheep have been fed on the average during the last seven years. Hence, from the small beginning of feeding sheep in 1889, the industry has grown until Colorado has come to occupy the dominant position in this industry in the nation.

The customary practice in Northern Colorado is to bring the feeder stock on the farms in the fall and put

them on an intensive feed for a period of from three to five months. The surplus feed crops and sugar-beet by-products are consumed. This enterprise makes an important source of income under favorable price conditions. It also supplies work for the dull winter months.

The average number of sheep fed per farm studied for the five-year period, 1922 to 1926, inclusive, was 1,464. The average number on feed in Northern Colorado for these years was 1,403,000. This means that in this section there were about 960 farms on which sheep were fed. A fairly good portion of the lamb feeding enterprise will be found in the irrigated districts of Weld County.

The feeder sheep industry has not been a stable one. There have been years in which the price situation has been very unfavorable to the feeders. Over-production and depressed prices have occurred with more or less regularity in the last thirty years. How lamb prices suddenly alternate up and down is well illustrated by the following situation. In the year of 1920, lambs costing eleven to twelve cents per pound sold at about eight cents per pound the following spring. The result was disastrous to the feeders. The next year those who had the courage and were able to finance their feeding operations fully recovered their losses of the previous period. This is an example of what is likely to happen in this industry and shows a need for stabilization of feeder lamb prices. In view of this fact, lamb feeders in Colorado and Nebraska have

organized for the purpose of stabilizing the industry through improvements in marketing methods and through advertising the product.

Necessity for Partnership Feeding. The feeding industry requires a considerable amount of capital. The heaviest expense items on the feeder farms are the purchase of the feeder cattle and sheep and feed for the same. The largest single item of the other remaining expenses is labor. Examples of the size of capital needed may be quoted from the feeder farms used in this study. For the feeder year 1925-1926 one feeder spent $21,958 for the purchase of 1,857 lambs and $4,662 for purchased feed for them. He also spent $3,543 for the purchase of 101 feeder cows and $2,020 for purchased feed for them. These items make a total cash outlay of $32,183. Another feeder in the same year feeding 1,511 lambs spent $20,192 for their purchase and bought feeds. This number of head is rather close to the average number fed in the area studied. An example of the necessary capital for a smaller feeding unit is taken from a 1927-1928 record. The purchase and feed cost for 65 feeder cattle was $6,143 while the value of these two items for the 994 lambs fed was $8,396, or a grand total of $14,538 for his feeding operation

From these actual illustrations it is evident that a capital of not much less than $8,000 is needed for a rather small-sized feeding operation, while not much less than $15,000 is necessary for the average-sized feeding unit in

the area. Very few of the tenants have accumulated sufficient savings to enable them to feed lambs on their own financial resources. Some of the tenants are young farmers just starting in the farming business and it will be safe to assume that in most instances they are short in capital. Since it requires not much less than $6,500 for the purchase cost alone of 1,000 lambs, very few of the tenants have this amount of capital available. For these reasons the tenant needs the financial assistance of the landlord. On the other hand, the landlord's limiting factors are generally labor, horse work, and farm machinery which the tenant is able to supply. Out of this situation has evolved partnership feeding. Under this system the risks of the feeding business are divided between the tenant and owner in varying proportions. It offers to the young tenant with relatively little capital an opportunity to increase his income, thus enabling him to enlarge his savings for the purchase of a farm or for more equipments with which to operate a larger unit.

This trend toward partnership feeding has gone hand in hand with the growth of tenancy in Weld County. The census of 1900 indicates that the percentage of all farms operated by tenants was 43.6; by 1910 it dropped to 34.9, raised to 35.4 in 1920, and to 50.3 in 1925, or an increase of 14.9 per cent over the previous census period. In 1928 the farms in this county numbered 4,600 of which 1,729 were owner farms, 2,419 renters, and 452 owners and

renters. The renter farms constituted 52.6 per cent of all farms which is a slight increase over 1925. This high percentage in tenancy is not alarming as it is generally conceded to be a convenient way of approach to full ownership. It is in fact a part of the agricultural ladder.

The increase in tenancy in Weld County can be accounted for partly by the gradual but constant appreciation in land values which tends to lengthen somewhat the time necessary for the young farmer to accumulate savings for the purchase of a farm. From the census of 1910, the value for all farm lands and buildings per acre was $39.77. This value advanced to $54.63 in 1920 and to $63.89 in 1925. Thus, the growth in tenancy has likewise been accompanied by an increase in land values.

Source of Credit. From the foregoing discussion it is evident that considerable capital is needed for the feeding enterprise. Most of the feeders finance a part or the whole of their feeding operation each season by borrowing the money. Short-time credit is used and is usually obtained through the agency of a bank or a livestock commission house. Credit is given only by producing sufficient and satisfactory written evidence on the part of the borrower to the lender of the net amount of his assets and their proportion to his total worth. Not only must the financial soundness of the debtor be determined, but also the state of his particular business. In other words, the credit institutions only look at the enterprise from

the standpoint of their security, and, therefore, force the enterpriser to use his judgment and knowledge in deciding whether he wishes to risk his substantial credit in the feeding enterprise.

Kinds of Partnerships. Partnership feeding in the area studied has developed into two important types, the specified-fixed ratio and the flexible-ratio.

In the specified-fixed ratio type the division of the expenses and receipts is made according to a certain stated proportion, as the half-and-half share method, the one-third and two-thirds method, and the one-fourth and three-fourths method. Of these three methods the half-and-half share, or as it is more often called, the fifty-fifty, is the one most commonly used.

In the flexible-ratio type the residue of the enterprise is expected to be shared in equal proportions. Each partner is to have the assurance of receiving returns in direct proportion to his assumed risks and his invested capital. The arrangement of the division of the expense items between the partners, however, is such that the partners do not always receive equal shares of the financial returns. The most frequently used contract under this system is known as labor against capital.

There are exceptions and modifications to these contracts included under each type but they are of minor importance. The fifty-fifty and the labor against capital contracts will be given special analysis in this study.

Fifty-fifty contract. The half-and-half share method is less frequently followed than the labor against capital contract because of the inadequacy of the tenant's capital. Yet some tenants have accumulated enough capital to engage in the feeding enterprise on a fifty-fifty basis with their landlords. Under this system the tenant furnishes one-half of the farm raised feeds, and pays one-half of the purchase cost of the feeders and one-half of all the other cash items such as interest, purchased feeds, contract labor, and other small miscellaneous items entering into the feeding operation. The landlord furnishes and pays the other half of the above listed items and in addition furnishes the corrals and water system while the tenant furnishes the farm machinery and the work stock. The work stock used for the enterprise is usually fed out of the feeds held in common for the feeders.

An itemized account is kept, usually by the landlord. Into this account is entered all the cash expense items, the value of the farm raised feeds at market prices, and the value of unpaid man labor at farm-wage rates. Sugar beet tops and pasturage are not considered in the farm raised feeds. Deducting all these items from the total cash received from the sale of the feeders, the amount left is divided equally between the partners. This is about the usual method of settlement under the half-and-half system.

Labor against capital contract. The labor versus capital method is very frequently followed because the tenant does not have sufficient capital with which to finance the feeding operation. However, he is able to furnish man labor, horse work, farm machinery and some of the farm raised feeds for the undertaking. While the landlord is able to supply the capital in addition to his share of the farm raised feeds, and can also furnish the corrals and the water system.

Under this system a joint account of all cash items and farm raised feeds except sugar beet tops, is kept but into which neither the charge for labor, except contract labor, nor interest enters. At the close of the feeding period the expenses for the purchase of the feeder stock, the feed, the marketing, the contract labor, and the small miscellaneous cash items are deducted from the total cash receipts from the sale of the stock. The resulting balance is divided equally between the partners. These half shares are expected to cover the remaining expenses of each partner. The largest expense items left are man labor and interest. Now the interest on the landlord's capital is conceded to equal the value of the man labor furnished by the tenant and thus, is derived the name for this contract, labor against capital. Usually the only charge made for the horse work is for their feed which is taken from the feed owned in common for the feeders. This expense item, then, is included in the total feed cost of the enterprise.

VARIATIONS IN RESULTS FROM DIFFERENT CONTRACTS

The approach to the analysis of the problem herewith presented is made by giving tables to show the division of the expenses and receipts under the fifty-fifty and the labor against capital partnerships for feeder cattle and sheep. The actual settlements made under these respective contracts are given in Tables II and IV. By actual settlement is meant all the cash and non-cash costs and receipts considered by the partners under each of these two methods. The non-cash costs are the home-grown feeds and the labor of the operator and his family. Prorated farm costs were added to the costs included in the actual settlements in Tables III and V. Prorated farm costs are comprised of certain actual farm costs which have been disregarded by the feeders in computing the costs of their feeding operations.

What are prorated farm costs? Farm costs are made up of cash items and calculated items. The first item means the actual cash that is paid out while the second item means costs that are figured. The calculated items consist of interest and depreciation figured on buildings, machinery, and work stock, and a charge for the labor of the operator and his family at current rates. Depreciation has

to be met if the farmer is to remain in business. He should allow for interest on his investment before he can decide that an enterprise is profitable. He must receive wages for his labor in order to meet the family expenses. The cash and calculated costs will be used in the settlements including prorated farm costs.

There are certain general expense items which have to be allocated to the several enterprises, as the water system, the farm machinery, the man and horse labor costs to feeder sheep and cattle. The water system and the farm machinery charges include cash repairs, fuel, labor, interest and depreciation. The total water system charge is prorated to the livestock enterprises on the animal unit basis, while the farm machinery charge is prorated to the crop and livestock enterprises on the productive horse hour basis.

Another prorated farm cost is man labor. In finding the actual man labor cost, the labor of the operator and his family is charged up at current rates. To the value of this labor is added the cost of the hired labor. The sum of these two items is divided by the total hours spent by these workers on the farm to secure the rate per hour. This rate is applied, then, to the total hours spent on each enterprise. By this method the actual man labor cost is given to each enterprise.

Another important prorated farm cost is horse work. Horse costs include home-grown feeds at their farm values,

building and equipment charges, man labor costs, interest on the investment and depreciation on the work stock. A credit is made for the manure. The horse work cost is prorated to the various enterprises in the same manner as given for man labor.

A comparative study of Tables II, III, IV, and V will show the variations in the net returns to the tenant and landlord under the different partnership systems.

Feeder Cattle Partnerships

Returns from Actual Settlements. The actual financial returns secured by the tenant and landlord from feeder cattle under the fifty-fifty and the labor against capital partnerships are shown in Table II. The listed items reveal the ones which the feeders considered in their settlements. The most important expense items are the purchase of the feeder cattle, the feed for the same, the marketing, the interest, the contract labor and the man labor. The contract labor is mostly for hauling the wet sugar beet pulp. These costs are all cash except the home-grown feeds and the value of the operator's labor.

In theory both the half-and-half share and the labor-capital methods will give to each partner one-half share of the residue. It will be seen in Table II under the labor-capital system that the landlord receives 54 per cent of the net returns while the tenant receives 46 per cent. Under this system, as has been stated, it is assumed that

Table II. Division of returns from feeder cattle, based on actual settlements.

