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A Study of Relationships Used in Farm Record Analysis

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A Study of Relationships Used in Farm Record Analysis

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INTRODUCTION

An important tool which has been used extensively by farm management extension workers in Europe and the U.S.A. for many years is farm business analysis. Farm business analysis is used here to include standardized income and receipt statements and the various earnings measures such as farm and family income, operators return, management return and return to capital which are derived from these statements, and any physical or financial ratios or farm standards which may be reported and used with the other data.

Farm business analysis has been used to diagnose weaknesses in an existing farm business. The standards may be used to set goals which could be achieved by farmers in the local environment, and towards which a business operating at lower levels of performance may be directed. Alternatively, the data may provide part of the raw material for budgets to show how the changes could be implemented or what the final result is expected to be.[1] However, the information from a farm business analysis generally is of greater value in showing in which area of the business there is a weakness[2] than it is in determining the cause of the weakness.[3] This statement will be modified by the extent to which physical as well as financial information is available.

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[1]Two different ideas are suggested, first that one might budget to see if a reorganization will enable the business to better attain its goal. Secondly, if so, and if this implies a drastic change from the existing organization, transition budgets will be required to show how the changes should be implemented over time.

[2]The analysis will also indicate the strengths of the organization. This information may be of value in suggesting what changes in organization or enterprisees will best make use of the farmer's interests and ability. However, we must consider whether these results are due to superior management and not spurious indicators resulting from say weather or price effects.

[3]For instance, one farm studied by the author indicated the farmer had far too few milk cows and although his yields from livestock and crops were above average he was not making wages. A visit to the farm showed he was limited by barn space and felt he could not afford to build more. The problem of too few cows was accurately diagnosed but not the underlying cause.

Farm business analysis may be a by-product of a farm record program or it may be the reason for the project. In any case, once records are kept in an organized program it is unusual if at least a simple business analysis is not provided for participants based on an analysis of the farms in it. The grouping of farms for record analysis is subject to wide variation, mainly due to the numbers of farms in the program. Generally, the farms are divided into type-of-farm groups and these may be further subdivided by size or locality or both if there are enough farms for such detailed subdivision to be meaningful. In addition to presenting group averages there may be an analysis of the top 10 percent, 33 percent, or 50 percent of farms based upon some profitability criteria to show differences in ratios and standards between the "above average" and the average farms. It is assumed that the *above average* farmers are better farmers and that by examining the manner (on average) in which they have combined their resources one can better understand how to improve the result of a below average farm. Note that there is no uniformity of opinion on the proportion of farms which constitutes an *above average* group. Equal confusion exists about what ratios and standards should be calculated; they vary as extensively within a country as they do between nations. Obviously, they will differ due to farm type; the point is, there is no agreement as to what should be calculated for a given type of farming e.g. dairy farms. The author has personal experience of record projects which have calculated as few as 20 standards and as many as 200, over and above the receipts and expenditure or profit and loss account. In the first instance it was the belief of the university farm management personnel that an extension worker could not use more than 20 factors practically for farm business diagnosis. They selected those which they believed had greatest economic content or meaning for management decisions.

It is the usual practice to forward to cooperating farmers the detailed group analysis of all farms in the association or at least of those in the same type-of-farm group. The stated purposes for doing this are: (1) to enable the farmer to see how he compares with the average and above-average of his own and of other groups, (2) to give him an idea of attainable levels of production, and (3) to enable him to learn more of his business and make adjustments which will help him to better satisfy his goals in life. The author believes that to present more than perhaps a dozen factors to a person untrained in their use and unskilled in their application will have one or other of two effects: Either the farmer will attempt self diagnosis, with the probability of making serious errors, or, and more likely, he will be so bewildered by the mass of figures that he will discard the analysis and conclude that record data are of little use to him in planning and decision-making.[4]

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[4]Discussion with the leaders of many of the EDP record projects in the USA shows that they are seriously concerned by the lack of use of record material by farmers for other than tax purposes.

If either of these hypotheses is true, or even true for a number of farmers enrolled in record associations, what should be done? Here it is argued that a practical first step, which would not require nearly the money needed to educate the farmer in record analysis, would be to select and provide a limited number of standards. The selected standards should be: (1) ones farmers can control or influence; (2) unambiguous, so that costly errors are not a likely result of their application by the unskilled; (3) related to profitability. This would not preclude calculating additional factors which would assist trained extension workers in farm business analysis. These additional factors could be published separately and not made available to farmers except by special request.

This last paragraph raises the question: Are there a limited number of standards, say between five and twenty in number, which for a given farm type are of critical importance in indicating farm business efficiency and which satisfy the conditions specified above? If there are, what are they? The subject matter of this report is the methodology and results of a study designed to answer these questions.

