June 2, 1965

To the Graduate Council:

I am submitting a thesis written by Daniel Bruce Smith entitled "An Analysis of Selected Livestock Practices and Enterprise Returns on Farms in the Elk River Watershed." I recommend that it be accepted for nine quarter hours credit in partial fulfillment of the requirements for the degree of Master of Science, with a major in Agricultural Economics.

H. P. Ramsey
Major Professor

We have read this thesis and recommend its acceptance:

[illegible]

Robert M. Kay

Accepted for the Council:

Hilton A. Smith
Dean of the Graduate School

AN ANALYSIS OF SELECTED LIVESTOCK PRACTICES AND ENTERPRISE RETURNS ON FARMS IN THE ELK RIVER WATERSHED

A Thesis

Presented to

the Graduate Council of

The University of Tennessee

In Partial Fulfillment

of the Requirements for the Degree

Master of Science

---

by

Daniel Bruce Smith

August 1965

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CHAPTER I

INTRODUCTION

I. THE PROBLEM

Much concern has been given to the economic development of the livestock industry in various regions of Tennessee. The livestock industry in a particular area is composed of many firms or farm units throughout the area. The goal of these individual units is generally that of increasing net returns, which at the farm level, would not only contribute to the competititive position of the farmers in the agricultural industry but would quite likely contribute to the overall development of the particular area.

The Elk River Watershed, the area in which this study was made, is one in which the livestock industry is a major agricultural industry. The Watershed includes Coffee, Franklin, Giles, Grundy, Lawrence, Lincoln, and Moore Counties of Middle Tennessee. Livestock and livestock products have provided a substantial source of agricultural income to farmers in the above counties for many years. In 1939, income from livestock and livestock products composed 56 per cent of the total value of all agricultural products sold in the seven counties. By 1959, this percentage had increased to 64 per cent (Figure 1). It is worthwhile to note that the percentage of total value of all agricultural products sold in this area has been greater for livestock and livestock products than for crops for the 1939-1959 period, whereas the opposite is true for the state of Tennessee (Figure 2).

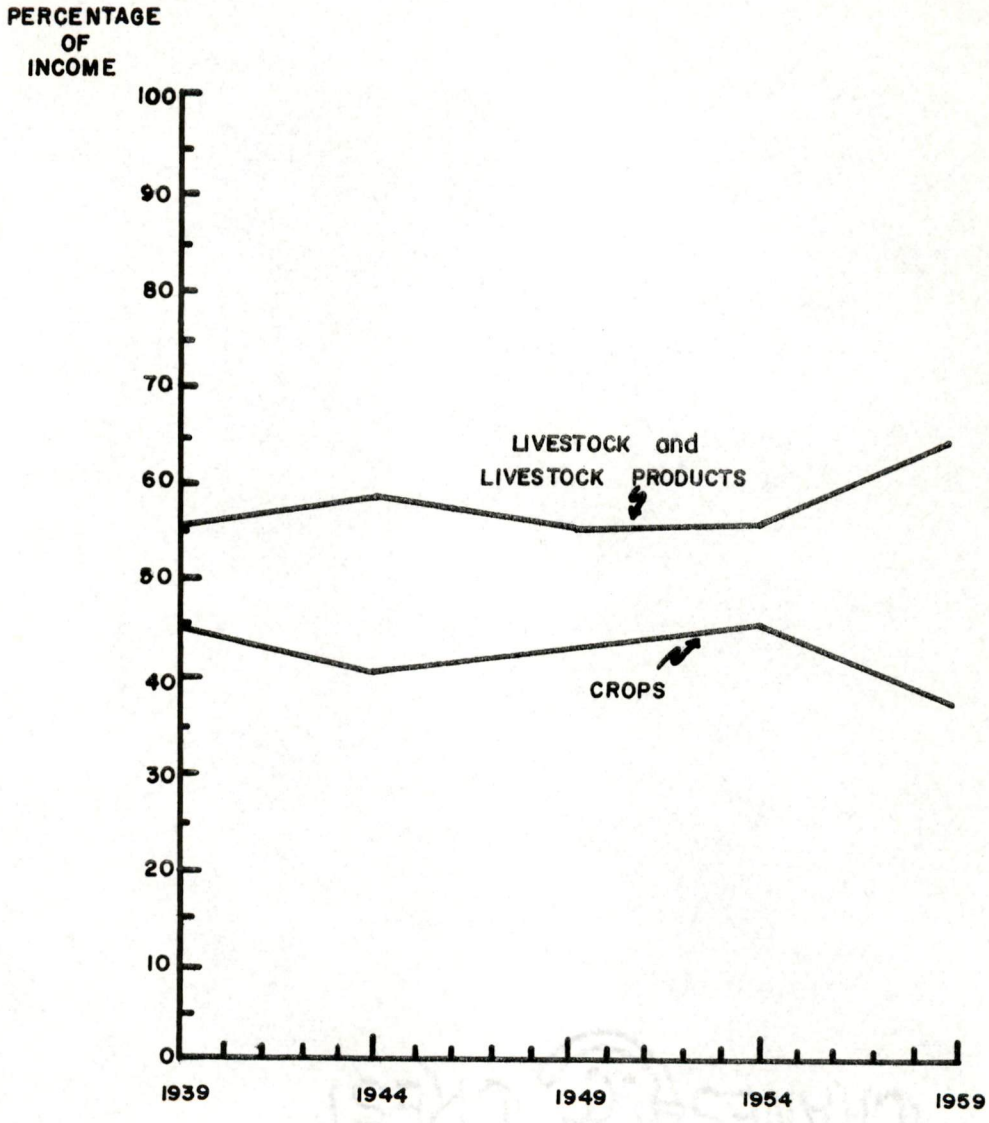


Figure 1. Percentages of income from crops and livestock and livestock products sold, Elk River Watershed, 1939-1959. (From United States Census of Agriculture, Tennessee, Vol. I, Washington: Government Printing Office, 1940, 1945, 1950, 1954, 1959.)