	Fifty-fifty		Labor vs. capital		All records Labor vs. capital	
	Tenant	Landlord	Tenant	Landlord	Tenant	Landlord
No. of records	8		6		14	
	Dollars		Dollars		Dollars	
RECEIPTS						
Sales.....	2558.76	2558.76	2228.36	2228.35	2417.16	2417.15
Miscellaneous...	5.00	5.00	.62	.63	3.12	3.13
Total.....	2563.76	2563.76	2228.98	2228.98	2420.28	2420.28
EXPENSES						
Purchase.....	1611.52	1611.52	1290.91	1290.92	1474.11	1474.12
Feed.....	546.53	546.52	487.84	487.84	521.38	521.37
Contract labor..	69.23	69.23	27.60	27.60	51.39	51.39
Miscellaneous...	9.55	9.55	21.52	21.53	14.68	14.68
Veterinary.....	1.44	1.44	...	...	.82	.82
Engine gas.....	.37	.38	.38	.38	.38	.38
Engine repair...	...	...	.15	.15	.07	.06
Straw.....	4.25	4.25	3.59	3.58	3.96	3.96
Corral.....	.85	.86	...	...	.49	.49
Equipment.....	.27	.27	...	...	.15	.16
Marketing.....	14.41	14.40	...	...	8.24	8.23
Total.....	2258.42	2258.42	1831.99	1832.00	2075.67	2075.66
Balance to cover	305.34	305.34	396.99	396.98	344.61	344.62
Interest.....	35.94	35.94	...	73.58	...	72.61
Man labor.....	86.18	86.18	120.26	...	150.03	...
Total.....	122.12	122.12	120.26	73.58	150.03	72.61
NET RETURNS.....	183.22	183.22	276.73	323.40	194.58	272.01
Per cent of total net returns.....	50	50	46	54	42	58

the value of man labor will closely approach the value of interest. Labor is a larger item than interest on these records. If this item increases and the balance left to cover the same becomes less, the tenant's share decreases accordingly.

In order to further test the above theory more records were used so as to trace the probable changes in the results upon the shares to be received by the partners. Therefore, the records of the first two groups were combined, averaged and converted into the labor-capital arrangement. The results of the conversion are seen in the last two columns of Table II. It is to be noted that the interest charge changed but little, being $73.58 for the six labor-capital records and $72.61 for the 14 conversion records, while, on the other hand, the man labor cost increased from $120.26 to $150.03. The balance left to cover labor and interest decreased. With this increased labor cost and a decreased balance to cover the same under the conversion the tenant received but 42 per cent of the net returns while under the six labor-capital records he had received 46 per cent of the net returns.

Under both the labor-capital groups the value of man labor exceeded that of interest.

Returns from Settlements, Including Prorated Farm Costs.

In direct contrast with the actual returns shown in Table II, Table III is given to show the difference in net returns under the two systems with the inclusion of prorated

Table III. Division of returns from feeder cattle, including prorated farm costs.

	Fifty-fifty		Labor vs. capital		All records Labor vs. capital	
	Tenant	Landlord	Tenant	Landlord	Tenant	Landlord
No. of records	6		8		14	
	Dollars		Dollars		Dollars	
RECEIPTS						
Sales.....	2577.76	2577.76	2261.10	2261.10	2442.05	2442.05
Miscellaneous...	5.00	5.00	6.66	6.67	5.70	5.71
Total.....	2582.76	2582.76	2267.76	2267.77	2447.75	2447.76
EXPENSES						
Purchase.....	1611.52	1611.52	1290.91	1290.92	1474.12	1474.12
Feed.....	555.23	555.24	576.45	576.44	564.32	564.33
Marketing.....	33.41	33.40	32.75	32.74	33.13	33.12
Contract labor..	69.23	69.23	47.84	47.85	60.06	60.06
Miscellaneous...	10.45	10.46	3.58	3.59	7.51	7.51
Total.....	2279.84	2279.85	1951.53	1951.54	2139.14	2139.14
Balance to cover	302.92	302.91	316.23	316.23	308.61	308.62
Interest.....	35.94	35.94	...	73.58	...	72.60
Man labor.....	76.23	76.23	104.85	...	132.06	...
Horse work....	43.23	43.23	41.42	...	67.15	...
Total.....	155.40	155.40	146.27	73.58	199.21	72.60
Balance to cover	147.52	147.51	169.96	242.65	109.40	236.02
Water charge..	8.72	20.36	4.56	10.65	6.94	16.20
Corral.....	.79	1.83	.58	1.35	.70	1.62
Equipment.....	13.82	...	12.34	...	13.18	...
Truck.....	1.52	...	2.12	...	1.79	...
Straw.....	2.50	2.50	1.67	1.66	2.14	2.14
Total.....	27.35	24.69	21.27	13.66	24.75	19.96
NET RETURNS.....	120.17	122.82	148.69	228.99	84.65	216.06
Per cent of total net returns.....	50	50	39	61	28	72

farm costs. By net returns is meant the difference between the gross receipts and the total costs as listed in the settlements, including prorated farm costs. Actual farm costs were given to man labor, horse work, water system, farm machinery, and corrals used in the feeding operation. Home-grown straw and sugar beet tops, and pasturage were added to the feed costs. By actual compiling of the cash and non-cash costs, as is shown in Tables XX and XXI, of the corrals and of the water system, respectively, it was found that the ratio of expense for these two items was 70 per cent for the landlord and 30 per cent for the tenant. In this Table the division of the total costs of the corrals and water system was made in the above proportion.

In this Table, also, the first groups of records were combined and converted into the labor-capital system for the same reasons given for the conversion in Table II. Under the conversion man labor increased from $104.85 to $132.06, while the interest charge slightly decreased. The cost of horse work increased from $41.42 to $67.15. The increase in labor cut heavily into the tenant's share of the gains, as he received only 28 per cent of them, whereas the landlord's share was 72 per cent, or an advantage of 22 per cent above 50 per cent of the net returns. When these proportions are compared with those under the labor-capital arrangement for 6 records, it will be seen that the tenant received 39 per cent of the net returns while the

landlord received 61 per cent, or 11 per cent more than one-half of the net returns.

The still lesser advantage of the tenant's share in the net returns under the conversion basis can be attributed largely to the increased labor costs and the decreased balance with which to cover the same.

Feeder Sheep Partnerships

Similar tables were prepared from the 21 partnership feeder sheep records to further show the differences in returns to the partners under the two systems.

Returns from Actual Settlements. The actual settlements are given in Table IV. The partners do not share alike under the labor-capital method, for under the 12 records the tenant received 48 per cent of the returns and under the conversion he received a 58 per cent share.

Returns from Settlements, Including Prorated Farm Costs. When the prorated farm costs were added to the costs included in the actual settlements, the tenant's share of the final balance was considerably less under the system where both partners are expected to receive equal share of the gains or to bear losses in the same proportion. By a careful scrutiny of Table V it can be seen that the average net returns from the 9 fifty-fifty records were a minus. When these records were combined with the 12 labor-capital records and converted into the labor-capital system the result was a minus return for both the tenant and

the landlord. On the conversional basis the tenant's first balance of $409.56 was insufficient by $107.94 to cover the labor cost. The landlord's first balance was ample by $56.67 to cover the interest charge. This shrinkage in returns bore heavily upon the tenant, as he was compelled to carry 28 per cent more of the loss than did the landlord. When the returns were a plus on the 12 labor-capital records, the landlord received 12 per cent more of the gains above the expected one-half than did the tenant.

Table IV. Division of returns from feeder sheep, based on actual settlements.

	Fifty-fifty		Labor vs. capital		All records Labor vs. capital	
	Tenant	Landlord	Tenant	Landlord	Tenant	Landlord
No. of records	9		12		21	
	Dollars		Dollars		Dollars	
RECEIPTS						
Sales.....	6820.51	6820.52	7891.61	7891.62	7432.57	7432.58
Miscellaneous...	15.04	15.03	66.03	66.03	44.18	44.17
Pelts.....	22.45	22.45	7.82	7.81	14.09	14.08
Total.....	6858.00	6858.00	7965.46	7965.46	7490.84	7490.83
EXPENSES						
Purchase.....	5239.45	5239.45	5091.38	5091.38	5154.83	5154.84
Feed.....	1862.73	1862.73	1980.13	1980.13	1929.82	1929.81
Contract labor..	...	...	.36	.35	.21	.20
Miscellaneous...	19.78	19.78	1.78	1.77	9.49	9.50
Horse feed.....	17.85	17.85	1.76	1.76	8.66	8.65
Veterinary.....	.39	.38	...	...	.16	.17
Shoeing.....	1.00	1.00	...	...	.43	.43
Lumber.....	.90	.91	...	...	.39	.38
Engine gas.....	6.45	6.46	1.98	1.98	3.89	3.90
Engine repair...	5.41	5.41	1.04	1.05	2.92	2.91
Straw.....	1.45	1.45	5.29	5.29	3.64	3.65
Corral.....	1.44	1.44	...	...	.61	.62
Dipping.....	.06	.06	1.12	1.13	.67	.67
Equipment.....	...	...	.12	.11	.07	.06
Total.....	7156.91	7156.92	7084.96	7084.95	7115.79	7115.79
Balance to cover	-298.91	-298.92	880.50	880.51	375.05	375.04
Interest.....	180.17	180.16	...	343.01	...	350.43
Man labor.....	140.84	140.84	384.92	...	340.68	...
Total.....	321.01	321.00	384.92	343.01	340.68	350.43
NET RETURNS.....	-619.92	-619.92	495.58	537.50	34.37	24.61
Per cent of total net returns.....	-50	-50	48	52	58	42

Table V. Division of returns from feeder sheep, including prorated farm costs.

	Fifty-fifty		Labor vs. capital		All records Labor vs. capital	
	Tenant	Landlord	Tenant	Landlord	Tenant	Landlord
No. of records	9		12		21	
	Dollars		Dollars		Dollars	
RECEIPTS						
Sales.....	7105.35	7105.35	8274.10	8274.10	7773.20	7773.20
Pelts.....	23.20	23.20	14.73	14.73	18.36	18.36
Inventory.....	...	...	.42	.42	.24	.24
Miscellaneous...	12.32	12.31	66.03	66.03	43.01	43.00
Total.....	7140.87	7140.86	8355.28	8355.28	7834.81	7834.80
EXPENSES						
Purchase.....	5242.01	5242.01	5091.37	5091.38	5155.94	5155.93
Feed.....	1858.40	1858.39	1964.72	1964.71	1919.15	1919.15
Marketing.....	277.92	277.93	388.22	388.21	340.94	340.95
Contract labor..	.11	.11	.36	.36	.25	.25
Miscellaneous...	10.83	10.82	7.57	7.57	8.97	8.97
Total.....	7389.27	7389.26	7452.24	7452.23	7425.25	7425.25
Balance to cover	-248.40	-248.40	903.04	903.05	409.56	409.55
Interest.....	183.02	183.02	...	343.01	...	352.88
Man labor.....	174.22	174.23	383.19	...	368.30	...
Horse work....	74.75	74.75	148.98	...	149.20	...
Total.....	431.99	432.00	532.17	343.01	517.50	352.88
Balance to cover	-680.39	-680.40	370.87	560.04	-107.94	56.67
Water charge..	29.60	69.08	22.79	53.18	25.70	60.00
Corral.....	24.55	57.30	16.13	37.63	19.74	46.06
Equipment.....	55.13	...	42.66	...	48.00	...
Truck.....	...	...	2.14	...	1.22	...
Straw.....	15.45	15.44	7.58	7.58	10.95	10.95
Total.....	124.73	141.82	91.30	98.39	105.61	117.01
NET RETURNS.....	-805.12	-822.22	279.57	461.65	-213.55	-60.34
Per cent of total net returns.....	-49	-51	38	62	-78	-22

Effect of Increased Selling Price upon the Net Returns

From the preceding analysis of the actual settlements for both feeder cattle and sheep it is clear that the partners did not share equally under the labor-capital method. After the prorated farm costs had been added to the actual settlements a still wider difference appeared between the shares of the returns going to each partner. Under these settlements the value of the man labor and the horse work was greater than the interest charge and when the balances to cover these items diminished, the tenant assumed a greater loss than did the landlord. This fact led to the question, what effect would increased financial returns have upon equalizing the returns between the partners. Financial returns may be increased effectively by securing higher sale prices for the product. This principal was applied in Tables VI and VII.

All further analysis will be based upon the data including the prorated farm costs.