REVIEW OF LITERATURE

The problems which arise from the use of farm records have several sources. Many of the ratios do not have a basis of economic principle. For example it may happen that *above average* farmers have a lower feed cost per hundredweight of milk produced. It does not necessarily follow that by reducing feed input another farmer will decrease costs and increase profits. We might find that *above average* grain farmers have a higher fertilizer cost per acre of crop than operators of average farms but this does not necessarily mean that the more we spend on fertilizer the greater will be our grain profits. These comments suggest that economic concepts such as diminishing returns and complementarity must be kept in mind when applying efficiency factor analysis to a farm business.

Another source of difficulty is that the farms which compose a type-of-farm group may be scattered over a wide area, and be on different soils subject to a different rainfall pattern and they may be of different sizes. It is probable that in such circumstances the "above average" farms may be on a quite different production function to the individual farm under analysis and to suggest moving to their organization or levels of performance might be disastrous.

A further source of difficulty is that of pricing the inputs when calculating residual efficiency factors such as *management return, return to capital and management* and *operators return to labor and management.* Incorrect pricing can lead to contrary results and, in fact, one can almost derive any conclusion one wants by manipulating the interest rate or the return allowed to the farmer for his personal exertion.

For a detailed exposition on these problems see Candler and Sargant, 1962; Heady, 1952; Hopkins and Heady, 1955; McAlexander, 1956; Swanson, 1953.

Some of these authors suggest that these deficiencies are so vital that efficiency ratios should be calculated and used. What alternative do we have with which to replace them in business analysis? To date the alternatives such as production functions do not seem to be much superior and are not generally available. Candler and Sargant suggest the adviser will soon pick up appropriate bench marks as he works in an area. However, it would seem that records over time would give a less subjective picture.

The author's belief is that before using standards and efficiency factors the extension worker should be well grounded in the dangers of careless application. Further, if they are used as signals or "warning flags" to detect differences, and the extension worker then establishes the causes of the differences, it is unlikely that unthinking, arbitrary, rule-of-thumb plans or decisions will be applied in solving the problem.

An additional source of difficulty in using records is that, usually, only the results for one year are presented. Rasmussen and Sandiland, in an analysis of 1648 farm accounts over a four year period, show that differences in residual income measures is due to both "random" and "managerial" elements and that each makes about an equal contribution. For a given level of input on Livestock farms they suggest that 68 percent of actual values will be between 89 percent and 113 percent of the predicted value. Therefore in selecting an "above average" group it is probable that many farms are there due to "random" causes rather than to superior management. They show that if the results are averaged over a four year period the "random" element is "substantially reduced, and *it is the author's firm opinion that far too many farm management analyses are being carried out using accounts from a single year only where it would be possible, and much more reliable, to use accounts averaged over, say, a four-year period.*"[5] Rasmussen (1962) has extended this analysis in a study of Danish farm accounts but once again it seemed that differences in residual return measures for a given level of output were due in about equal measure to "random" and "managerial" influences.

Following upon Rasmussen's comments, Black specifically investigated the problem of selecting the farms which should constitute the *above average* group. He suggests that a farm which has a return greater than three standard errors of estimate above average over an average of five years' results should be considered *above average.* Record analysis should be forward-looking and the five-year period would cause the data to be out of date. So Rasmussen averaged the results for five years and calculated the average profitability and its standard error. Using the standard error estimate, he calculated the profitability required to be two and three standard errors above average profitability. This included 60 percent and 33 percent of the farms, respectively. A study of the top 33 percent of farms showed

[5]Knud Rasmussen with M. M. Sandilands, "Production Function Analyses of British and Irish Farm Accounts", Department of Agricultural Economics, University of Nottingham, Sutton Barington, Loughborough, England. June 1962, p. 23.

that they were considerably different from the average farm and that they did not necessarily represent a farming system which a *below average* farmer would be able to attain. Therefore, they did not offer a good goal; thus, he rejected using the top 33 percent as defining the *above average* group for extension purposes. For convenience he decided to use the top 50 percent of farms for calculating the *above average* results. He states "this conclusion differs somewhat from the general practice of forming permium averages from the 25 percent most profitable farms in a given year. . . . Generalizing from the evidence, over a period of five years only 20 percent of farms exceed the level indicated by two standard errors above the ordinary average; only 10 percent exceed the level of plus three standard errors and even fewer pass the target set by averaging the top 25 percent. Further this constitutes a selection of the more intensive and less typical farms in a group and so average and premium average represent different types of farming."[6] Later in his analysis Black shows that size of farm does not affect the applicability of his method. He also suggests that one could define efficiency by the extent to which farm profit exceeds average profits for a given level of input. If the premium farms are calculated in this way the effect of intensity of operation is eliminated, and it is possible to obtain a more consistent group of premium farms, and use the top 33 percent rather than the top 50 percent.

This review of literature indicates that there are problems associated with farm business analysis but that by a thoughtful consideration of the problem it should be possible to make worthwhile use of the data. It also suggests that there may be considerable danger in placing the analysis in the hands of those unskilled in its use and unaware of the possible pitfalls in application of the results.