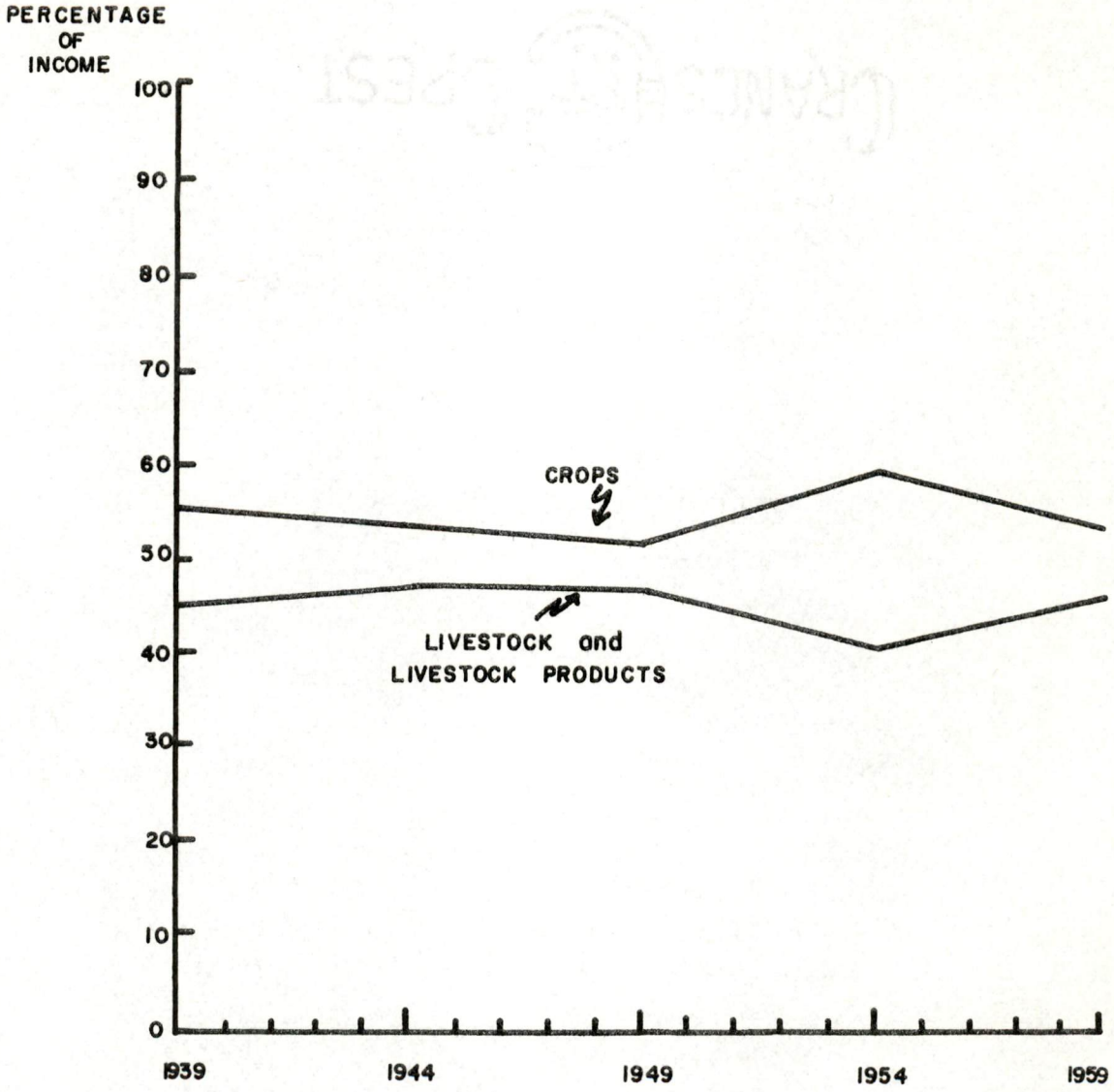


Figure 2. Percentages of income from crops and livestock and livestock products sold, Tennessee, 1939-1959. (From United States Census of Agriculture, Tennessee, Vol. I, Washington: Government Printing Office, 1940, 1945, 1950, 1954, 1959.)

Farm production expenses for all farms in the Elk River Watershed increased 96 per cent for the period 1950-1959 (Table I). During the same period gross income increased only 53 per cent. The increase in cost of production, accompanied by unstable prices, which have contributed to fluctuating farm incomes, has resulted in the farmer having been caught in a price-cost squeeze. It has become more important than ever for the agricultural producer to use better management and new technology as tools for increasing profits.

"Farm management is concerned with the decisions that affect the profitability of the farm business."[1] This comprehensive study of livestock practices and their effect on farm income should provide useful information for livestock farmers in the Elk River Watershed as they attempt to increase net returns through better management of livestock enterprises.

It is hoped that this study will also serve as a basis for further analyses of livestock enterprises in this area of the state. Additional analyses could include development of planning models based on various analytical tools, such as marginal analyses, partial budgets and linear programming, for arriving at net income. These analyses will necessitate the gathering of considerable input data.

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[1] Emery N. Castle and Manning H. Becker, Farm Business Management. (New York: The Macmillan Company, 1964), p. 1.

TABLE I

PERCENTAGE CHANGE IN GROSS INCOME AND FARM PRODUCTION EXPENSES PER FARM IN ELK RIVER WATERSHED, 1950 AND 1959

Item	1950	1959	Percentage change
Average gross income per farm	$2,583	$3,962	+53
Average farm production expenses per farm	$1,205	$2,366	+96

Source: United States Bureau of the Census, United States Census of Agriculture: 1950 and 1959, Tennessee, Vol. I (Washington: Government Printing Office); Ormond C. Corry and Patricia Ann Price, Population and Personal Income Estimates for Tennessee Counties, 1950 through 1962 (Knoxville: The University of Tennessee, May 1963), pp. 127-139.

II. OBJECTIVES

The Elk River survey provided a large amount of data which have been useful for various studies of special phases of livestock production and efficiency. The special phase chosen for this thesis pertains to farm management practices related to gross farm income from hogs, beef cattle, and dairy cattle.

The specific objectives of this study were:

1. To estimate the separate and combined effects of selected farm management practices on the average gross income received per brood animal from the production of beef calves and market hogs.

2. To estimate the separate and combined effects of selected farm management practices on the average amount of Grade A and manufactured milk sold per cow.

III. METHODOLOGY

The data used in this study were obtained from a previous study entitled "Livestock Production and Marketing Practices in the Elk River Watershed."[2] The study was a joint project by the Agricultural Extension Service and the Department of Agricultural Economics and Rural Sociology of the University of Tennessee, and the Tennessee Valley Authority. The field schedules were compiled by representatives from these organizations.

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[2]Master contract between the University of Tennessee and the Tennessee Valley Authority, "Livestock Production and Marketing Practices in the Elk River Watershed" (Unpublished, Tennessee Valley Authority, Knoxville, 1964), p. 1.

This survey did not provide the necessary data for analyzing net income over all costs; therefore, gross income was used as a measure of net income. There is usually considerable correlation between net and gross incomes, with the degree of correlation depending largely upon the relative prices of inputs and outputs. It is assumed that if information is made available to the livestock producer concerning the practices and resources involved in producing gross income, he could then proceed to evaluate the costs that would be entailed in following each practice on his own farm. Such information would also provide a basis for determining the marginal point of application of inputs in following a particular practice.

A random block sampling procedure was used by the Experiment Station to obtain data from 811 farms in the seven-county area. The number visited was approximately eleven per cent of all farms in the area.

The schedules were taken in the summer of 1964 by personal interviews with the farmers. Milk production records were obtained from the various milk companies which purchased milk from farmers in the sample area.

The farm management practices chosen to be analyzed for the selected livestock and livestock products are listed in detail in Chapter III. It is recognized that the performance of a single practice may not have a great effect on gross income; therefore, the analysis considers both the separate and the combined effects of several practices.

Analyses of variance, t tests, and other statistical techniques were used as tools for analysis.