The averages of the 14 partnership feeder cattle and 21 partnership feeder sheep records were used for the experiment. These averages were converted into the labor-capital arrangements which are seen in Tables III and V, respectively. To enlarge the returns the average sale price of both feeder cattle and sheep was increased successively at an uniform rate of $ .50 per cwt. sold,

while the average costs remained the same in all cases.

The probable differences in the proportions of the increased net returns to be received by the tenant and the landlord as a result of these computations are given in Tables VI and VII.

Feeder Cattle. Very interesting variations in the proportion of the returns from feeder cattle received by the tenant and the landlord due to the successive increases in the selling price with all cost factors remaining the same appear in Table VI.

Table VI. Variations in the proportion of returns from feeder cattle received by the tenant and landlord, by increasing the selling price at an uniform rate, all cost factors held constant. Labor against capital basis. 14 Records.

Selling price per cwt.	Average $ 8.16	$ 8.66	$ 9.16	$ 9.66	$10.16
Net returns per head fed	$ 5.18	$12.30	$22.87	$31.72	$40.56
Per cent of net returns received by:					
Tenant	28	34	45	47	47
Landlord	72	66	55	53	53

It can be seen that when the average selling price of $8.16 had been increased to $9.16 that the tenant lacked only 5 per cent of receiving 50 per cent of the net returns, and that when the sale price reached $9.66, he just lacked 3 per cent. The last sale price of $10.16 did not change this percentage.

Feeder Sheep. A likewise increasing share in the returns from feeder sheep received by the tenant by following the same process as for feeder cattle appears in Table VII.

Table VII. Variations in the proportion of returns from feeder sheep received by the tenant and landlord, by increasing the selling price at an uniform rate, all cost factors held constant. Labor against capital basis. 21 Records.

Selling price per cwt.	Average $14.14	$14.64	$15.14	$15.64	$16.14	$16.64
Net returns per head fed	$ -.22	$ .22	$ .67	$ 1.15	$ 1.56	$ 2.00
Per cent of net returns received by:						
Tenant	-78	22	41	44	46	47
Landlord	-22	78	59	56	54	53

Under the average column the tenant bears 28 per cent more of the losses than does the landlord. When the average sale price of $14.14 was increased to $14.64 the returns were a plus and the tenant received 22 per cent of them and the landlord 78 per cent. Again, when the sale price became $15.14 the tenant received 41 per cent of the net returns and at $16.64 the share rose to 47 per cent. The spread between the average sale price and the last sale price used was $2.50.

An examination of this Table reveals that at least a net return per head of about one dollar was necessary to bring the shares of the returns more nearly equal between the tenant and the landlord.

Results. An outstanding feature in connection with these Tables is that as the sale price increased, the share of the returns received by the tenant more nearly equaled the share received by the landlord. The second increase in the sale price was the most effective in equalizing the division of the returns between the partners for both the feeder sheep and the cattle. In both cases the other successive raises but slightly smoothed out the difference. This statement is well illustrated in Figure I. This discovery then led to an intense study of the relative importance of the different combinations of factors and their relation to the net return per head fed.

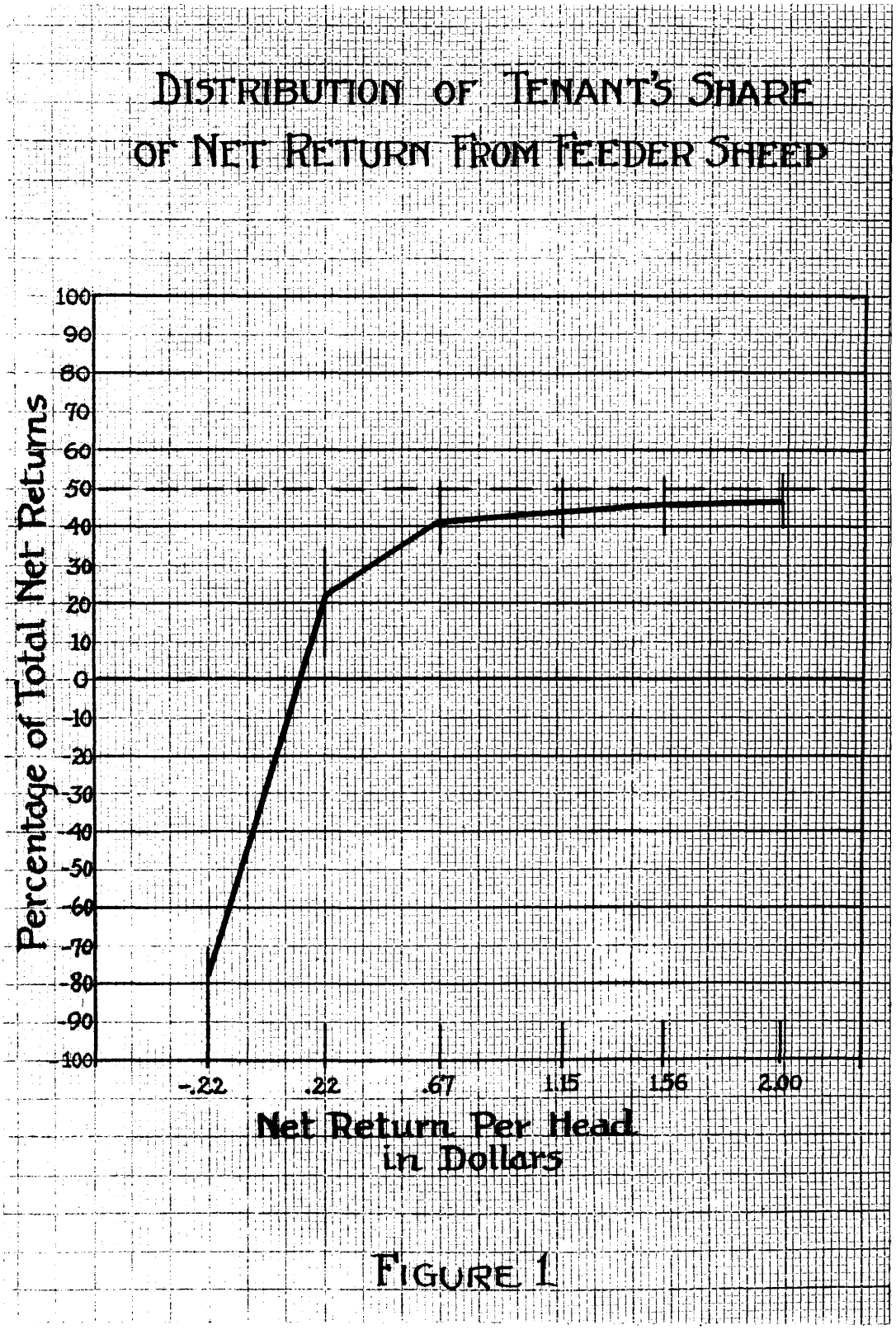
DISTRIBUTION OF TENANT'S SHARE
OF NET RETURN FROM FEEDER SHEEP
Percentage of Total Net Returns
100
90
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-.22
.22
.67
1.15
1.56
2.00
Net Return Per Head
in Dollars

FIGURE 1

METHOD OF STUDY EMPLOYED

Linear Correlations

For the preliminary test of finding the most important variables the linear correlation method was employed. The relationship of the factors was assumed to be essentially linear. In the pursuance of the statistical analysis of the problem by the correlation method feeder cattle were omitted due to the small number of records and to the various classes of the cattle. For these reasons the data would probably yield unreliable conclusions.

Gross correlation was applied to the feeder sheep records first. Through its aid the closeness of the relationship between the different pairs of variables was measured. From the resulting coefficients of gross correlation of the different pairs of variables the apparently most important ones were selected to which the multiple correlation was applied to secure their combined effect upon the net result, the net return per head. Then in order to find the net contribution of each selected variable used in the multiple correlation, the partial correlation was employed. In this measurement all causal factors can be held constant except one and thus its net effect on the dependent variable is measured.

The net and multiple linear correlation methods are

usually more accurate and complete in their indication of the relations than the gross method. Tolley (15) states, that although it is not possible to give a definite concrete meaning to correlation coefficients, they are very concise relative measures of the degree of relationship existing between the factors being studied. He further states that this method is especially useful if only a limited number of records or observations are available, for it does away with the necessity of sorting into groups, with the subsequent falling off in reliability of the average obtained. Also that it is impossible without a large number of records and a great amount of sorting and tabulation to separate all the factors being considered in the study and find the effect that each would have had if the others had not been present, or if they had been constant throughout the investigation. Thus, the correlation method will be an efficient tool in measuring and testing the different sets of relationships between the various economic inputs and the resulting economic output in this study.

FACTORS CONSIDERED

The more important economic inputs available for the statistical analysis to show their effect on the economic output, or net return per head, were purchase price per hundredweight, sale price per hundredweight, feed cost per pound of gain, initial weight per head, man hours per thousand head, and average length of feeding period. There are many influences affecting each of these causal factors, or independent variables. There is much interest attached in determining to just what extent each of the factors under consideration is responsible for the farmer's gain or loss in his sheep feeding enterprise.

Gross Correlations of the Relations

The correlation studies of the relationship of these factors were first considered by the gross linear correlation method applied to the 21 partnership feeder sheep records. The results are shown in Tables VIII, IX, and X.

Table VIII. Gross correlation between net return per head and other factors. 21 partnership records.

Factors correlated Net return per head with:	Gross Correlation Coefficients
Purchase price per hundredweight	-.536 ± .107
Selling price per hundredweight	+.966 ± .0099
Man hours per thousand head	-.0312± .0004
Initial weight per head	-.395 ± .127

Table IX. Gross correlation between initial weight per head and other factors.

Factors correlated Initial weight per head with:	Gross correlation Coefficients
Feed cost per pound of gain	-.360 ± .130
Average length of feed period	-.433 ± .121

In Table VIII is seen the closeness of the relationship between the net return per head and each of the other factors. The gross correlation coefficient[1] found between net return per head and selling price per hundredweight was +.966 with a very small probable error[2] of ±.0099. This coefficient indicates a very high positive relationship. The coefficient for net return per head and purchase price per hundredweight was -.536 with a probable error of ±.107. This coefficient shows a moderate relationship in consideration of the size of its probable error.[3] The relationship between initial weight per head and net return per head is rather small, while the relationship between man hours per thousand head and net return per head was insignificant, being a coefficient of -.0312.

The relationship between initial weight per head and feed cost per pound of gain and between initial weight per

---

[1]By definition from Chaddock's "Principles and Methods of Statistics", "coefficient of correlation is a pure number ranging between zero and unity, which serves as an index of the degree of association between two series of data". Page 303.

[2]By definition from Secrist's "An Introduction to Statistical Method", "probable error is that amount on either side of the average coefficient of correlation within which half of the values of a large number of coefficient fall if computed from series of pairs of items chosen at random from a universe having in general the given correlation coefficient." Page 429.

[3]Chaddock's "Principles and Methods of Statistics". "Conservative statistical practice in interpreting r requires that the size of the coefficient be 4 P E before it becomes indicative of any significant degree of association". Page 275.

head and average length of feed period is shown in Table IX.

The degree of association between these pairs of variables was not of enough significance to be further considered in the study.

From the coefficients in Table VIII it is evident that the sale price per hundredweight was the most important factor affecting the net return per head; the other factors in order of their importance were purchase price per hundredweight, initial weight per head, and man hours per thousand head. However, the correlation between man hours per thousand head and net return per head was too small to be of any importance. The number of records used for the preceding correlation was too small, being 21. Therefore, to secure a greater accuracy from the gross correlation process, the entire 54 feeder sheep records for the five-year period studied were used.

In the continuance of the analysis of the factors with the use of 54 records, each factor was correlated with every other factor to measure their relationships. The results appear in Table X.