OBJECTIVES

Farm business analysis factors have been in use for many years but there has been little attempt to discriminate between them in terms of their likely effectiveness in application to the advisory situation. The objectives for this study were:

(1) to analyze the main efficiency factors generated by the Missouri University mail-in record program and determine whether there were common groups into which these ratios could be placed.

(2) to determine whether a relatively few standards could be used to predict farm income and, if so, whether these were factors over which the farmer could exercise some control.

(3) to use some of Black's techniques to analyze the Missouri dairy farm record type.

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[6]Black, C.J., "Premium Averages for Farm Management Purpose." *Farm Economist*, Vol. 10, No. 3, 268-281, 1963.

PROCEDURE

The analysis methods were dictated in part by the availability of appropriate data. The material available consisted of: (1) the analysis of mail-in records for dairy type farms, 1961 to 1964, inclusive; (2) the analysis for all farmers who had participated in the program for three of those four years; and (3) the analysis for 237 of the 240 farms processed in 1964.

The 1964 data was used to determine whether it is necessary to use different analyses for different types of farms, and to see whether there was any common grouping of relationships for all the farm types. The four years of dairy data were used to establish the consistency of the patterns. Records of farms which had been in the mail-in record project for three or more years were the basis for an analysis similar to that carried out by Black.

The statistical tools used were multiple correlation analysis, stepwise regression analysis, analysis of variance, and factor analysis. The latter technique is not commonly used by agricultural economists so enough explanation to understand the subsequent analysis is set out below. The reader who seeks a fuller understanding of factor analysis is referred to Harman.[7] The outline below owes a debt to Harman, MacEachern *et al.,* Hotelling, and Burt.[8]

Factor Analysis

Factor analysis is a means by which we can reduce a large correlation matrix to a workable number of variables. Suppose we have *n* variables attached to each farm in our population, so that $X_1, X_2, X_3 \ldots X_n$ are variables measuring part of the farm business. These variables will be correlated, some with a high correlation, others with a low correlation. The question is, can we find another set of independant variables (or factors), fewer in number that the X's, which largely determine the values the X's will take?

It is argued that for a correlation matrix there is a set of factors which will do this. Several types of factors are distinguished:

(1) Common Factors which involve *more than one* variable.

  (a) General factor—present in all factors.

  (b) Group factor—present in more than one but not all variables.

(2) Unique factors—which involve a *single* variable.

The common factors account for the inter-correlation of the variables, while the unique factors represent the portion of a variable *not* ascribable to its correla-

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[7]Harman, Harry H., *Modern Factor Analysis,* Chicago Univ. Press, 1960.

[8]MacEachern, Gordon A., D. Woods Thomas and Ludwig M. Eisgruber, "Analysis of Human Attributes and Their Relationship to Performance Level of Farm Tenants", *Research Bulletin No. 751,* Purdue University, Agricultural Experiment Station, Lafayette, Indiana, (November 1962); Hotelling, H. "Analysis of a Complex of Statistical Variables into Principal Components", *J. Educational Psychology,* Vol. 24, 1933; Burt, C., *The Factors of the Mind,* New York, Macmillan Company, 1941.

tions with other variables in the set.[9]

In factor analysis it is usual to standardize the variables, because it considerably reduces the complexity of formulation. The standardized value of a variable, X_j, for individual i is:

$$Z_{ji} = X_{ji}/\sigma_j \tag{1}$$

The mean of Z_j is zero, and its variance is unity.

We may now express the variable, Z_j, in factor form, using $F_1, F_2, \ldots F_m$ for *m* common factors and $U_1, U_2, \ldots U_n$ for the n unique factors,

$$Z_j = a_{j1}F_1 + a_{j2}F_2 + \ldots + a_{jm}F_m + a_jU_j \tag{2}$$

where there are $j=1, 2, \ldots n$ variables, and $1, 2, \ldots m$ common factors. The basic problem of factor analysis is to determine the coefficients $a_{j1}, a_{j2}, \ldots a_{jm}$ of the common factors. They are derived from the observed correlations between the n variables. There are a number of ways of estimating the "a's" but they need not concern us here.