IV. PREVIOUS RESEARCH

The results of a study of more than one hundred farms in the wheat and dairy area of St. Louis showed that farmers earning the highest returns on capital were those that excelled in the highest number of good management factors. Farmers excelling in only one or two particular factors had lower returns on capital investment. The authors emphasized that "it was balanced farming that made profitable farming."[3]

Studies by Case and Mosher of several hundred farms in Illinois revealed that a difference of $1,000 to $3,000 in net income is not an uncommon occurrence in any year among comparable farms in the same community. These differences in farm earnings are due in part to matters over which the farmer has some control. The key to many differences lies in the skill of the operator to adapt management practices that will reduce the cost per unit of production. Any one of the practices may seem a small matter in itself, but the study showed that a performance of several practices resulted in a substantial increase in net income.[4]

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[3] R. H. Wilcox, C. W. Crickman, and R. G. Trummel, Management Factors That Influence Profits in Southwest Illinois, Bulletin 374 (Urbana: Illinois Agricultural Experiment Station, October 1931).

[4] H. C. M. Case and M. L. Mosher, Farm Practices That Pay, Circular 389 (Urbana: Illinois Agricultural Experiment Station, March 1932).

Pond and Nodland made studies of five factors which affect returns above feed costs for dairy herds in Minnesota. The interrelationship of the factors studied made it difficult to measure accurately the independent relationship of each factor to production and returns over feed costs per cow. However, the combined effects of the factors could be measured and the results indicated that the farmers excelling in all five factors had the greatest returns over feed costs.[5]

A similar study was made by Pond and Nodland from farm records of several swine enterprises in Minnesota. The results of an analysis of six management factors that affect net income revealed that farmers who were below the average in all six factors did not receive an income sufficiently large to cover feed costs.[6]

McConnen, McCorkle, and Caton of the Economic Research Service have outlined three major production stages of livestock firms. They are (1) feed procurement, (2) feed consumption, and (3) feed conversion. These stages form a sequence in production. The efficiency of the production sequence depends largely on a combination of management practices that are used in each stage of production.[7]

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[5]T. R. Nodland and G. A. Pond, Managing the Dairy Herd for Greater Returns, Bulletin 378 (Minneapolis: Minnesota Agricultural Experiment Station, June 1944).

[6]T. R. Nodland and G. A. Pond, Managing Hogs for Greater Returns, Bulletin 379 (Minneapolis: Minnesota Agricultural Experiment Station, June 1944).

[7]R. J. McConnen, C. M. McCorkle, Jr., and D. Caton, "Feed-Livestock Relationships: A Model for Analyzing Management Decisions," USDA Economic Research Service, 15, 41-48, April 1963 (Washington: Government Printing Office).

In a study of factors affecting costs of producing Grade A milk in Georgia, it was emphasized that individual feeding and management practices are difficult to measure. The results of the study showed that a performance of a combination of practices, rather than of individual practices, resulted in efficient production of Grade A milk.[8]

These studies indicate that the level of farm income is influenced by the management decisions of farmers in livestock production. The effect of management practices on the level of farm income is difficult to measure, but estimates based on farm records provide useful information for increasing net returns in livestock production.

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[8]J. C. Purcell, J. R. Russell, and J. C. Elrod, Analysis of Factors Affecting Costs of Producing Grade A Milk in Georgia, Bulletin N. S. 21 (Athens: Georgia Agricultural Experiment Station, December 1960).

CHAPTER II

DESCRIPTION OF THE STUDY AREA

I. INTRODUCTION

The area of study included Coffee, Franklin, Giles, Grundy, Lawrence, Lincoln, and Moore Counties of Middle Tennessee (Figure 3). The approximate land area in these counties is 2,111,582 acres. Of this amount, 1,336,082 acres, or 66.3 per cent, were in farms in 1959.[1]

II. SOIL DESCRIPTION

The seven-county area lies in parts of the following soil associations of Tennessee: Muskingum-Hartsells, Hartsells-Muskingum, Sango-Bodine, Baxter-Dellrose-Mimosa, Dickson-Mountview-Bodine, and Cumberland-Waynesboro-Decatur (Figure 3). A brief description of the soils in these associations, as outlined in a bulletin entitled "Types of Farming in Tennessee," will provide a general knowledge of the soils in the Elk River Watershed.[2]

Beginning with Grundy County, in the eastern part of the area, the Hartsells-Muskingum Association is characterized by soils that are

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[1]United States Bureau of the Census, United States Census of Agriculture: 1959, Tennessee, Volume I (Washington: Government Printing Office, 1961).

[2]Joe A. Martin and B. H. Luebke, Types of Farming in Tennessee, Bulletin 311 (Knoxville: The University of Tennessee Agricultural Experiment Station, March 1960), pp. 17-18.

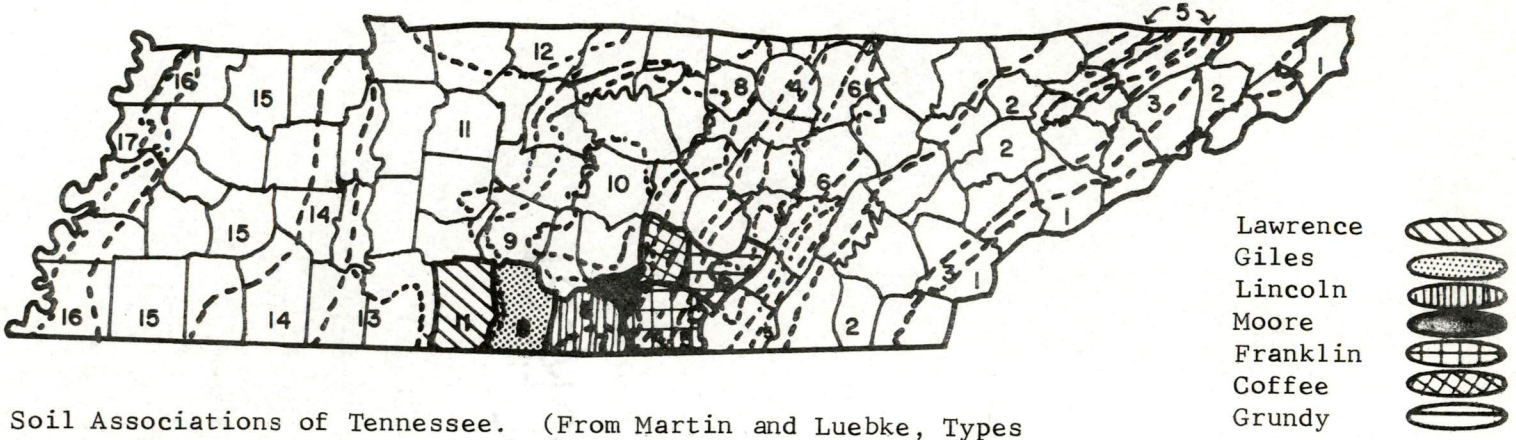


Figure 3. Soil Associations of Tennessee. (From Martin and Luebke, Types of Farming in Tennessee, Bulletin 311, The University of Tennessee Agricultural Experiment Station, March 1960.)