An examination of this Table reveals that the gross coefficient for net return per head and purchase price per hundredweight was -.688; for net return per head and selling price per hundredweight +.818; for net return per head and feed cost per pound of gain -.686; and for net return per head and initial weight per head -.430. It is clear

Table X. Gross correlation with net return per head for four factors and intercorrelations. Fifty-four records

Factors correlated	B Purchase price per hundred-weight	C Selling price per hundred-weight	D Feed cost per pound gain	E Initial weight per head
A Net return per head	-.688 ±.0485	/.818 ±.0308	-.686 ±.0408	-.430 ±.0748
B		-.481 ±.0707	/.335 ±.0816	/.350 ±.0806
C			-.333 ±.0816	-.366 ±.0796
D				/.190 ±.0872

that the degree of association of the first three independent[1] factors with the dependent[1] factor, net return per head, is high, while it is moderate for the fourth. The intercorrelation coefficients are all moderate in size except that of initial weight per head with feed cost per pound of gain.

From the results obtained in Table X the following factors were selected for further analysis by the multiple correlation process to determine their individual importance.

A	Net return per head	dependent factor
B	Purchase price per hundredweight	independent factor
C	Selling price per hundredweight	" "
D	Feed cost per pound of gain	" "
E	Initial weight per head	" "

As revealed in Table X there is a moderate degree of association of nearly all independent factors with each other as well as their greater or less correlation with the dependent factor. The results show, then, an interrelation of all factors, and, therefore, their direct effect upon the net return per head cannot be measured by gross correlation. The separate effect of each variable may be obtained through multiple linear correlation and thus eliminate the interrelated influences.

[1]See EXPLANATION OF STATISTICAL TERMS USED.

Statistical Significance of the Dot Charts

Before proceeding with the multiple correlation solution, dot charts, or scatter diagrams, are presented. They are given to show visually; (1) the apparent relation between the variables with the regression lines obtained from gross correlation; (2) the direction of the relation; (3) the linearity or nature of the relation; and (4) the effect of the extreme cases on the results. Dot charts also yield measurement of the accuracy of the arithmetical work which is seen by passing of the regression lines through the point of intersection of the means. In Figures 2, 3, and 5 the horizontal scales represent the factors, purchase price per hundredweight, sale price per hundredweight, and initial weight per head, respectively, and the vertical scales represent the factor, net return per head. In Figure 4, the horizontal scale represents the net return per head and the vertical scale represents the factor, feed cost per pound of gain. In the diagrams each dot shows the relation between these different pairs of factors in that it represents the deviation of each factor from its own mean at the point of convergence. For example, in Figure 2, each dot represents the net return per head at the several purchase prices per hundredweight found on the 54 feeder sheep records. These scatter diagrams,

RELATION BETWEEN PURCHASE PRICE PER CWT. AND NET RETURN PER HEAD OF FEEDER SHEEP

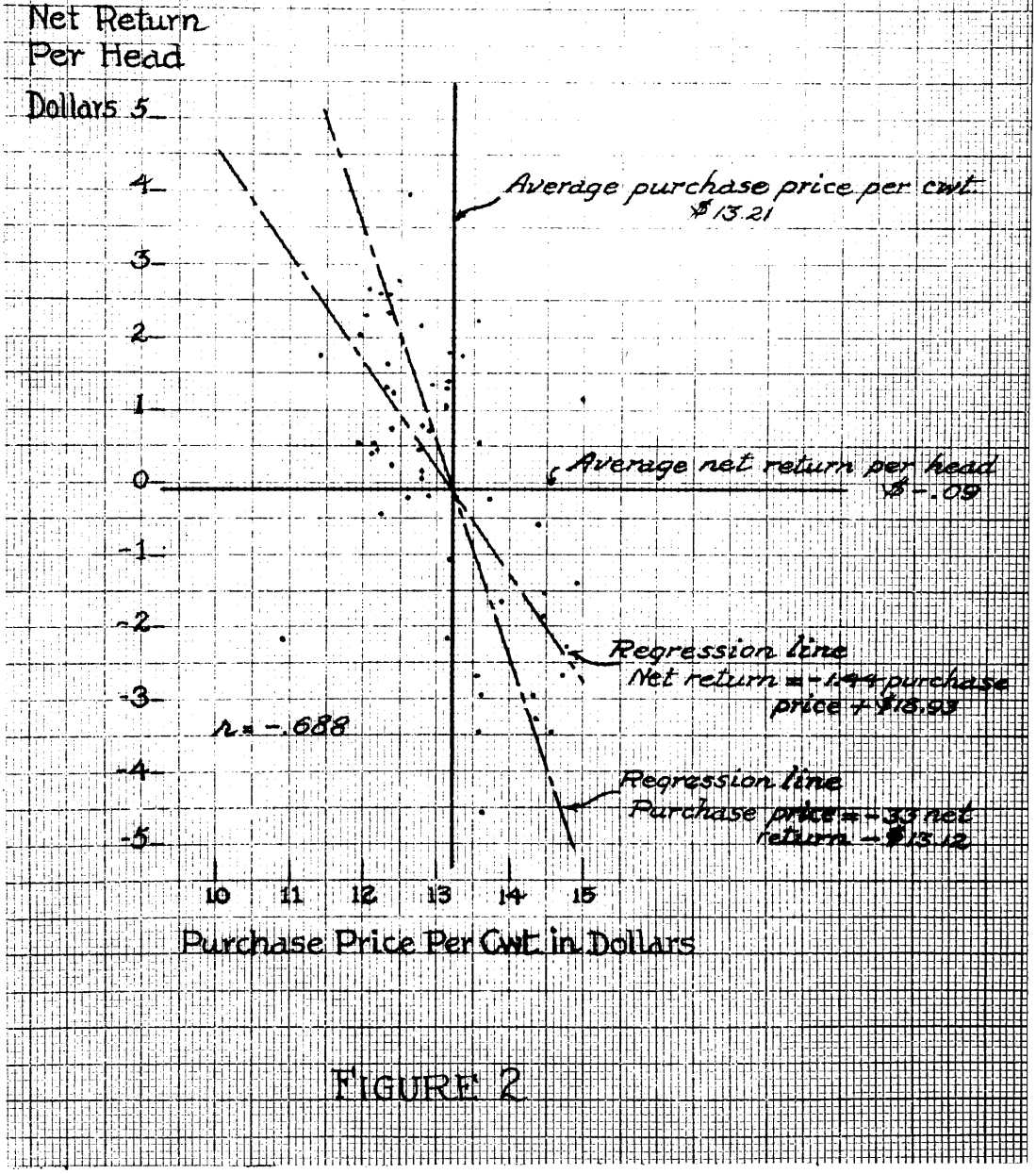

FIGURE 2

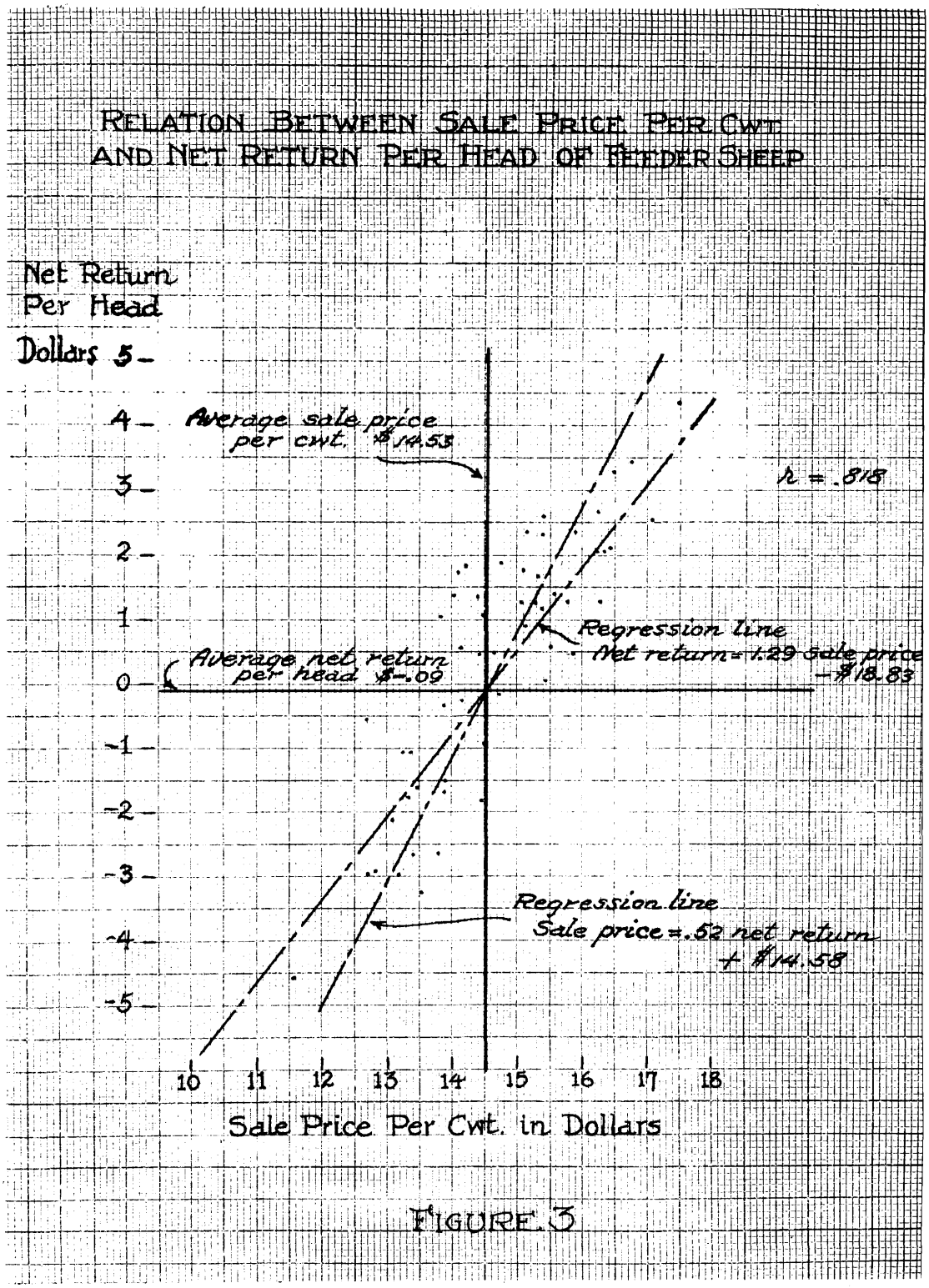
RELATION BETWEEN SALE PRICE PER CWT.
AND NET RETURN PER HEAD OF FEEDER SHEEP
Net Return
Per Head
Dollars
5
4
3
2
1
0
-1
-2
-3
-4
-5
Average sale price
per cwt. $14.53
r = .818
Regression line
Net return = 1.29 Sale price
-$18.83
Average net return
per head $-.09
Regression line
Sale price = .52 net return
+ $14.58
10
11
12
13
14
15
16
17
18
Sale Price Per Cwt. in Dollars