The variance of Z_j may be allocated between the factors (if they are uncorrelated) according to:

$$1 = \sigma_j^2 = a_{j1}^2 + a_{j2}^2 + \ldots + a_{jm}^2 + a_j^2 \tag{3}$$

We see that a_{jp}^2 is the proportion of the variance explained by factor P, $P=1, 2, \ldots M$ for any one variable j. The proportion of the *total* variance explained by a factor is:

$$V_p = \sum_{j=1}^{n} a_{jp}^2 \quad (p = 1, 2 \ldots m) \tag{4}$$

from (3) we may estimate the "communality", h^2, of a variable Z_j,

$$h^2 = a_{j1}^2 + a_{j2}^2 + \ldots a_{jm}^2 \tag{5}$$

$$h^2 = 1 - a_j^2 = a_{j1}^2 + a_{j2}^2 + \ldots a_{jm}^2 \tag{6}$$

and the *uniqueness* which is the contribution of the unique factor. This variance may be farther divided to the *specificity* of a variable, which is due to the particular vari-

[9]A basis of factor analysis is, (1) two variables measuring the same thing give similar results; (2) two variables measuring something in common will agree to the extent of the common grounds; (3) variables A and B may have some agreement, as might A and C. We may think A, B, and C are measuring the same thing, so a common factor is at work, and hence we expect agreement between B and C. If not, B. and C must agree with different parts of A. Factor analysis should show us such linkages.

ables selected for study, and *error variance* or *unreliability* due to imperfections in measurement. This permits us to rewrite (2) as:

$$Z_j = a_{j1}F_1 + a_{j2}F_2 \ldots + a_{jm}F_m + b_jS_j + c_jE_j \qquad (7)$$

where S_j and E_j are the specific and error factors of variable j. These factors are uncorrelated so we may rewrite (3).

$$1 = \sigma_j^2 = h_j^2 + a_j^2 = h_j^2 + b_j^2 + c_j^2 \qquad (8)$$

which suggests that the variance of a variable may be due to that attributable to the factors, to specificity, and to error.

The end point of our factor analysis is a series of factor loadings, a_{jp}, which explain as much of the variance of all variable as is possible in each successive factor. These factors are artificial and may not be capable of explanation. However by subjecting these "artificial factors," of which we now know the number, p, to "rotation" we can redistribute their explantory functions among a corresponding number of new factors that are identifiable as interpretable entities. "The identification is carried out by inspecting the items which end up with large loadings on a given factor and discovering what they have in common which is not shared by items not getting large loadings on that factor. Consequently, *the last stage in factor analysis may* be largely subjective."[10]

FACTOR ANALYSIS RESULTS

Each year the Cooperative Extension Service, University of Missouri publishes a Farm Business Summary based upon records derived from the mail-in Record program. It contains tables of data for comparative analysis by type of farm or by region and size of farm. The tables are split into "financial" summaries and "management and production factor" summaries. The size of the computer available limited the amount of material which could be handled to 72 variables. The variables were chosen from those in the "management and production factor" table with the addition of some from the financial table which measured earnings. These variables are listed in Table 1.

There were 240 records for 1964 of which 237 were suitable for analysis. They were divided into 10 type-of-farm groups, on the basis of the proportion of total productive man work units (PMWU) allocated to the crop and livestock enterprises. There were 35 grain, 13 grain-beef, 12 grain-hog, 1 grain-dairy, 8 hog, 7 beef, 33 dairy, 1 poultry, 2 mixed livestock and 128 general farms. For analysis these were placed into five groups: 33 dairy, 35 grain, 41 grain and livestock or

[10]MacEachern *et al. op. cit.;* p. 7.

TABLE 1--THE VARIABLES USED IN THE FACTOR AND REGRESSION ANALYSES

Variable Number	Variable
1.	Farm and family earnings
2.	Operator's labor and management.
3.	Management return
4.	Management and capital return
5.	Per cent return to capital and management
6.	Acres of cropland and open pasture
7.	Acres of cropland
8.	Total capital managed
9.	Capital invested in - land and improvements
10.	Capital invested in - livestock
11.	Capital invested in - machinery and equipment
12.	Capital invested in - feed, seed and supplies.
13.	Total value of farm production
14.	Productive man work units (PMWU)
15.	Man years of labor used.
16.	Capital managed per acre
17.	Value of production per acre
18.	Total value of harvested crops
19.	Value of harvested crops per crop acre
20.	Total value of all crops on cropland
21.	Value of all crops on cropland per crop acre
22.	Machine costs per cropland acre
23.	Fertilizer costs per cropland acre
24.	Seed and crop supplies per cropland acre
25.	Crop cost (excluding labor and land) per cropland acre
26.	Returns for land and labor per cropland acre
27.	Returns for land and labor per crop PMWU
28.	Crop PMWU
29.	Total acres of crop harvested
30.	Percentage of open land in harvested crop.
31.	Corn - acres
32.	Corn - yield
33.	Wheat - acres
34.	Wheat - yield
35.	Soybean - acres
36.	Soybean - yield
37.	All hay - acres
38.	All hay, tons per acre
39.	All silage - acres
40.	All silage - yield
41.	Rotation pasture - acres
42.	Rotation pasture - tons hay equivalent per acre.
43.	Permanent pasture - acres
44.	Permanent pasture - tons hay equivalent per acre
45.	Government retired acres $
46.	Returns per $100 of feed fed: all livestock
47.	Value of all livestock production
48.	Value of feed fed
49.	Returns above cost of feed (47-48)
50.	Returns per livestock PMWU