1. Ramsey - Stony Land - Porters
2. Fullerton - Dewey - Sequoia
3. Dandridge - Needmore
4. Cumberland - Waynesboro - Decatur
5. Muskingum - Hartsells
6. Hartsells - Muskingum
7. Sango - Bodine
8. Baxter - Dellrose - Mimosa
9. Maury - Mimosa - Stony Land
10. Talbott - Hagerstown - Stony Land
11. Dickson - Mountview - Bodine
12. Bewleyville - Baxter - Crider
13. Guin - Atwood - Savannah
14. Providence - Dulac - Ruston
15. Grenada - Loring - Memphis
16. Memphis - Loring
17. Sharkey - Robinsonville - Yazoo

low in fertility but generally respond well to good management. This association includes part of Grundy County.

The Muskingum-Hartsells Association consists of soils that are fairly low in natural fertility. The adaptability of these soils to crops or pasture is limited. Portions of Grundy and Franklin Counties are in this association.

Parts of Franklin, Grundy, and Coffee Counties are in the Cumberland-Waynesboro-Decatur Association. The soils of this association, when under good management, are considered to be among the most productive soils in the Elk River Watershed. They are well-drained, moderate to fairly high in fertility, and adaptable to a variety of crops.

The Sango-Bodine Association includes parts of Lincoln, Franklin, and Coffee Counties. This soil association is composed of soils that have slow internal drainage and are moderate to low in fertility. Fragipans, which form barriers to root penetration, limit the adaptability of these soils to various crops.

Except for the cherty soils on the high ridges, the soils of the Baxter-Dellrose-Mimosa Association are moderate to high in natural fertility. Sections of Giles, Lincoln, Moore, Franklin, and Coffee Counties are in this association, which occupies the largest portion of the Elk River Watershed.

Lawrence County and a small portion of Giles County are in the Dickson-Mountview-Bodine Association. The upland soils are usually acid and low in fertility while the soils in the valleys, when well managed, are moderate to high in fertility.

The topography ranges from the mountainous regions of Grundy County to the level valley floors in Lawrence and Giles Counties.

III. LAND USE

A general distribution of land use, as taken from the results of the survey, is shown in Table II. Cropland used for pasture was the major land use, which accounted for 38,189 acres or 27.9 per cent of the total acres in the sample farms.

The many different soil types contribute to the variety of crops that are produced in the seven-county area. Corn is usually grown on the river bottoms while the uplands are generally used for tobacco, cotton, hay crops, and pasture.

Corn, lespedeza hay, tobacco, and cotton were the major field crops with corn being the most prevalent crop on all farms. The average yield per acre and the number of farms producing these and other important field crops are listed in Table III.

Beef cattle was the predominant livestock enterprise on all farms. Fifty-six per cent of all reporting farms had beef cattle, 43 per cent had dairy herds, and 29 per cent reported hog enterprises. As stated earlier, livestock and livestock products provide the largest source of income to farmers in the Elk River Watershed. The total value of all agricultural products sold by farmers in the area in 1954 and 1959 is shown in Table IV.

TABLE II

PERCENTAGE DISTRIBUTION OF LAND USE FOR 811 FARMS IN THE ELK RIVER WATERSHED, SUMMER, 1964

Land use	Acres	% of total
Cropland pasture	38,189	27.9
Cropland harvested	30,649	22.4
Idle cropland	10,392	7.6
Woodland pasture	26,697	19.5
Woodland not pastured and other land[a]	30,915	22.6
Total	136,842	100.0

[a]Includes land for houses, roads, ponds, etc.

TABLE III

AVERAGE YIELD PER ACRE OF IMPORTANT CROPS PRODUCED ON 811 FARMS IN THE ELK RIVER WATERSHED, SUMMER, 1964

Crops	Average yield per acre	Number of farms	% of total farms
Corn	62.7 bu.	428	52.8
Lespedeza hay	1.6 tons	355	43.8
Burley tobacco	1830.7 lbs.	274	33.8
Cotton	553.6 lbs.	253	31.2
Grass hay	1.5 tons	153	18.9
Bean hay	2.1 tons	146	18.0
Alfalfa hay	3.0 tons	115	14.2
Wheat	28.6 bu.	83	10.2
Hay after grain	1.6 tons	38	4.7
Barley	31.8 bu.	18	2.2

TABLE IV

VALUE OF FARM PRODUCTS SOLD IN THE ELK RIVER WATERSHED, 1954 AND 1959

Farm product	1954 Value (dollars)	1954 % of total	1959 Value (dollars)	1959 % of total
All crops				
Field crops	11,032,981	40.3	11,199,299	31.9
Vegetables	128,022	0.5	106,067	0.3
Fruits and nuts	284,560	1.0	106,290	0.3
Forest and horticulture products	714,380	2.6	1,218,662	3.5
Total	12,159,943	44.4	12,630,313	36.0
Livestock and livestock products				
Poultry and poultry products	1,182,499	4.3	1,934,385	5.5
Dairy products	6,613,340	24.2	6,906,789	19.7
Beef, hogs, and other	7,411,066	27.1	13,615,386	38.8
Total	15,206,905	55.6	22,456,510	64.0
Total value of all products	27,366,848	100.0	35,086,828	100.0

Source: United States Bureau of the Census, United States Census of Agriculture: 1959, Tennessee, Volume 1 (Washington: Government Printing Office, 1961), pp. 176-181.

IV. NUMBER AND SIZE OF FARMS

In 1954, the United States Census reported 15,228 farms in the seven-county area. The average size of these farms was 99 acres. In 1959, the number, as reported by the census, had decreased to 12,261 while the average size had increased to 113 acres per farm. Based on estimates made by statistical inference from the sample taken in 1964 for this study, there are now approximately 7,500 farms in the seven counties, with the average size per farm estimated at 168 acres.

V. CHARACTERISTICS OF FARM OPERATORS

The average age of all the sample farmers was fifty-three and the average years of schooling was nine. Forty per cent of the farm operators worked off the farm 100 days or more during the previous year. The growth of industry in the seven counties and the surrounding counties has provided part-time or full-time employment opportunities for many farmers in the sample area.

CHAPTER III

PRESENTATION OF THE ANALYSES

I. ANALYTICAL METHODS

A considerable amount of information on the management practices employed by livestock farmers and their resulting gross incomes was made available from the Elk River Survey. As a means for showing the relationships and the strength of the relationships for selected livestock practices to gross income, the following statistical tools were used: analyses of variance, t tests, and Scheffe's test.[1]

Analysis of variance is based on five assumptions: 1) additivity, 2) linearity, 3) normality, 4) independence, and 5) homogeneous variances.[2] In its simplest form, analysis of variance deals with two independent estimates of a population variance that can be compared with each other by means of F, which is the ratio of the mean square of individuals to the mean square of group means. In a more expanded form, analysis of variance considers the means of several groups and compares the estimated variance of these group means (one estimate of the variance in a population), with the estimated variances of the individuals (a second estimate of the variance in a population).[3] "Analysis of variance

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[1]Formulas for these tests are shown in the Appendix.