FIGURE 3

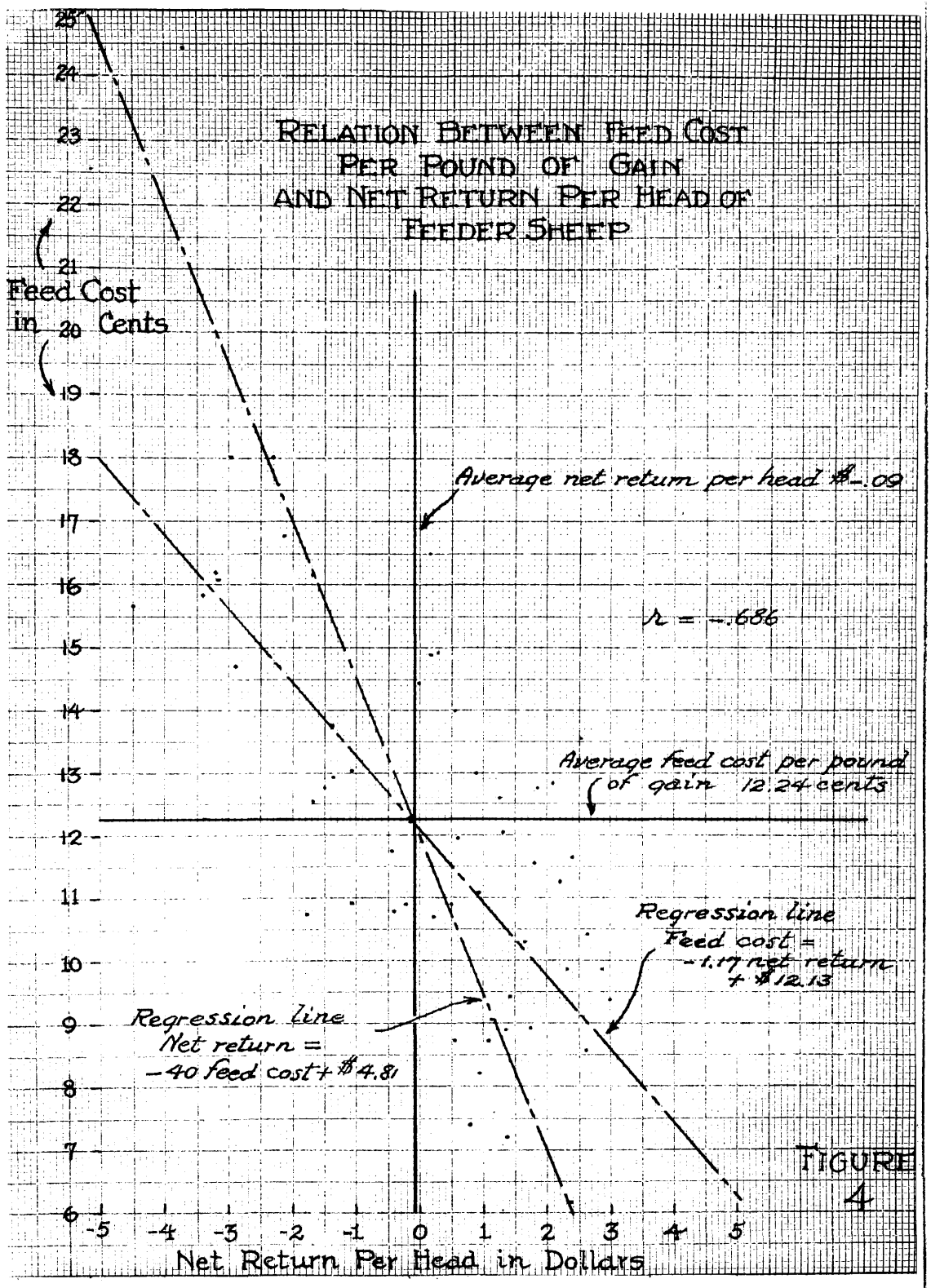
RELATION BETWEEN FEED COST PER POUND OF GAIN AND NET RETURN PER HEAD OF FEEDER SHEEP
Feed Cost in Cents
25
24
23
22
21
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
Average net return per head $-.09
r = -.686
Average feed cost per pound of gain 12.24 cents
Regression line
Feed cost = -1.17 net return + $12.13
Regression line
Net return = -.40 feed cost + $4.81
-5 -4 -3 -2 -1 0 1 2 3 4 5
Net Return Per Head in Dollars

FIGURE 4

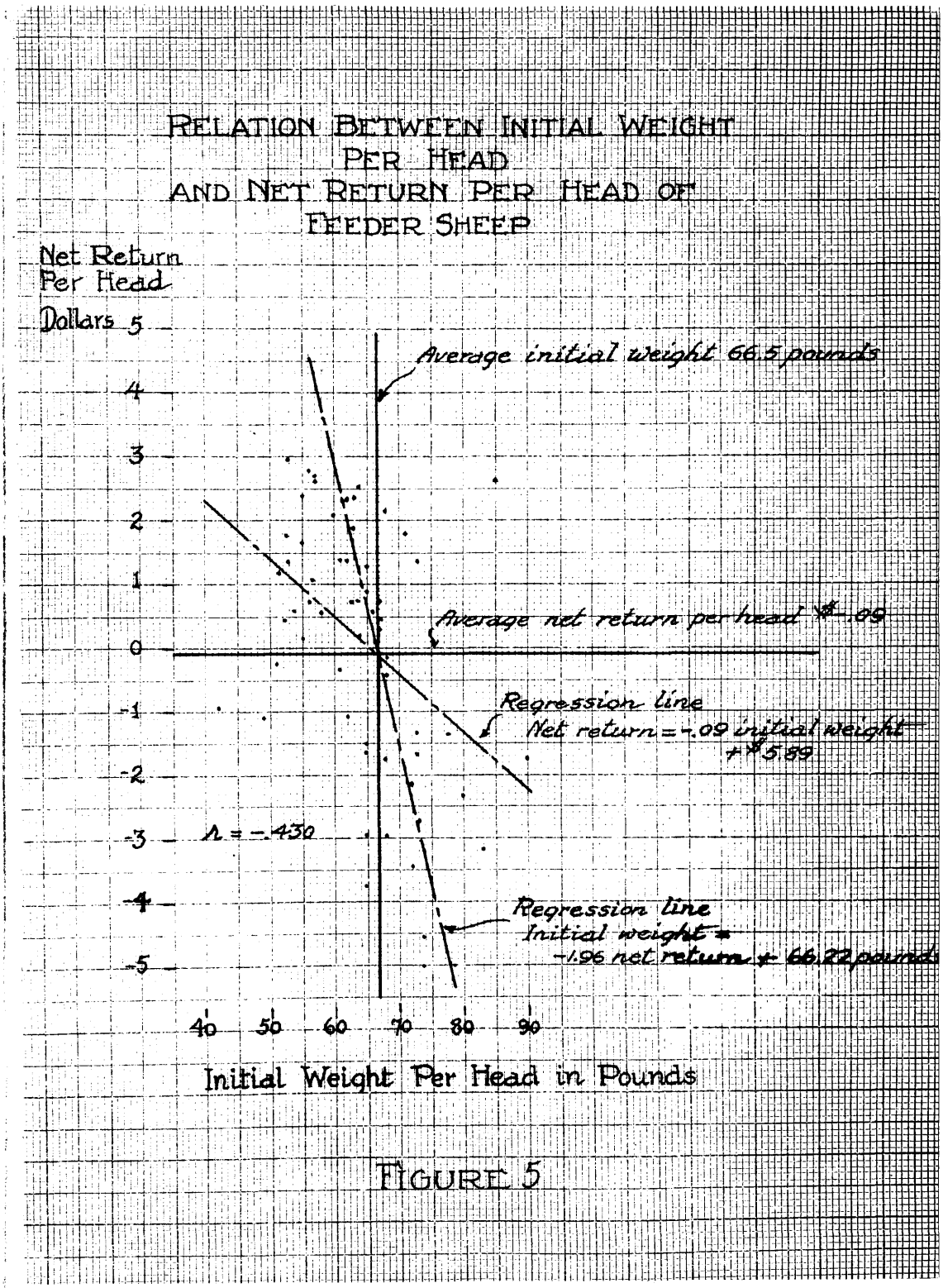
RELATION BETWEEN INITIAL WEIGHT PER HEAD AND NET RETURN PER HEAD OF FEEDER SHEEP
Net Return Per Head Dollars
5
4
3
2
1
0
-1
-2
-3
-4
-5
Average initial weight 66.5 pounds
Average net return per head $-.09
Regression line
Net return = -.09 initial weight + $5.99
r = -.430
Regression line
Initial weight = -1.96 net return + 66.22 pounds
40
50
60
70
80
90
Initial Weight Per Head in Pounds

FIGURE 5

then, give a graphic representation of the distribution of the relationship between each pair of variables.

In Figures 2, 3, 4, and 5 these expected results are present. A marked degree of association between the factors is shown by the closeness of the regression lines in Figure 2 between purchase price per hundredweight and net return per head, in Figure 3 between sale price per hundredweight and net return per head, and in Figure 4 between feed cost per pound of gain and net return per head. A lesser degree of association is seen in Figure 5 between initial weight per head and net return per head. In Figures 2 and 3 there is a closer fitting of the dots to the regression lines than in Figures 4 and 5.

The primary assumption in linear multiple correlation is linearity of relationship. An unit change of Y on X is the same at any point on X axis, whereas physiological relations are more often curvilinear which means that at some points on the X axis the change in Y will be greater or less for an unit change in X at other points. As would be expected, each pair of variables showed a linear relation, but because of the close association with physiological factors a slight curved relation is evident between net return per head and initial weight per head, net return per head and feed cost per pound of gain and net return per head and selling price per hundredweight. The relations are so nearly linear, however, as to justify the use of the linear multiple correlation analysis.

Net and Multiple Linear Correlation of the Factors

Since the gross correlation coefficients are not satisfactory in measuring separate effects of each variable where many independent factors are varying simultaneously, net correlation coefficients of the factors used in the study were obtained by the use of the multiple correlation process.

The analysis of the independent factors by net correlation method gave some interesting results. The net coefficients and also the gross coefficients for these independent factors are given in Table XI.

Table XI. Gross and net linear correlation between net return per head and other factors.

Item	Gross correlation Coefficient	Net correlation Coefficient
A Net return per head with:		
B Purchase price per hundredweight	-.688	-.784
C Selling price per hundredweight	+.818	+.936
D Feed cost per pound of gain	-.686	-.926
E Initial weight per head	-.430	-.273

A comparison of the gross and net coefficients indicates a considerable difference in their respective sizes. It is to be noted that the gross coefficient of -.688 for net return per head and purchase price per hundredweight became -.784 in the net correlation; the +.818 gross coefficient for net return per head and selling price per hundredweight became +.936; the -.686 gross coefficient for feed cost per pound of gain and net return per head became -.926; and the -.430 gross coefficient for initial weight per head and net return per head became -.273. The greatest change appeared between the two coefficients for feed cost per pound of gain and net return per head.

Of course, it follows, naturally, that each factor should have a higher degree of net correlation with the net return per head, since all the independent factors except one are held constant, in order to obtain the net effect of the one. Yet the result is more accurate as an indicator of the relative importance of the individual factors.

The joint effect of the four independent factors upon the net return per head is shown in Table XII. The multiple correlation coefficient was .985, almost unity. The remaining factors such as death loss, gain in weight per head, interest, value of man labor, and horse work, the use of equipments, and other miscellaneous items would have had but a minor effect on the dependent factor. In the adjustment of R .985 for the number of cases used, the final multiple correlation coefficient was .983 as is shown in

Table XII.

Table XII. Multiple linear correlation of net return per head with the four dependent factors.

	Multiple linear correlation	
Net return per head correlated with; Purchase price per hundredweight, Selling price per hundredweight, Feed cost per pound of gain, Initial weight per head	R	.985
	[1] $\bar{R}$	.983

[1] Corrected coefficient of R for number of variables used by formula $\bar{R}^2 = 1 - \frac{1 - R^2}{1 - \frac{m}{n}}$ where

m = the number of independent variables
n = the number of observations
$\bar{R}$ = the corrected coefficient

Relative Significance of Each Factor

It has been found that .985 per cent of the total variation in net return per head could be ascribed to the combined effect of the four independent factors. The relative significance of these factors as recorded in Table XIII are measured by the coefficients of determination which in their ranking order are: selling price per hundredweight, 45 per cent; feed cost per pound of gain, 32 per cent; purchase price per hundredweight, 18 per cent; and initial weight per head, 2 per cent. The first three factors named contribute 95 per cent of the total effect

upon the dependent factor.