51. Number of: Beef Cows
52. : Dairy cows
53. : Litters of pigs
54. : Stocker-feeder cattle
55. : Purchased feeder pigs
56. Per cent beef calf crop
57. Milk per cow
58. Pigs born alive per litter
59. Pounds of milk - sold and used
60. Labor charge per $100 of production
61. Value of production per man
62. PMWU per man
63. Capital invested per man
64. Labor charge per farm
65. Labor charge per man
66. Labor charge per PMWU
67. Machinery and equipment charges, fixed and variable, per $100 of production
68. Machinery and equipment charges fixed and variable, per farm
69. Machinery and equipment investment: per $100 of production
70. Machinery and equipment investment: per farm
71. Machinery and equipment investment: per man
72. Combined labor and machine cost per $100 of production

livestock;[11] 128 general (which included the poultry and mixed livestock) and all 237 farms. The farm types were aggregated because at least 30 farms had to be in a group if the results were to be meaningful statistically.

The five groups were then subjected to factor analysis using the Centroid method[12] and the resulting solution was rotated. In each instance 10 factors were extracted.[13]

The output of the computer showed the loading of each variable upon each factor. In terms of our previous discussion we noted that a general factor had a weighting on each variable while a group factor had a weighting upon more than one but not all variables. The factors all had some loading upon each variable but frequently this loading was very small; e.g., the maximum possible loading would be 1.0 (and in some cases loadings over .95 were found) and the small loadings were as low as .001. However, the loadings sometimes grew smaller at a fairly steady rate and at other times exhibited abrupt changes. Therefore it was necessary to select a means of assigning variables to a factor.

[11]The author hoped that by combining the grain-livestock and livestock groups a "feeder" type might be formed. He was advised that it might be best to place the groups in the "general" type. As the analysis developed it seems this would have been a better route to follow.

[12]A method of evaluating the factor loadings. It was the only method available for the computer at the time this work was done.

[13]Harman (op. cit.) suggests that rule of thumb indicates using from one-quarter to one-sixth the number of variables. However, examination of the residuals showed that 10 were adequate. It should be noted that each factor is reducing the variance left after extracting the variance accounted for by the previous factor or factors. Therefore, extracting six factors rather than five will not affect the factor loadings of the first five before rotation; it would only mean that some variance had not been accounted for, and this might or might not be a significant part of the total variance. Further, Harman shows an extra factor may be statistically significant but not of practical significance.

A study of the factors showed a considerable variation in the total variance[14] which they explained, ranging from 31 percent to one percent. Therefore, it seemed that the best approach would be to look at the variables which accounted for a large proportion of the variance due to a factor. It was decided that a factor would be defined by those variables which accounted for at least 75 percent of its variation. The percentage of the variation variable j contributed to factor p[15] was calculated for all groups. Then the percentages of the variables were summed, starting with the highest and continuing until 75 percent of the factor variance was reached. At this point, if a number of variables contributed a percentage close to that of the last variable included they were also included; e.g., in the grain farms, factor one (Table 2) accounts for 25 percent of the variation and it is expressed as 18 variables which account for 80 percent of the 25 percent of variation attributed to it. The last five factors included accounted for 2.7, 2.5, 2.14, 2.19, 2.07[16] percent of the variance. Thus, to get 75 percent one had to drop from 2.53 percent to 2.19 percent and it then seemed desirable to include 2.14 percent and 2.07 percent as the next biggest figure was 1.64 percent. The next eight variables were over 1 percent and would have added 12.6 percent to the variance accounted for but at the expense of having 50 percent more variables attributed to the group factor. It seemed to the author more desirable to use 18 variables and account for 80 percent than to have 27 and account for 93 percent of the variability.[17]

From the above discussion we may also note that the first factor would have fairly high loadings on a large number of variables and seemed as if it might be a general factor. However, when we find that 27 or 37.5 percent of the variables account for 93 percent of the variation we can forget this suggestion. In fact in no case was it found that more than 20 variables were required to account for the stipulated 75 percent.[18] In fact, not only was the first factor not a general factor but in no case was a general factor observed.

At the foot of each table (showing the combination of variables which were allocated to a factor) is shown the percentage of the variation within the factor

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[14] V_p of equation (4) above.

[15] $(a_{jp}/V_p) X 100.0$

[16] It may be of interest to note that usually one did not need a variable contributing much less than 2.5 percent of the variation and sometimes around 3.5-4.0 percent were the smallest. If variance was equal for each variable the percentage would be 1.4 percent.

[17] The decision was purely arbitrary but based in part on the unwieldliness of Tables if large numbers of variables were included.