[2]Bernard Ostle, Statistics in Research (Ames: The Iowa State University Press, 1963), p. 281.

[3]Frederick E. Croxton and Dudley J. Cowden, Applied General Statistics (Englewood Cliffs: Prentice-Hall, Inc., 1958), p. 706.

and regression analysis are essentially the same."[4]

The t test was used as a method for determining the significant difference between two sample means. The t value is the ratio of the means of $X_1 - X_2$ to an estimate of the standard error of the difference between two sample means.

The Scheffe test provides a procedure for testing the significance between group means in an analysis of variance model.[5] This method was used for indicating if there was a significant difference between the gross income per brood animal for farmers who followed various management practices. The Scheffe method, rather than the Duncan test, was used because of the unequal number of observations in the various percentage groups.

There are numerous livestock management practices that influence the amount of gross income received from the production of livestock and livestock products. Many management practices, because of their nature, cannot be expressed in a statistical relationship. Therefore, only those practices that could be applied to a statistical model were used for analytical purposes.

The livestock practices chosen for analysis were those that are recommended by the Animal Husbandry Department of the University of Tennessee as ones that are related to good livestock management, and

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[4]Ostle, op. cit., p. 341.

[5]Chester H. McCall, Jr., "Linear Contrasts," Industrial Quality Control, Part II, 20-21, July 1960 (Booz-Allen Applied Research, Inc.).

thus would probably influence the amount of gross income received from livestock production.

The percentage of total practices followed by each farmer for the selected livestock enterprises was computed and arrayed in an increasing order. Classification of farms according to the percentage of practices followed was arbitrarily selected and the average total gross income for the selected livestock products was computed on a per brood animal basis for the corresponding percentage groups. Offspring from purebred swine and beef cattle that were sold for breeding stock were eliminated from the analysis because these animals usually bring a price that exceeds the market price of pigs and calves sold for slaughter or feeders.

II. SWINE PRACTICES

Listed below are the swine management practices that were selected for analysis as possibly influencing the amount of gross income received from the production of market hogs:

1. Pigs from sows of one breed and boars of another breed.
2. Pigs from sows of meat type or crossbred (partly meat type).
3. Most hogs marketed from June through August.[6]
4. Pigs self-fed grain after weaning.
5. Pigs self-fed supplement after weaning.
6. Pigs fed minerals after weaning.

---

[6]June through August was the period of highest prices for market hogs for 1963, as reported by personnel of the Extension Service.

7. Pigs creep fed before weaning.
8. Pigs vaccinated for erysipelas.
9. Pigs treated for lice.
10. Pigs treated for mange.
11. Pigs treated for worms.
12. Pigs needle teeth clipped.
13. Pigs treated for naval infection.
14. Pigs treated for anemia.
15. Sows washed and houses scrubbed before farrowing.
16. Pigs weaned and castrated at the same time.
17. Pigs raised on clean pasture and/or concrete.
18. Number of pigs weaned per litter above average.[7]

Table V shows the relationship of the percentage of the selected swine practices followed to the total value of market hogs sold per sow.

The number of pigs weaned per litter is an important factor that influences the gross returns from swine production. A separate analysis of management practices which influence the number of pigs weaned per litter can help explain to a greater extent the amount of gross income received from producing market hogs. The practices that were chosen as affecting the number of pigs weaned per litter were:

1. Sows chosen for breeding were of meat type or crossbred (partly meat type).

---

[7]Average number of pigs weaned per litter was 7.0.

TABLE V

RELATIONSHIP OF PERCENTAGE OF SELECTED SWINE PRACTICES FOLLOWED TO TOTAL VALUE OF MARKET HOGS SOLD PER SOW

% of practices followed	Number of farms	Average total value of market hogs sold per sow bred
		dollars
30 or less	17	398
31 - 50	42	438
51 - 70	20	498
71 and over	4	506

2. Gilts chosen from sows that farrowed large litters.
3. Boars performance tested.
4. Boars not allowed to remain continuously with sows.
5. Boars not used for more than 15 sows.
6. Sows flushed or self-fed just before and after breeding.
7. Sows fed more lightly during remainder of gestation period.
8. Sows fed more grain or self-fed when nursing pigs.
9. Sows fed supplement at least part of the time.
10. Sows fed minerals at least part of the time.
11. Sows pastured on legumes part of the time.
12. Sows vaccinated for leptospirosis.
13. Sows treated for lice and/or mange and/or worms.
14. Percentage of litters from old sows above average.
15. Used heat lamps in farrowing pens.
16. Provided guard rails for farrowing pens.
17. Used a concrete feeding floor for sows.

Table VI shows the relationship of the percentage of the practices followed to the number of pigs weaned per litter.

III. BEEF PRACTICES

The cow-calf enterprise, which is only one phase of beef cattle production, was selected for analysis because it represented the predominant beef enterprise in the seven-county area. The data for this type of beef enterprise were more complete than for the other phases of livestock production.

TABLE VI

RELATIONSHIP OF PERCENTAGE OF SWINE PRACTICES FOLLOWED TO NUMBER OF PIGS WEANED PER LITTER

% of practices followed	Number of farms	Average number of pigs weaned per litter
40 or less	20	5.8
41 to 50	69	6.8
51 or over	83	7.4

The beef cattle management practices that were selected as influencing the amount of gross income received from cow-calf enterprises were:

1. Rated above average in percentage of calf crop.[8]
2. Rated above average in percentage of practices followed in managing roughage production: including legumes in pastures, cutting hay and silage before too mature, reporting little or no rain damage to hay, varying clipping height, and alternating use of pasture.[9]
3. Included legumes in hay and/or fed protein supplement.
4. Used sire of different breed from that of the cows.
5. Used a registered sire.
6. Used a sire that has been performance tested.
7. Followed a breeding program that allowed for most of the calves to be born in January or February.[10]
8. Marketed most of the calves at organizational or special stocker sales.
9. Calves were polled or dehorned.

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[8]Average percentage of calf crop on the sample farms in 1963 was 92.

[9]Average percentage of specified forage practices followed on the sample farms in 1963 was 51.

[10]Calves born in January and February are usually ready for market (weighing from 400-600 pounds) at the time of special organizational sales that are held in the sample area and adjoining counties. The demand for calves at these sales is usually good and the average prices received generally exceed those of weekly auctions.

10. Creep fed calves.
11. Castrated bull calves.
12. Wormed calves.
13. Practiced fly and/or grub control.
14. Vaccinated calves for blackleg and/or malignant edema and/or leptospirosis.

The data in Table VII show the relationship of the percentage of beef cattle practices followed to the average total value of calves sold per cow bred.

IV. DAIRY PRACTICES

Of the 241 milk producers that supplied sufficient data for analysis, 40 were Grade A producers and the remainder were manufacturing producers. Separate analyses were made for each, although many of the same management practices were used for each type of enterprise.