Table XIII. Relative significance of each factor

Factors	Coefficient of determination
B Purchase price per hundredweight	18
C Selling price per hundredweight	45
D Feed cost per pound of gain	32
E Initial weight per head	2
All factors	97

PREDICTION FORMULA

The multiple linear correlation analysis applied to the problem in question, "what is the relative importance of the several economic factors affecting livestock feeding and what is their combined effect upon the resulting financial returns?", has been answered. It was discovered that the composite influence of the four significant factors, namely, the purchase price, the sale price, the feed cost per pound of gain, and the initial weight almost entirely determined the gain or loss to the farmer in finishing the sheep for the market. Tolley, (15) found these same factors to be the most significant in determining the gain or loss in fattening baby beef for the market.

The purpose of the correlation analysis, thus far, has been to show that relationship exists between the above named independent factors and the dependent factor. The degree of these relationships has been measured and expressed in terms of gross, net, and multiple coefficients. Then the relative effect of each factor upon the financial returns was obtained through the net coefficients of determination.

Another purpose of correlation analysis is to be able to estimate prices. Price estimates are found by the use

of a regression[1] equation. The co-variation of the independent factors was found to be R.985. If the correlation had been 1.000 or perfect correlation, a regression equation based upon this correlation should have given prices exactly the same as the actual prices. But since the correlation was .985 the estimated prices will differ some from the actual prices. The multiple correlation coefficient and the per cent of determination are valuable as measures of the reliability of the estimated prices. A high correlation permits closer estimates than a moderate size correlation.

If the farm data have been carefully gathered, checked and analyzed, and if the samples may be assumed to be typical of the area, then the estimates made by using the computations from the observed data ought to apply to other farms not included in the detailed cost route with about the same degree of accuracy as was true of the observed data according to Tolley (13). The degree of correlation of the factors as shown by the size of the correlation coefficients is another important consideration in the accuracy of estimating results for other farms. In the main the feeder sheep data analyzed in this study come well under the qualifications just specified. If these assumptions are relatively true, then some reliance can be placed upon estimating results for other farms, or for finding

[1]See EXPLANATION OF STATISTICAL TERMS USED.

probable results with different assumed prices for the same farms studied.

Illustration of the Use of the Prediction Equation

The regression or prediction equation was derived from the multiple correlation process. The prediction equation contains the independent factors with their net regressions plus the constant. The equation is:

K (-1.4553) equals Constant
B (- .5451) equals Purchase price per hundredweight
C (+ .8637) equals Selling price per hundredweight
D (- .2615) equals Feed cost per pound of gain
E (- .01177) equals Initial weight per head
A equals Net return per head fed.
The sum of K, B, C, D, and E equals A

How may the equation be used? By substituting any desired values for all the factors in the equation except one, it is possible to compute the value of the unknown one. Thus, what would be the value of net return per head with the following assumed values for the independent factors: purchase price $11 per hundredweight; selling price $13 per hundredweight; feed cost per pound of gain $.08; and initial weight per head 65 pounds.

Using these assumed values, solve for net return per head:

A equals (-1.4533) plus (11 times -.5451) plus
(13 times -.8637) plus (8 times -.2615)
plus
(65 times +.01177)
equals (-1.4553) plus (-5.9961) plus (+11.2281)
plus
(-2.0920) plus (-.7650)
equals -.92

By the solution of this equation the net return per head was found to be $.92.

Only assumed values for the factors can be used which would fall within the sphere studied. The data show the range of purchase price per hundredweight was $11.42 to $14.98; selling price per hundredweight, $11.53 to $17.06; feed cost per pound of gain, $.0616 to $.2446; and initial weight per head, 49.1 pounds to 85 pounds.

Practical Use of the Prediction Equation

In the practical use of the prediction equation, or forecasting formula, recognition must be taken of the assumption upon which it is based. It is assumed that these same dominant relationships discovered in the correlation study will continue to operate to about the same extent in a future period, and that these situations do repeat themselves in the main. However, there is always a possibility for a combination of new influences to develop but probably

not to such an extent as to upset the relative importance of the factors in the forecast, and therefore, does not demolish its reliability. Nevertheless a minor factor, as death loss can become of such magnitude as to convert it into a dominant factor and thereby disturb the forecasting equation for that particular period.

The limitations of the equation have been discussed and an example of using the equation has been given. For illustrative purpose a series of tables constructed from the prediction equation are set forth for inspection. In giving values for the factors in the equation only those were used which were the most representative of the actual values of these factors of the records used in the study. The given values do not differ widely from the average values of these factors. Hence, the estimated values for the different factors will be very representative of the period studied.

Several arrangements were devised in substituting values for the factors in the equation in solving for the different assumed unknowns.

In the first arrangement both assumed and average values for the factors were used in solving for the unknown, net return per head. The average values for the factors for the five year period studied are:

Purchase price	$13.21 per hundredweight
Selling price	$14.53 per hundredweight
Feed cost per pound of gain	$ .1224 per pound
Initial weight per head	66.5 pounds
Net return per head	$ -.09

The results from the computations are shown in Tables XIV, XV, and XVI. It can be seen that by increasing the selling price per hundredweight by $1 in Table XIV the net return per head was enlarged much more than by decreasing the purchasing price per hundredweight by $1 in Table XV or by decreasing the feed cost per pound of gain in Table XVI.

Table XIV. Predicted values of net return per head with assumed values of selling price per hundredweight, all other factors held constant at their average values for the 54 records.

Assumed	Predicted
Selling price per hundredweight	Net return per head
Dollars	Dollars
14	- .55
15	.32
16	1.18
17	2.04

Table XV. Predicted values of net return per head with assumed values for purchase price per hundredweight, all other factors held constant at their average values for the 54 records.

Assumed	Predicted
Purchase price per hundredweight	Net return per head
Dollars	Dollars
13	.02
12	.57
11	1.11
10	1.65

Table XVI. Predicted values of net return per head with assumed values for feed cost per pound of gain, all other factors held constant at their average values for the 54 records.

Assumed	Predicted
Cost per pound of gain	Net return per head
Dollars	Dollars
.14	- .55
.12	- .03
.10	.50
.08	1.02

In the second arrangement only assumed values for the factors were used. The results are given in Tables XVII, XVIII, and XIX. Some of the assumed factors were held constant while others were varied. The unknown factor in Table XVII was the selling price per hundredweight and the assumed net return per head in all cases was $1. In Table XVIII the unknown factor was the purchase price per hundredweight with assumed values of $1 and $1.50 for the net return per head. Feed cost per pound of gain became the unknown factor with assumed values for net return per head of 0, $1.00 and $1.50 in Table XIX.

These prediction tables are indicators as to what combinations of values for the independent factors are necessary to break even or to make certain gains in the sheep feeding enterprise. These forecasted results are likely to appear in the future under similar conditions for the period studied.

Reference will be made to the prediction Tables under the comparative analysis of partnership contracts.

Table XVII. Predicted values of selling price per hundredweight with assumed values for all other factors; initial weight per head and net return per head held constant.

B Assumed Purchase price per hundredweight	C Predicted Selling price per hundredweight	D Assumed Feed cost per pound of gain	E Assumed Initial weight per head	A Assumed Net return per head
Dollars	Dollars	Dollars	Pounds	Dollars
11	13.10	.08	65	1.00
11	13.70	.10	65	1.00
11	14.30	.12	65	1.00
12	13.70	.08	65	1.00
* 12	14.30	.10	65	1.00
** 12	14.90	.12	65	1.00
13	14.30	.08	65	1.00
13	14.95	.10	65	1.00
13	15.60	.12	65	1.00

Table XVIII. Predicted values of purchase price per hundredweight with assumed values for all other factors; initial weight per head held constant.

B Predicted Purchase price per hundred-weight	C Assumed Selling price per hundred-weight	D Assumed Feed cost per pound of gain	E Assumed Initial weight per head	A Assumed Net return per head
Dollars	Dollars	Dollars	Pounds	Dollars
9.30	12	.08	65	1.00
8.30	12	.10	65	1.00
7.30	12	.12	65	1.00
10.90	13	.08	65	1.00
9.90	13	.10	65	1.00
8.90	13	.12	65	1.00
12.50	14	.08	65	1.00
11.50	14	.10	65	1.00
10.50	14	.12	65	1.00
9.50	14	.14	65	1.00
12.15	15	.10	65	1.50
*11.15	15	.12	65	1.50
10.15	15	.14	65	1.50
**12.75	16	.12	65	1.50
11.75	16	.14	65	1.50

Table XIX. Predicted values of cost per pound of gain with assumed values for all other factors; initial weight per head held constant.

B Assumed Purchase price per hundred-weight	C Assumed Selling price per hundred-weight	D Predicted Feed cost per pound of gain	E Assumed Initial weight per head	A Assumed Net return per head
Dollars	Dollars	Dollars	Pounds	Dollars
11	11	.049	65	.00
12	12	.061	65	.00
13	13	.073	65	.00
14	14	.086	65	.00
12	13	.094	65	.00
12	13	.056	65	1.00
12	14	.127	65	1.00
13	15	.101	65	1.00
13	15	.082	65	1.50
12	14	.070	65	1.50
11	13	.058	65	1.50

PARTNERSHIP CONTRACTS

In the preceding economic and statistical research analysis the dominant factors which influence the profit or losses from feeding sheep have been found. They are in ranking order, selling price, feed cost per pound of gain, purchase price, and initial weight. These factors with their respective regressions have been set up into a forecasting equation. This formula will be serviceable in determining an equitable division of expenses and receipts between the tenant and the landlord under the various partnership arrangements.

Essentials of a Fair Partnership Contract

What is a fair partnership contract? The net profit of the sheep feeding enterprise is the residue or pay for the management of both the tenant and the landlord, the former for his skill and knowledge in handling and feeding the sheep and the latter for his judgment in buying and selling the sheep. The skill and knowledge of both partners are needed. Since the partners are mutually dependent upon each other for the success of the feeding enterprise, each are deserving of compensation. A fair partnership contract awards to each partner an equitable division of

the net profits in direct proportion to his invested capital and his assumed risks.

Relative Advantages of the Different Contracts

The two important types of partnerships, namely, the fixed-ratio type, and the flexible-ratio type, have been fully explained. What are the relative advantages of these two forms?

The Fixed-ratio Type. The fixed-ratio type gives a decided advantage in that each partner shares in the resulting gain or loss of the feeding enterprise according to the specified proportion agreed upon. This type offers to the tenant an opportunity to select from among the different shares, as the half-and-half, the one-third-two-thirds, or the one-fourth-three-fourths, the one best suited to his available capital or to the amount which he is willing to risk in the enterprise.

The Flexible-ratio Type. The flexible-ratio type, or labor against capital, on the other hand, offers to the tenant with but little capital an opportunity to engage in the feeding business, and thereby appreciably increase his farm income. Although he does not have the capital he can supply the man labor, and the horse work, the value of which is supposed to equal the interest on the capital of the landlord. Under this contract both partners are assumed to share equally in the final gain or loss. The study of the records has shown that they did not share

equally unless there was at least a margin ranging between $1.00 and $1.50 per head. In case of a loss the tenant bore the greater proportion of it. These statements are well verified in Figure 1.

Labor versus Capital Contract

Model and Customary Contracts. A model and a customary contract have been drawn up for direct comparison. Several differences appear in the contracts. It is to be noted in particular in the model contract that the landlord either purchases or furnishes all of the feed. This means that the tenant receives pay for his share of the farm grown feeds used in the feeding operation. This arrangement gives added security to the tenant in the undertaking.

Another difference lies in the division of the corral and water system costs. In the model contract the landlord pays the cash repair expenses on both items while the tenant pays for the fuel and oil used for the water system. The basis for this division was obtained from Tables XX and XXI. The ratio of expense on the corral and water system charges between the tenant and the landlord was found to be 30 and 70 per cent, respectively. It can be observed in Table V that the landlord's share of the corral and water system charges approximately offset the tenant's share plus the use of his farm machinery. These items, then, tend to cancel out in the long run.

Table XX. Distribution of feeder sheep corral costs on 50 records for the years 1922, 1923, 1924, 1925 and 1926.