[18] In some tables less than 75 percent is accounted for by the variables shown. In these cases the factor only accounted for three or four percent of the total variation and it seemed futile to keep adding variables which had little effect over all, e.g. factor 9 of the grain group accounted for 49 percent of its variance. To reach 75 percent one had to include 18 variables, four of which accounted for less than 2 percent of factor variation. Note that 2 percent of factor one is .5 percent of the total variation but 2 percent of factor nine is only .07 percent. In terms of total variance if we included a variable at 2.07 per cent in factor one, a variable at 14 per cent in factor nine would enter. There is little discussion in the literature the author has reviewed on just what basis one should take for selecting variables within a group.

TABLE 2--RESULTS OF FACTOR ANALYSIS FOR TYPE 01 - GRAIN FARMS

Factor	Item (See Table 1)	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	Factor 8	Factor 9	Factor 10	Com. %	Item %
1	29	.93+										99	87%
	28	.91+										94	88'
	8	.91+										98	84
	7	.89+										94	83
	9	.88+										97	80
	14	.85+										94	76
	20	.81										99	66
	13	.81		.44								100	84
	6	.80+			-.44							97	86
	18	.80	-.47									97	88
	68	.78	-.42					-.36				94	96
	31	.76+				-.32						76	90
	33	.66									.43	76	81
	54	.60							-.37	-.30		67	86
	63	.58				-.34				-.38	-.32	81	85
	35	.54							.32			53	74
	15	.53	-.55			.33				.23		84	88
	64	.52	-.53			.32				.18	.36	89	91
2	21		-.90+									99	88
	19		-.89+									98	81
	25		-.87+									95	80
	17		-.80		.42							98	66
	22		-.78					-.28				89	77
	23		-.76+						-.36			79	91
	26		-.64	.60								95	82
	32		-.62	.57								77	92
	16		-.61		.41					-.26	-.33	94	77
	15	.53	-.55			.33				.23		84	88
	64	.52	-.53			.32				.18	.36	89	91
	18	.80	-.47									97	88
	68	.78	-.42					-.36				94	96
3	3			.93*								93	94
	2			.93*								92	94
	4			.85+								96	76
	1			.84+								96	74
	27			.80+			-.24					85	83
	5			.76			.31				.37	92	75
	61			.67		-.40						91	67
	26		-.64	.60								95	82
	32		-.62	.57								77	92

TABLE 2 (Cont'd)--RESULTS OF FACTOR ANALYSIS FOR TYPE 01 - GRAIN FARMS

Factor	Item (See Table 1)	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	Factor 8	Factor 9	Factor 10	Com. %	Item %
3 (Cont'd)	13	.81		.44								100	84
	69			-.44		.28		-.56			-.28	73	81
	60			-.55		.52		.36				88	80
	67			-.58		.35		-.27			-.46	76	70
	72			-.67		.51						84	84
4	30				.48		.47					70	66
	17		-.80		.42							98	66
	16		-.61		.41							94	77
	66				.40	.65						83	71
	38				-.41		.31			.19		36	84
	6	.80			-.44							100	84
	10				-.57		.28		-.62			91	85
	43				-.69+							57	83
	37				-.70		.24			.20		70	84
	56				-.73+	-.28						68	89
	51				-.85+							85	86
5	66				.40	.65						83	71
	34					.53	.26					60	60
	60			-.55		.52		.36				88	80
	72			-.67		.51						84	84
	67			-.58		.35		-.27			-.46	76	70
	15	.53	-.55			.33				.23	.36	84	88
	64	.52	-.53			.32				.18	.36	89	91
	69			-.44		.28		-.56			-.28	73	81
	56				-.73	-.28						68	89
	31	.76				-.32						76	90
	63	.58				-.34				-.38	-.32	81	85
	61			.67		-.40						91	67
	42					-.59+						43	81
	62					-.61					.24	90	47
6	49						.80+					80	80
	50						.71+					60	84
	46						.64					64	65
	30				.48		.47					70	66
	47						.45		-.73			80	91
	5			.76			.31				.37	92	75
	38				-.41		.31			.19		36	84
	10				-.57		.28		-.62			91	85
	34					.53	.26					60	60
	37				-.70		.24			.20		70	84

TABLE 2 (Cont'd)--RESULTS OF FACTOR ANALYSIS FOR TYPE 01 - GRAIN FARMS

Factor	Item (See Table 1)	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	Factor 8	Factor 9	Factor 10	Com. %	Item %
6 (Cont'd)	27			-.80			-.24					85	83
	40						-.30		-.61			95	88
7	55							.40				34	46
	60			-.55		.52		.36				88	80
	67			-.58		.35		-.27			-.46	76	70
	22			-.78				-.28				89	77
	68	+.78	-.42					-.36				94	96
	41							-.38		-.30		36	64
	69			-.44		.28		-.56			-.28	73	81
	11							-.69		.25		88	62
	70							-.70		.25		88	62
	71							-.82*				72	92
8	36								.60+			44	80
	35	.54							.32			53	74
	24								.29		-.26	45	33
	23		-.76						-.36			79	91
	54								-.37	-.30		67	33
	39								-.60			51	71
	40						-.30		-.61			95	88
	10				-.57		.28		-.62			91	85
	47						.45		-.73			80	91
	48								-.79+			74	85
9	58									.51		42	62
	53									.51		43	60
	54	.60							-.37	-.30		67	86
	44									-.30		35	26
	41							-.38		-.30		36	64
	63	.58				-.34				-.38	-.31	81	85
10	65										.51	39	67
	33	.66									.43	76	81
	5			.76			.31				.37	92	75
	64	.52	-.53			.32				.18	.36	89	91
	63	.58				-.34				-.38	-.31	81	85
	16		-.61		.41					.26	-.33	94	77
	67			-.58		.35		-.27			-.46	76	70
Per Cent Total Variation Exp.													
Column		80	75	81	80	81	75	81	80	49	54		
Factor		25	14	17	9	7	7	6	7	4	4		