The management practices listed below are those considered as contributing to high production per cow:

1. Maintained an above average weighted acres of pasture per animal.[11]
2. Fertilized pasture at least 100 pounds per acre.

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[11]Weights for the various types of pasture were assigned in relation to the quality of the pasture. Pastures with clover mixtures were given a weight of 90. The value of weights decreased with the quality of the pasture. A low weight of 20 was assigned to woodland pasture. The average weighted acres of pasture per animal for the dairy sample was 1.74.

TABLE VII

RELATIONSHIP OF PERCENTAGE OF BEEF CATTLE PRACTICES FOLLOWED TO AVERAGE VALUE OF CALVES SOLD PER BEEF COW BRED, 1963

% of practices followed	Number of farms	Average total value of calves sold per cow bred
		dollars
25 and less	34	67
26 to 40	126	78
41 to 55	138	83
56 to 70	68	91
71 to 85	18	104

3. Maintained an above average value of feed per cow.[12]
4. Rated above average in percentage of practices followed for producing quality roughage.[13]
5. Kept production records on individual cows.[14]
6. Identified heifers by sire and dam.
7. Operator helped with milking.
8. Rated above average in percentage of fall freshening, September-December.[15]
9. Checked vacuum level of milking machine periodically.[16]
10. Treated for mastitis.
11. Treated for fly and grub control.[17]
12. Waited 65-100 days after calving before rebreeding.[18]

The relationship of the percentage of dairy practices followed to the average pounds of milk sold per cow for Grade A and manufacturing producers is shown in Tables VIII and IX, respectively.

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[12]Average for Grade A - $162 per cow. Average for manufactured milk - $100 per cow.

[13]Average for the dairy sample was 70.5.

[14]Used for Grade A analysis only.

[15]Average percentage of fall freshening for Grade A was 32.5 and for manufacturing producers, 27.0.

[16]Used in Grade A analysis only.

[17]Used for manufacturing producers only.

[18]Used for manufacturing producers only.

TABLE VIII

RELATIONSHIP OF PERCENTAGE OF SELECTED DAIRY PRACTICES FOLLOWED TO AVERAGE POUNDS OF MILK SOLD PER COW, GRADE A, 1963

% of practices followed	Number of farms	Average pounds of milk sold per cow
30 or less	3	4,159
30 - 49	11	5,360
50 - 69	16	6,396
70 - 89	6	6,660
90 and over	4	7,573

TABLE IX

RELATIONSHIP OF PERCENTAGE OF SELECTED DAIRY PRACTICES FOLLOWED TO AVERAGE POUNDS OF MANUFACTURED MILK SOLD PER COW, 1963

% of practices followed	Number of farms	Average pounds of milk sold per cow
0 - 19	11	3,373
20 - 39	88	3,712
40 - 80	102	4,055

CHAPTER IV

THE ANALYSES AND RESULTS

I. THE HYPOTHESES

It was hypothesized for the analyses of variance tests that an increase in the number of livestock management practices followed would result in a significant increase in gross income per brood animal. For the t tests, it was hypothesized that the farmers who performed a selected management practice would have a gross income per brood animal that was significantly different from the gross income of those farmers that failed to include that specific practice in their management program. In the dairy analysis, pounds of milk sold per cow was substituted in the hypothesis for gross income. The 5 per cent level of probability was the criterion for testing the hypotheses.

II. SWINE

A sample of 83 farms producing market hogs was taken from the original sample. Information on the percentage of practices followed and the average gross income per sow bred is shown in Table V of Chapter III, page 23. The data from Table V were summarized for computing the total sum of squares and the sum of squares for the practice means. The results of the F test, which is the ratio of the mean square for the percentage groups of practices followed (37,561.6) to the error term (19,483.0), indicated there was no significant

difference at the 5 per cent level of probability between the percentage of practices followed and the amount of average gross income received per sow bred (Table X).

Results of t tests on the means of several individual management practices did not show a significant difference in gross income per sow bred for those farmers that followed a specific practice.

Scheffe tests between the means of the percentage groups in the analysis of variance model did not show a significant difference between average gross income per sow bred and the percentage of practices followed. Based on the data analyzed, this indicated that all of the farms were from the same statistical population.

An analysis of 172 farms that raised either feeder pigs or market hogs was performed for showing the relationship between the number of pigs weaned per litter and the percentage of practices followed. Table XI contains the data used for determining an F value of 8.54, which was significant at the 1 per cent level of probability.

A t value for each of the following practices was computed:

1. Sows flushed or self-fed just before and after breeding.
2. Gilts chosen from sows that farrowed large litters.
3. Sows pastured on legumes part of the time.
4. Sows chosen for breeding were of meat type or crossbred (partly meat type).
5. Sows fed minerals at least part of the time.
6. Sows fed supplement at least part of the time.

TABLE X

ANALYSIS OF VARIANCE OF GROSS INCOME RECEIVED PER SOW BRED TO PERCENTAGE OF PRACTICES FOLLOWED, ELK RIVER WATERSHED, 1963

Source of variation	Degrees of freedom	Sum of squares	Mean square
Total	82	1,651,839.9	
Practice means	3	112,684.8	37,561.6
Error term	79	1,539,155.1	19,483.0

F = 37,561.6/19,483.0 = 1.93[a]

[a]Not significant at the 5 per cent level of probability.

TABLE XI

ANALYSIS OF VARIANCE OF PIGS WEANED PER LITTER TO THE PERCENTAGE OF PRACTICES FOLLOWED, ELK RIVER WATERSHED, 1963

Source of variation	Degrees of freedom	Sum of squares	Mean square
Total	171	484.6	
Practice means	2	44.4	22.2
Error term	169	440.2	2.6

$F = 22.2/2.6 = 8.54^{a}$

[a]Significant at the 1 per cent level of probability.

Only the sixth practice was found to be significant at the 5 per cent level of probability. The remaining five practices had t values ranging from 1.25 to 1.54, which is less than the required 1.96, the value of t at the .05 level of probability for more than 120 degrees of freedom.

Tests between the means of each percentage group in the analysis of variance model showed that a significant difference occurred between the farmers following over 40 per cent of the management practices and those following less than 40 per cent.

III. BEEF CATTLE

The cow-calf enterprise, with 384 farms available for statistical analysis, represented the largest subsample of livestock farms. An analysis of variance test on the cow-calf enterprises resulted in an F value of 10.71, which showed a significant difference at the 1 per cent level of probability between the amount of gross income received per cow bred and the percentage of practices followed (Table XII).

A t value was computed on each practice listed below to determine whether there was a significant difference in gross income per cow bred for those farmers that included the practice in their management program:

1. Creep fed calves.
2. Used a sire of different breed from that of the cows.
3. Followed a breeding program that allowed for most of the calves to be born in January or February.