[1]Items	Total cost	Per cent landlord's cost of the total cost	Per cent tenant's cost of the total cost
Total cost	$4,819.64	70	30
Landlord's cost:			
Depreciation	2,350.41	49	
Cash repairs	990.83	21	
Tenant's cost:			
Labor, man and horse	1,478.40		30

[1]The 50 records studied were on 21 different farms of which 10 were tenant farms and 11 were owner farms. The customary practice of dividing these costs on the tenant farms was applied to the owner farms.

Table XXI. Distribution of water system costs on 53 feeder farms for the years 1922, 1923, 1924, 1925 and 1926.

[1]Items	Total cost	Per cent landlord's cost of the total cost	Per cent tenant's cost of the total cost
Total cost	$5,832.50	70	30
Landlord's cost:			
Depreciation	3,171.56	54	
Cash repairs	947.90	16	
Tenant's cost:			
Labor, man and horse	696.70		12
Cash, fuel and oil	1,016.34		18

[1]The 53 records studied were on 21 different farms of which 14 were tenant farms and 7 were owner farms. The customary practice of dividing these costs on the tenant farms was applied to the owner farms.

Labor versus Capital

Model Contract

Items	Landlord	Tenant
	The landlord will pay or furnish:	The tenant will pay or furnish:
Feeder stock	All	
Feed:		
Grown on farm	All	
Purchased	All	
Corrals	Cash expenses	
Water system:		
Repairs	Cash expenses	
Fuel and oil		All
Farm machinery		All
Marketing	All	
Miscellaneous cash items	All	
	Landlord receives:	Tenant receives:
Residue after deducting above expenses from total receipts	One-half	One-half
To cover:		
Labor:		
Man		All
Horse work		All
Interest	All	
Wages of management	Profits	Profits

Labor versus Capital

Customary Contract

Items	Landlord	Tenant
	The landlord will pay or furnish:	The tenant will pay or furnish:
Feeder stock	All	
Feed:		
Grown on farm	One-half	One-half
Purchased	All	
Corrals	Cash expenses	
Water system:		
Fuel and oil	One-half	One-half
Marketing	All	
Miscellaneous cash items	One-half	One-half
	Landlord receives:	Tenant receives:
Residue after deducting above expenses from total cash receipts	One-half	One-half
To cover:		
Labor:		
Man		All
Horse work[1]		All
Farm machinery		All
Interest	All	
Wages of management	Profits	Profits

[1]Horse feed included in joint supply.

The Necessary Net Return per Head. The study has shown that a net return per head ranging between $1.00 and $1.50 is necessary in order that the value of the labor and the horse work furnished by the tenant shall approach close parity to the interest on the capital furnished by the landlord. What are the necessary values for the independent factors to secure this net return? Reference is made to the prediction tables.

Predicted Values for Net Return per Head. By reference to Table XVIII there will be seen two marked lines. The one-starred line shows a spread of $3.85 between the purchase price per hundredweight and the selling price per hundredweight, and the two-starred line shows a spread of $3.25. The assumed values of $.12 for the feed cost per pound of gain, and 65 pounds for the initial weight per head were close to the five-year averages for these items. This combination of values gave the necessary $1.50 net return per head. The average spread between the purchase price per hundredweight and the selling price per hundredweight for the 54 records was approximately $1 and the average net return per head was $-.09.

What other combinations of costs would give $1.50 net return per head? They can be seen in Table XIX. In this Table feed cost per pound of gain was made the unknown factor. With an assumed spread of $2 between the purchase price per hundredweight and the selling price per hundred-

weight, and 65 pounds for the initial weight per head, the resulting values for the feed cost per pound of gain were $.082, $.070 and $.058. These values are much below the five-year average feed cost. However, some feeders have been able to keep their feed costs as low as $.08 per pound of gain.

Predicted values built on the five-year average for the net return per head are given in Tables XIV, XV and XVI. It is to be noted in Table XIV that an increase of $1 in the selling price per hundredweight enlarges the balance per head more than by decreasing the purchase price per hundredweight by $1 in Table XV or by decreasing the feed cost per pound of gain in Table XVI.

From the preceding discussion it appears that a return of $1.50 per head cannot be expected very often so consideration is given to the values of the cost factors necessary for a $1 net return per head. These values appear in Table XVII. Two starred lines are observed. The one-starred line shows that in order to obtain the $1 net return per head, the selling price per hundredweight must be $14.30 or a spread of $2.30 between the purchase price and the selling price. The two-starred line shows a spread of $2.90 between these two items, but the feed cost per pound of gain was increased from $.10 to $.12 per pound of gain while the purchase price remained the same in both cases. The values used for the dominant factors in these two examples represent the more usual values in

the data studied.

Chances of Securing the Necessary Net Return per Head. If the labor-capital contract is to be followed, a minimum of not less than $1 return must be obtained so that the tenant will not be discriminated against. What are the chances of making this required gain? Table XXII reveals the probabilities.

Table XXII. The number of times that the net return per head was a gain or a loss on fifty-four feeder sheep records for five years.

Year	1922-1923	1923-1924	1924-1925	1925-1926	1926-1927	Total
Number of gains	7	13	10		4	34
Number of losses	2	1	3	14		20
Number of gains from;						
$ 1.00 to 1.49	1	3	1		2	7
1.50 to 1.99	2	2				4
2.00 to 2.49	2	1				3
2.50 to 2.99	3	1			2	6

It was found in the five years studied, that 20 records showed losses and 34 records showed gains. Out of the 34 profitable records there were only 20 which showed adequate profit to reward the tenant in about the same proportion as the landlord. The evidence seems clear that the tenant will lose more times than win under the labor-capital contract which is assumed to divide the gains or losses in the same proportion.

Fifty-fifty Contract

Model and Customary Contracts. Since the fifty-fifty contract is followed more often than any of the other fixed-ratio types in the area studied, a model and a customary one have been drawn up for review. In comparing these two contracts several differences are obvious. Under the customary provisions the landlord paid the cash repairs and one-half of the fuel and oil cost of the water system charge. In the model contract the latter cost is paid by the tenant. This division was made in the light of the facts revealed in Table XXI. The farm cost of horse work was added in the model draft. In the customary settlements under this contract the major charge made for horse work is the feed cost which is generally included in the sheep feed cost. Of course, it is known that the feed cost is only a part of the horse labor cost.

Fifty-fifty

Model Contract

Items	Landlord	Tenant
	The landlord will pay or furnish:	The tenant will pay or furnish:
Feeder stock	One-half	One-half
Feed:		
Grown on farm	One-half	One-half
Purchased	One-half	One-half
Corrals	Cash expenses	
Water system:		
Repairs	Cash expenses	
Fuel and oil		All
Farm machinery		All
Marketing	One-half	One-half
Miscellaneous cash items	One-half	One-half
	Landlord receives:	Tenant receives:
Residue after deducting above expenses from total receipts	One-half	One-half
To cover:		
Labor:		
Man	One-half	One-half
Horse work	One-half	One-half
Interest	One-half	One-half
Wages of management	Profits	Profits

Fifty-fifty

Customary Contract

Items	Landlord	Tenant
	The landlord will pay or furnish:	The tenant will pay or furnish:
Feeder stock	One-half	One-half
Feed:		
Grown on farm	One-half	One-half
Purchased	One-half	One-half
Corrals	Cash expenses	
Water system:		
Repairs	Cash expenses	
Fuel and oil	One-half	One-half
Marketing	One-half	One-half
Miscellaneous cash items	One-half	One-half
	Landlord receives:	Tenant receives:
Residue after deducting above expenses from total cash receipts	One-half	One-half
To cover:		
Labor:		
Man	One-half	One-half
Horse work[1]		All
Interest	One-half	One-half
Wages of management	Profits	Profits

[1]Horse feed included in joint supply.

Comparative Theoretical Returns from the Different Contracts

To obtain a theoretical comparison of the returns from different contract, Table XXIII was constructed. The average of the 54 records was used as the basis for the conversion into the different partnership arrangements. The average number of head fed was 1,464, the average net return per head was $-.09. By an examination of this Table it is found that the landlord under the labor versus capital contract made the only gain, of $56.33 of all the arrangements, and that the tenant suffered the greatest loss. The loss was $174.80 as compared with $-59.23 under the fifty-fifty; $-39.48 under the one-third-two-thirds; and $-29.61 under the one-fourth-three-fourths. Further, the tenant's total cost of $612.06 for man labor and horse work is considerably larger than the interest charge of $369.43 paid by the landlord. It is evident that the wide difference in these costs bears heavily upon the tenant.

In each kind of partnership there is adequate margin to pay for the man labor, the horse work, and the interest after the purchase cost, the feed cost, the marketing, and the miscellaneous cash items had been paid, except in the case of the tenant under the labor against capital arrangement. Here there was a deficiency of $53.95 for meeting the above listed items. The last balance was not enough

Table XXIII. Comparative returns from feeder sheep under the different kinds of partnerships. Based on the average of 54 records for 5 years.

	All Farms	Fifty-fifty		One-third two-thirds		One-fourth three-fourths		Labor vs. capital	
		Tenant	Landlord	Tenant	Landlord	Tenant	Landlord	Tenant	Landlord
RECEIPTS.....	$19235.23	$9617.61	$9617.62	$6411.75	$12823.48	$4808.81	$14426.42	$	$19235.23
EXPENSES									
Purchase.....	12509.04	6254.52	6254.52	4169.68	8339.36	3127.26	9381.78		12509.04
Feed.....	4574.21	2287.11	2287.10	1524.74	3049.47	1143.55	3430.66		4574.21
Marketing.....	879.46	439.73	439.73	293.15	586.31	219.88	659.58		879.46
Miscellaneous...	156.29	78.14	78.15	52.10	104.19	39.06	117.23		156.29
Total	18119.00	9059.50	9059.50	6039.67	12079.33	4529.75	13589.25		18119.00
Balance to cover	1116.23	558.11	558.12	372.08	744.15	279.06	837.17	558.11	558.12
Interest.....	369.43	184.71	184.72	123.14	246.29	92.36	277.07		369.43
Man labor.....	434.85	217.42	217.43	144.95	289.90	108.71	326.14	434.85	
Horse work....	177.21	88.61	88.60	59.07	118.14	144.30	132.91	177.21	
Total	981.49	490.74	490.75	327.16	654.33	245.37	736.12	612.06	369.43
Balance to cover	134.74	67.37	67.37	44.92	89.82	33.69	101.05	-53.95	188.69
Water charge..	83.01	41.50	41.51	27.67	55.34	20.75	62.26	24.90	58.11
Corrals.....	106.07	53.04	53.03	35.36	70.71	26.52	79.55	31.82	74.25
Equipment.....	64.13	32.06	32.07	21.37	42.76	16.03	48.10	64.13	
Total	253.21	126.60	126.61	84.40	168.81	63.30	189.91	120.85	132.36
NET RETURNS.....	-118.47	-59.23	-59.24	-39.48	-78.99	-29.61	-88.86	-174.80	56.33

to cover the total cost of the water system, the corral and the equipment charges except again in the case of the landlord under the labor against capital contract.

The figures in this Table are indicative of sufficient funds to pay for the majority of the costs of the feeding operation. They also show that the tenant would not have lost his capital under the fixed-ratio type, if he had fed continuously for the five years.[1]

[1]By the addition of two more years to the five years studied, the average net return per head was raised from $-.09 to $.14. This increase strengthens further the above statement. But the addition of the 8th year, or the 1929-1930 year, will make the weighted average much lower than the five-year average.

SUMMARY

The real purpose for making this economic study of feeder sheep and cattle partnerships was to analyze statistically the different kinds of contracts and the economic factors which cause variations in the financial returns from the feeding operation and then with these bases to decide which form of contract was the fairest to its contracting parties.

The source of the data used was described.

A brief history of cattle and sheep feeding in Northern Colorado and in the state as a whole was given to show the magnitude and the risks of the industry.