explained by the variables allocated to the factor.

The next problem is that of relating the individual variables to the factors. We can see that in some cases a variable has a very high weight on one factor. For example, variable 28 in factor one (Table 2) of the grain type has a loading of .91. Its communality is .94 so most of its variance is explained by the group factors, and factor one accounts for 88 percent of it; i.e., 88 percent of .94. In contrast, variable 64 has a communality of .89, and has a weight on factors 1, 2, 5, 9, and 10 which accounts for 89 percent of its variance. In terms of communality and amount of variance explained by the factors including them, there is little to choose between variables 28 and 64, but in one instance the variable is related to only one factor, in the other, to five factors. What does this suggest from the veiwpoint of record analysis?

We are interested in the variables which have been selected to define the factor: Do they form one or meaningful groups from a management point of view? If they do we are especially interested to see which of them have a strong relationship with the factor. A variable which is associated with a number of factors will be of less interest because it does not differentiate between them. In the example above, variable 64 has roughly equal loadings on factors 1 and 2, loadings which are relatively high, but not for these two factors, and low loadings on the other factors. In every case if we were to drop out the three lowest variables we would lose 64. To assist in distinguishing variables which have a high loading on a given factor, any variable which has one factor accounting for 74-89 percent of its communality is marked by a plus (+); e.g., variable 28, factor one, Table 2, grain type. If 90 percent or more is due to one factor, it is marked by an asterisk (*); e.g., variables two and three, factor three, Table 2.

We may also note that nearly all of the 72 variables are allocated to at least one factor. In the grain group we find only five variables not allocated,[19] 12 (capital investment in feed, seed and supplies), 45 (government retired acres), 52, 57, and 59 which are zero because there are no dairy cows on the grain farms. Variable 12 has a fairly high communality, about .63, of which half is acounted for by factor one. It would be the next variable to be allocated to factor one. Variable 45 has a communality of .32 and its highest loading is 63 percent on factor one, and it would be allocated after variable 12.

It should be noted that most of the 72 variables have a high communality; e.g., a glance at Table 2 shows that for the grain type farms 25 variables have a communality of .90 or more, 38 variables have a communality of more than .80 while only 16 have a communality of less than .53. It can also be seen that the variables which have a high proportion of their variance accounted for by the group factors usually have a high proportion acounted for by the factor(s) to

[19]It should be noted that the theory of factor analysis is based upon the expectation that the variables will be normally distributed. It is quite possible that some of these variables are not, e.g. some farms may not have a particular crop or livestock enterprise, which may be the cause of som [illegible]

which they are allocated. Where this is not the case it often means that factor one accounts for a large percentage of that variable's variance, but not sufficient for it to be allocated to factor one; e.g., variable 45 in the last paragraph.

The result of the factor analysis for each type of farm is presented and briefly discussed. The reader should read the comments for Type 01, grain farms, because the general discussion of table layout and some terminology is presented. The following types need only be read if the reader has a special interest in them. They are presented here, rather than in an appendix because the general discussion of factor analysis is dependent upon all the results. Also, an attempt is made to name or describe most of the factors generated and these names are used in the general discussion.

Grain Farms—Type 01.

The main results of the analysis are presented in Table 2. Each of the tables reporting results of the factor analysis has the same layout. The variables used to describe each factor are listed in order of magnitude of their loading upon the factor. If a variable has a loading upon more than one factor this is also shown. Reading across the page for any variable shows the loading it has upon cash factor. Should only one loading appear, that variable did not have a sufficiently high loading upon the remaining factors for it to be used in defining them. The next to last column shows the communality of the variable as calculated by the centroid method. The final column indicates the percentage of the communality explained by the loadings used to define the factors; e.g., in Table 2, factor 1, item (or variable) 29 is shown as having a loading on factor 1 of .93; it has a communality of .99 and 87 percent of that communality is explained by the loading on factor one. In the case of varible 64 we see that is has a communality of .89 and that it has loadings upon factors 1, 2, 5, 9, and 10 which explain 91 percent of its communality. At the end of the table is shown how much of the communality is explained by each factor and how much of a factor or column's communality is explained by the variables as presented.