TABLE XII

ANALYSIS OF VARIANCE OF GROSS INCOME RECEIVED PER COW BRED TO THE PERCENTAGE OF PRACTICES FOLLOWED, ELK RIVER WATERSHED, 1963

Source of variation	Degrees of freedom	Sum of squares	Mean square
Total	383	226,198.6	
Practice means	4	22,978.6	5744.7
Error term	379	203,220.0	536.2

$F = 5744.7/536.2 = 10.71^{a}$

[a]Significant at the 1 per cent level of probability.

4. Rated above average in percentage of practices followed in managing roughage production.

5. Rated above average in percentage of calf crop.

The results of the tests showed a significant difference in the amount of gross income per cow bred for the farmers employing all of the above practices except the second. The t value for this practice indicated that a significant difference occurred in the amount of gross income for those farmers that had cows and bulls of the same breed.

The Scheffe test among the income means of the percentage groups in the analysis of variance model indicated there was a significant difference between the mean gross income per cow bred for the producers following more than 40 per cent of the selected practices as compared to those following 25 per cent and less.

IV. DAIRY

Grade A producers accounted for 40 of the 241 dairy producers that provided sufficient data for analyzing the relationship between the percentage of practices followed and the average pounds of milk sold per cow. The results of the analysis of variance test showed a significant relationship existing between the percentage of practices followed and the average pounds of milk sold per cow (Table XIII).

Separate analyses were made for all ten of the individual management practices listed in Chapter III, pages 27 and 29, for Grade A producers. Farmers employing the practices listed below had a significant difference in the pounds of milk sold per cow when compared to those that did not follow the practices:

TABLE XIII

ANALYSIS OF VARIANCE OF POUNDS OF MILK SOLD PER COW TO THE PERCENTAGE OF PRACTICES FOLLOWED, GRADE A, ELK RIVER WATERSHED, 1963

Source of variation	Degrees of freedom	Sum of squares	Mean square
Total	39	94,855,411.0	
Practice means	4	29,289,562.1	7,322,390.5
Error term	35	65,565,848.9	1,873,310.0

F = 7,322,390.5/1,873,310.0 = 3.91[a]

[a]Significant at the 1 per cent level of probability.

1. Identified heifers by sire and dam.
2. Kept production records on individual cows.
3. Rated above average in percentage of fall freshening, September-December.

The remaining seven practices tested significant at the 10-25 per cent levels of probability.

A significant difference between the means (average pounds of milk sold per cow) for farmers that followed less than 30 per cent of the practices and those that followed 90 per cent or more was indicated by the Scheffe method of testing.

The results of the analysis of variance test for 201 manufacturing milk producers showed there was no significant difference at the 5 per cent level of probability between the percentage of practices followed and the average pounds of milk sold per cow (Table XIV).

A t value was computed for each practice listed below:

1. Maintained an above average weighted acres of pasture per animal.
2. Fertilized pasture at least 100 pounds per acre.
3. Maintained an above average value of feed per cow.
4. Rated above average in percentage of practices followed for producing quality roughage.
5. Rated above average in percentage of fall freshening, September-December.
6. Waited 65-100 days after calving before rebreeding.

TABLE XIV

ANALYSIS OF VARIANCE OF POUNDS OF MANUFACTURED MILK SOLD PER COW TO THE PERCENTAGE OF PRACTICES FOLLOWED, ELK RIVER WATERSHED, 1963

Source of variation	Degrees of freedom	Sum of squares	Mean square
Total	200	401,169,620	
Practice means	2	8,430,168	4,215,084
Error term	198	392,739,452	1,983,533

$F = 4,215,084/1,983,533 = 2.13^{a}$

[a]Not significant at the 5 per cent level of probability.

The t value for farmers who were above average in the value of feed per cow tested significant at the 5 per cent level of probability. Performance of the remaining practices did not show individually any significant relationships at the .05 level.

The Scheffe method indicated there were no significant differences between the means of the percentage groups. Thus, based on the results of the data that were studied in this sample, it can be assumed that all of the manufacturing producers were from the same statistical population.

CHAPTER V

SUMMARY AND CONCLUSIONS

The reliability of the results obtained from a statistical analysis depends largely upon the method of sampling, the accuracy of the data, and the statistical methods employed for analytical purposes. Data of the nature used in this study are subject to normal sample errors. However, attempts were made by the enumerators to collect reliable field data. The statistical techniques used for analyses were those that were considered capable of accomplishing the objectives stated on page 6 of Chapter I.

The analysis of variance tests showed significant relationships between the dependent and independent variables for beef cattle, Grade A dairy, and the number of pigs weaned per litter. Thus, the null hypothesis, an increase in the number of practices followed will result in a significant increase in the amount of average gross income received per brood animal, or pounds of milk sold per cow in the case of the Grade A enterprises, can be accepted for beef cattle, Grade A dairy, and the number of pigs weaned per litter. The hypothesis cannot be accepted for the livestock enterprises producing market hogs and manufactured milk in the sample studied.

The non-significant results obtained for market hog enterprises can be partly attributed to the relatively small sample that was used in the analysis of variance model. A relatively larger sample might have given significant results.

Variations in the level of milk production per cow were expected for different breeds of cows. The genetic composition of each cow contributes to her inherent ability to produce under given feeding and management conditions. A relatively small percentage of the manufacturing milk producers studied had dairy cows that were purebred or that could be considered as high-bred cows. This factor, in part, could account for the non-significant results obtained from the data of manufacturing milk producers. Milk used for home consumption and milk fed to calves were other factors that probably influenced the results. There was no way of accurately measuring the pounds of milk used in the home or consumed by calves. The latter factor was thought to be very important because most farmers in the sample allowed the baby calf to remain with the mother for several weeks or even several months.

Tests for significant differences between the mean values (average gross income and average pounds of milk sold per brood animal) for farmers who followed a certain management practice and for those who failed to include that practice in their management program showed very few significant relationships. Based on the results of the data analyzed, the hypothesis for the t tests, which is stated on page 32 of Chapter IV, cannot be accepted at the 5 per cent level of probability, the criterion chosen for testing the hypothesis.

The results of the Scheffe tests indicated for all livestock enterprises studied, except manufactured milk, that a significant difference occurred between the mean values (average gross income or pounds of milk sold per brood animal) of certain percentage groups of practices followed

in the analysis of variance models. A significant increase in gross returns usually occurred for farmers that followed more than 40 per cent of the selected management practices as compared to those who followed less than 40 per cent of the practices. This does not mean that a farmer must perform over 40 per cent of the selected management practices in order to have an average gross income significantly different from those farmers following less than 40 per cent of the selected practices. However, the results do indicate that the farmers performing a high percentage of the selected practices had the highest gross returns.

The production of livestock involves so many different practices that it is difficult to measure the effect of each one separately. The result of the influence of each practice may be offset by adverse effects of other independent practices.

Based upon the results of the data that were analyzed and the statistical methods employed, it can be concluded that the individual performance of each selected livestock management practice did not result in a significantly measurable increase in the amount of average gross income received per brood animal and the average amount of milk sold per cow for Grade A and manufactured milk producers. But, by use of the analysis of variance model, which considers the combined effect of all livestock management practices employed by each farmer, it was found that in three of the five livestock enterprises studied, that the combined performance of many practices resulted in a significant increase in average gross returns per brood animal.