To show the necessity for partnership feeding a very brief review was made of the growth of tenancy in the area studied. In this connection actual examples of the amount of capital required for the feeding enterprise and the source of credit were given.

The important types of partnerships were discussed and the common provisions of the two most common contracts, namely, the fifty-fifty and the labor-capital, were described.

A comparative study of the actual settlements and the settlements, including the prorated farm costs for the

fifty-fifty and the labor-capital arrangements was made.

The gross linear correlation method was employed for the analysis of the various economic input factors.

Gross correlation method was first applied to the 21 partnership feeder sheep records. Then, to secure greater accuracy from more samples, the data from the 54 feeder sheep records which extend over a period of five years were studied by gross, net, and multiple linear correlation methods to find the most important factors influencing the financial returns from feeding sheep.

Correlations among the variables have been calculated and are given, Tables VIII to XIII, inclusive, and Figures 2 to 5, inclusive.

The significant causal factors as a result of the linear correlation method were found to be selling price, purchase price, feed cost per pound of gain, and initial weight. The multiple correlation of these factors was R.985, or almost unity.

Ninety-seven per cent in the variations in the financial returns was found to be due to the combined effect of these four factors.

A forecasting equation derived from the multiple correlation process was used for predicting the fluctuations for each of the four independent variables and for the probable return. An example illustrating the use of the equation was given. The accuracy and the limitations of the prediction formula were discussed. A series of

prediction tables were constructed to show the effect of the various price and cost combinations upon the resulting gain per head fed for feeder sheep.

The relative advantages of the different contracts were discussed. This discussion was followed by a set-up of a model and a customary contract for both the half-and-half share and the labor-capital methods, and the fairness of their respective contractual relations among the partners was analyzed. In the analysis of these two contracts use was made of the prediction equation.

For a final comparison of the fixed-ratio and the flexible-ratio types of partnerships, the average of the 54 feeder sheep records was used as the basis for a theoretical conversion into the several kinds of contracts in Table XXIII.

CONCLUSIONS

The statistical analysis of the 54 feeder sheep records, mostly from Weld County, Colorado has demonstrated that the fixed-ratio partnerships were the fairest to the tenant. In the fixed-ratio agreements one partner was not penalized at the expense of the other if the feeding venture proved to be a loss. Furthermore, the analysis has shown that the tenant would not have lost his capital in the five-year period studied, since the receipts were large enough to meet the major expenses of the feeding enterprise.

The study also revealed that the labor against capital contract, or flexible type, will penalize the tenant more than the landlord under the existence of unfavorable prices, and also if the returns should be rather small, the tenant will receive a lesser share of them than the landlord. On the other hand, when favorable prices prevail, the tenant has a chance to win a large return without having risked his capital. Practically all of the individual feeder sheep records studied showed that the sum of man labor and horse work is greater than the interest cost and, therefore, it takes a good margin to equalize the shares of the partners. In the five-year

period the capital of the landlord remained intact.

The data in this study will be serviceable to prospective sheep feeders who wish to enter into a partnership to make a wiser choice from among the respective analyzed contracts. Before a particular partnership contract is selected a study of the prediction Tables XIV to XIX, inclusive, would be helpful in seeing the probable returns as a result of the varying values for the dominant factors. These figures can be compared with the estimated or the actual cost of the individual's previous feeding operations.

Which contract in the last analysis should be selected for partnership feeding? The decision will be always influenced by the financial resources of the contracting parties, by their managerial abilities, by their skill and knowledge of the feeding game, and by their bargaining abilities. There must be a willingness to study the ever-changing economic forces of price, supply and demand with regard to the sheep feeding industry.

EXPLANATION OF STATISTICAL TERMS USED (9)

(The use and meanings of these terms are here explained in order that the information contained in the articles referred to may be more readily used by persons who are not familiar with correlation procedure)

The relation between two or more factors may be measured by gross, net, and multiple correlation methods.

Gross Correlation deals with the relationship between two factors, the influence of all other factors being ignored. It is an effective method when fluctuations in one factor are due chiefly to the influence of only one other factor.

Net Correlation deals with the relationship between two factors, the influence of certain other selected factors being eliminated by eliminating their effects by mathematical methods.

Multiple Correlation deals with the relationship between one factor and a group of selected factors acting as a unit. It is seldom, if ever, possible to include in an investigation all factors responsible for fluctuations, but the important factors of immediate interest may be considered, and the combined influence of these important factors all acting upon the one factor is determined by

this method.

The way in which one factor affects another factor may be represented (graphically) either by a straight line or a curve. Linear correlation considers the relationship as indicated by the straight line of best fit, represented by the equation of a straight line. Curvilinear correlation considers the relationship represented by the curve of best fit. The true relationship between factors can usually be determined more accurately by curvilinear method than by linear methods.

The coefficient of correlation is a measure, in abstract terms, of the degree of relationship between factors insofar as this relationship may be determined by linear correlation. Since the coefficient is an abstract term wholly detached from any concrete term of measurement, a comparison is afforded of the relation between factors employing entirely different units of measure. The relationship, or correlation, is perfect when a change in one factor is always accompanied by a similar change in the other. When an increase in one factor is accompanied by an increase in the other factor the correlation is positive and is signified by a plus (+) sign. On the other hand, if the increase in one factor is accompanied by a decrease in the other, the correlation is said to be negative and is signified by a minus (-) sign. Perfect positive correlation is represented by a coefficient of +1.0, perfect negative correlation by a coefficient of

-1.0 and no correlation by a coefficient of 0.

The coefficients of determination indicate in terms of percentages the portion of variability of the dependent factor for which each of the causal, or independent, factors are apparently responsible. The per cent of variation in the dependent factor which is determined by the entire group of causal factors is the sum of the coefficients of determination. When other factors are included in a study the relative importance of each factor may change somewhat.

The coefficient of regression measures the average change in the dependent factor associated with a unit change in the causal, or independent factor, where the relation is expressed by a straight line.

The independent factors are those whose values change for causes other than those considered in the particular study. The dependent factor is the one the value of which is regarded as being dependent upon, or caused by, changes in the independent factor or factors.

By substituting values derived by linear correlation in the equation to a straight line, or by reading values from the curves when curvilinear correlation has been employed, an estimate of the value of the dependent factor most likely to accompany given values for the independent factors can be made.

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A B S T R A C T

OF THE

T H E S I S

A N E C O N O M I C S T U D Y O F F E E D E R S H E E P P A R T N E R S H I P S

Submitted by

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In partial fulfillment of the requirements

for the Degree of Master of Science

Colorado Agricultural College

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Sheep and cattle feeding on irrigated farms in Northern Colorado has become an economic necessity due to the system of farming which has developed in the area. Well-balanced systems have been built around staple enterprises adapted to the area. Crops and livestock have been selected which fitted well together and contributed to each other. Under this program the operator is given an opportunity to use his labor and his equipments effectively. The most important livestock enterprise is the feeding of sheep and cattle which provides the best means for the utilization of the non-marketable feeds. Since these feeding operations require considerable financial resources, two or more persons very frequently enter into a partnership for the undertaking. These persons are usually the tenant and the landlord.

The real purpose for making this economic study of feeder sheep and cattle partnerships was to analyze statistically the different kinds of contracts and the economic factors which cause variations in the financial returns from the feeding operation and then with these bases to decide which form of contract was the fairest to its contracting parties.

The data for this investigation were obtained from farmers in Northern Colorado during the years 1922, 1923, 1924, 1925, and 1926. The farms studied are located chiefly in Weld County. The records were taken from the farmers by the detailed cost route method. By this method the farms were visited at regular intervals each year and the farmers were assisted in keeping complete and accurate records of all their farming operations. The data gathered show the man labor, the horse work, the seed, the fertilizer, and other materials in growing crops and the feed, the man labor, the horse work, and the miscellaneous cash costs in producing livestock and livestock products. The data also show the yield of each crop, the quantity sold, and the disposition of the balance and the sales of the livestock and livestock products. The sheep and cattle feeding enterprises on these farms were selected for particular analysis.

The feeding of sheep and cattle on the irrigated farms in Northern Colorado has grown into an extensive business. This whole area has taken the lead in the feeding of lambs in the United States. Colorado is one of the important cattle feeding markets in the country and is the leading lamb feeding state of the nation. In 1929 Northern Colorado fed 88 per cent of the cattle and 80 per cent of the sheep and lambs in Colorado. For the last seven years the average number of sheep and lambs on feed in the state was about one and a half million.

To show the necessity for partnership feeding a very brief review was made of the growth of tenancy in the area studied. In this connection actual examples of the amount of capital required for the feeding enterprises and the source of credit were given.

The important types of partnerships, the fixed-ratio and the flexible-ratio were discussed and the common provisions of the two most common contracts of these types, namely, the fifty-fifty and the labor-capital, were described.

A comparative study of the actual settlements and the settlements, including the prorated farm costs for the fifty-fifty and the labor-capital arrangements was made.

The gross linear correlation method was employed for the analysis of the various economic input factors.

Gross correlation method was first applied to the 21 partnership feeder sheep records. Then, to secure greater accuracy from more samples, the data from the 54 feeder sheep records which extend over a period of five years were studied by the gross, the net, and the multiple linear correlation methods to find the most important factors influencing the financial returns from feeding sheep. Correlations among the variables can be found in Tables VIII to XIII, inclusive, and in Figures 2 to 5, inclusive.

The significant causal factors as a result of the linear correlation method were found to be selling price, purchase price, feed cost per pound of gain, and initial

weight. The multiple correlation of these factors was R.985, or almost unity. Ninety-seven per cent in the variations in the financial returns was found to be due to the combined effect of these four factors.

A forecasting equation derived from the multiple correlation process was used for predicting the fluctuations for each of the four independent variables and for the probable return. An example illustrating the use of the equation was given. The accuracy and the limitations of the prediction formula were discussed. A series of prediction tables were constructed to show the effect of the various price and cost combinations upon the resulting gain per head for feeder sheep.

The relative advantages of the different contracts were discussed. This discussion was followed by a set-up of a model and a customary contract for both the half-and half share and the labor-capital methods and the fairness of their respective contractual relations among the partners was analyzed. In the analysis of these two contracts use was made of the prediction equation.

For a final comparison of the fixed-ratio and the flexible-ratio types of partnerships, the average of the 54 feeder sheep records was used as the basis for a theoretical conversion into the several kinds of contracts in Table XXIII.

CONCLUSIONS

The statistical analysis of the 54 feeder sheep records, mostly from Weld County, Colorado, has demonstrated that the fixed-ratio partnerships were the fairest to the tenant. In the fixed-ratio agreements one partner was not penalized at the expense of the other if the feeding venture proved to be a loss. Furthermore, the analysis has shown that the tenant would not have lost his capital in the five-year period studied, since the receipts were large enough to meet the major expenses of the feeding enterprise.

The study also revealed that the labor against capital contract, or flexible type, will penalize the tenant more than the landlord under the existence of unfavorable prices, and also if the returns should be rather small, the tenant will receive a lesser share of them than the landlord. On the other hand, when favorable prices prevail, the tenant has a chance to win a large return without having risked his capital. Practically all of the individual feeder sheep records studied showed that the sum of man labor and horse work is greater than the interest cost and that it takes a good margin to equalize the shares of the partners. In the five-year period the capital of the landlord remained intact.

The data in this study will be serviceable to prospective sheep feeders who wish to enter into a partnership to

make a wiser choice from among the respective analyzed contracts. Before a particular partnership contract is selected, a study of the prediction Tables XIV to XIX, inclusive, would be helpful in seeing the probable returns as a result of the varying values for the dominant factors. These figures can be compared with the estimated or the actual cost of the individual's previous feeding operations.

Which contract in the last analysis should be selected for partnership feeding? The decision will be always influenced by the financial resources of the contracting parties, by their managerial abilities, by their skill and knowledge of the feeding game, and by their bargaining abilities. There must be a willingness to study the ever-changing economic forces of price, supply and demand with regard to the sheep feeding industry.