It can be concluded from this study that it is necessary to perform many recommended livestock management practices rather than just a few in order to get a substantial increase in gross returns from livestock enterprises in the Elk River Watershed. Also, in some cases, the results depend on the skills applied in carrying out the practices. These skills are not always measurable.

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APPENDIXES

APPENDIX A

ANALYTICAL FORMULAS

1. Analysis of Variance[1]

$$\frac{\sum X_1^2}{N_1} + \frac{\sum X_2^2}{N2} + \ldots\ldots\ldots + \frac{\sum X_n^2}{N_n} - C$$

where

X = Sum of the selected values for each observation,

N = Number of observations, and

C = Correction term $\frac{\sum X_n^2}{N_n}$.

2. t Test[2]

$$N_1 \qquad N_2$$

$$\sum X_1 \qquad \sum X_2$$

$$\sum X_1^2 \qquad \sum X_2^2$$

$$\bar{X}_1 \qquad \bar{X}_2$$

$$\sum x_1^2 = \sum X_1^2 - (\sum X_1)(\bar{X}_1)$$

$$\sum x_2^2 = \sum X_2^2 - (\sum X_2)(\bar{X}_2)$$

$$s^2 = \frac{\sum x_1^2 + \sum x_2^2}{(N_1-1) + (N_2-1)}$$

$$s_{\bar{x}}^2 = \frac{s^2 (N_1 + N_2)}{(N_1)(N_2)}$$

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[1]George W. Snedecor, Statistical Methods (Ames: The Iowa State College Press, 1950), p. 233.

[2]Frederick E. Croxton and Dudley J. Cowder, Applied General Statistics (Englewood Cliffs: Prentice-Hall, Inc., 1958), p. 644.

$$t = \frac{\bar{X}_1 - \bar{X}_2}{s_{\bar{x}}}$$

where

N_1 = Number of observations with a yes answer,

$\sum X_1$ = Sum of individual observations,

$\bar{X}_1$ = Mean of individual observations,

N_2 = Number of observations with a no answer,

$\sum X_2$ = Sum of individual observations,

$\sum x_1^2$ and $\sum x_2^2$ = Sum of squared deviations,

s^2 = Standard deviation of the population, and

$s_{\bar{x}}$ = Standard error of the means.

3. Scheffe Test[3]

$$A^2 = (k-1)\ (F)$$

$$\hat{\sigma}^2_{\hat{\theta}} = \hat{\sigma}^2_{\bar{x}}\ (1/n_i + 1/n_j)$$

$$\hat{\sigma}^2_{\bar{x}} = \frac{1}{n_i} + \frac{1}{n_j}$$

$A\hat{\sigma}_{\hat{\theta}}$ = The difference that must occur between the means that are being tested in order for them to be significantly different, where

A^2 = Transformed F value at the 5 per cent level of probability,

k = Number of percentage groups in the analysis of variance model,

F = Table F value.

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[3]Chester H. McCall, Jr., "Linear Contrasts," Industrial Quality Control, Part II, 20-21, July 1960 (Booz-Allen Applied Research, Inc.).

$\hat{\sigma}^2_{\hat{\theta}}$ = Variance of the sample estimate,

$\hat{\sigma}^2_{\bar{x}}$ = Residual mean square (error term),

n_i = Number of observations in one percentage group, and

n_j = Number of observations in a second percentage group.

APPENDIX B

SUMMARIZATION DATA FOR ANALYSES OF VARIANCE MODELS

TABLE XV

SYMBOLICAL SUMMARY OF COMPUTATIONS, WITH VARYING DEGREES OF FREEDOM IN THE SUBSAMPLES

The data		
Percentage group 1	Percentage group 2	Percentage group n
X_1	X_2	X_n
.	.	.
.	.	.
.	.	.
.	.	.
N_1 items	N_2 items.	N_n items
ΣX_1	ΣX_2	ΣX_n

Source: George W. Snedecor, Statistical Methods (Ames: The Iowa State College Press, 1950), p. 234.

TABLE XVI

SUM OF THE NUMBER OF PIGS WEANED PER LITTER, BY PERCENTAGE OF PRACTICES FOLLOWED, ELK RIVER WATERSHED, 1963

	Per cent of practices followed			
	40 and less	41-51	51 and over	Total
$\sum X$	116	967	613	1,196
N	20	69	83	172
$\bar{X}$	5.8	6.8	7.4	
$\sum X^2$	727	3,348	4,726	8,801

TABLE XVII

SUM OF THE POUNDS OF MANUFACTURED MILK SOLD PER COW, BY PERCENTAGE OF PRACTICES FOLLOWED, ELK RIVER WATERSHED, 1963

	Per cent of practices followed			
	0-19	20-39	40-80	Total
$\sum X$	37,102	326,627	413,654	777,383
N	11	88	102	201
$\bar{X}$	3,373	3,712	4,055	
$\sum X^2$	149,990,998	1,435,980,721	1,821,786,601	3,307,758,320

TABLE XVIII

SUM OF GROSS INCOME RECEIVED PER SOW BRED, BY PERCENTAGE OF PRACTICES FOLLOWED, FOR MARKET HOGS, ELK RIVER WATERSHED, 1963

	Per cent of practices followed				
	30 and less	31-50	51-70	71 and over	Total
ΣX	$ 6,766	$ 18,316	$ 9,968	$ 2,025	$ 37,075
N	17	42	20	4	83
$\bar{X}$	$ 398	$ 436	$ 498	$ 506	
ΣX^2	$3,066,988	$8,850,760	$5,265,998	$1,029,005	$18,212,751

TABLE XIX

SUM OF THE POUNDS OF GRADE A MILK SOLD PER COW, BY PERCENTAGE OF PRACTICES FOLLOWED, ELK RIVER WATERSHED, 1963

	Per cent of practices followed					
	30 and less	31-49	50-69	70-89	90 and over	Total
ΣX	12,476	58,954	102,332	39,957	30,290	244,009
N	3	11	16	6	4	40
$\bar{X}$	4,159	5,360	6,393	6,660	7,573	
ΣX^2	52,326,010	335,589,104	690,966,168	270,712,319	233,771,612	1,583,365,213

TABLE XX

SUM OF GROSS INCOME RECEIVED PER BEEF COW BRED, BY PERCENTAGE OF PRACTICES FOLLOWED, ELK RIVER WATERSHED, 1963

	Per cent of practices followed					
	25 and less	26-40	41-55	56-70	71-85	Total
$\sum X$	$ 2,345	$ 9,892	$ 11,325	$ 5,994	$ 1,863	$ 31,419
N	35	128	136	67	18	384
$\bar{X}$	$ 67	$ 77	$ 83	$ 89	$ 104	
$\sum X^2$	$172,471	$815,442	$1,027,105	$580,664	$201,229	$2,796,911