The maximum possible variance which could be explained by the factors is 72 or 100 percent if each variable had no specific or error variance. In this instance the variance explained by the 10 factors was 75.1 percent of the total variance, with all the variables loading upon each factor. As explained above, each factor was allotted variables until at least 75 percent of the variance explained by that factor was accounted for. This amount is defined for each factor by the figure beside "Percent total Variation explained: column," e.g.; for factor one it is 80 percent, falling to 49 percent for factor nine. Because of the exclusion of variables there was a drop in the variance explained to about 76 percent of that explained originally. That is to say the loadings and variables shown in Table 2 explain 57 percent (75% x 76%) of the total possible variance. We know that about 25 percent of the variance is due to specific factor and error variance. Therefore by defining the variables which constitute the factor by the method described we lose

18 percent of our explanation of variance in this instance. In return we have a much less unwieldy group of variables associated with each factor; this is especially true of those factors which explain little of the variance. The proportion of the variance explained by each factor is the figure beside "Percent total variation explained: Factor."

Turning to a consideration of each factor we see that **factor** 1 accounts for most of the variance of variables 6, 7, 8, 9, 14, 28, 29, and 31—note the +. Except for 31, *acres of corn,* each variable has a communality of .94 or more so that virtually all the variance for these variables is loaded upon the first factor. In general, the variables composing factor one are associated with *size and crop* measures. Specifically, variables 6, 7, 29, 31, 33, and 35 are all measures related to *crop acres;* 14, 15, 28, and 64 are measures of *labor input;* 13, 18, and 20 are measures of *returns;* 8, 9, and 63 are measures of *capital investment* and in this type of farm we see are closely related to 7, *acres of cropland.* The remaining variables are *machinery costs* and the single livestock variable 54, *number of stocker-feeder cattle.* The factor explains almost twice as much variance as does any other factor, and almost as much as the last five factors combined; i.e., 25 percent compared with 28 percent. It seems quite reasonable that so much of the variance associated with the variables on a grain type group should be loaded with *acres of crop and cropland, total capital invested, labor* required for cropping and area of crop harvested.

Factor 2 has four variables which account for most of its associated variance, 19, 21, 23, and 25. The first two measure returns per acre and the other two, crop costs per acre. At first sight it seems a highly significant observation to find that fertilizer and crop costs are closely related and factor out together with the *value of harvested crop* and *value of all crop* per crop acre. However, if we look further at the variables in this factor we find they are nearly all on a *per acre* or *per crop acre* basis and it may be that the factor is measuring the fact that each of these variables has been obtained by dividing by similar figures. Nevertheless, when we note the high communality of 19, 21, and 25 and see that most of their variance is explained by the factor it does seem a most suggestive grouping, especially as half of the variance of corn yield, variable 32, is associated with the factor. The variables 15, 16, 22, 23, 25, 64, and 68 all measure costs of input while variables 17, 18, 19, 21, and 26 are value measures of output with 32 a physical value of output. In view of the grouping of variables the factor may be called "an input-output factor associated with per acre divisors." Note that the last four variables are also associated with the first factor.

Factor 3 accounts for most of the variance of the five variables, 1, 2, 3, 4, and 27, and will be called the *income factor.* Each of these five variables is a "residual" measure of farm returns in the sense that some cost have been deducted from gross returns. Each variable has a high communality and it is of interest to note that *returns for land and labor per crop PMWU* is closely associated with such resources as *operators labor and management return* and *management and capital re-*

turn. Again this seems a reasonable association of variables for grain type farms. The remaining variables which have a positive association are also associated with returns; i.e., variables 5 and 26 measure residual returns. Note that 26 is the return to land and labor from cropping divided by crop acres and that it does not associate quite as closely with the return measures as does the same figure when divided by crop PMWU. Thirteen measures gross returns; 32 measures corn yield as the physical return from the major crop but not 31, corn acres which was mainly associated with the size factor and 61, *value of production per man,* i.e., 13 divided by the number of men. The latter again is importantly loaded on this factor and probably has a close association with item 27 which has a divisor of crop PMWU which ought to be closely related to number of men.

Inspection of the remaining variables reveals that their factor loadings are opposite in sign to those of the previous variables. A factor which has variables with both positive and negative loadings is called "bi-polar." The explanation of such factors is that the variables constituting them may be regarded as being at opposite ends of some scale. In this instance each of the remaining variables has a common divisor so that we can reasonably expect an inverse relationship. Each of the four variables is an input expressed as a percentage of the value of production. Their loading on this factor may be explained by their possessing a common divisor which is positively related to the factor and as division gives an inverse relationship this shows as a negative loading.

We may also note that the three factors described, among them, account for 56 percent of the variance explained by all 10 factors. The next five factors are of roughly equal importance in that each explains about 7 percent of the total communality.

Factor 4 explains 70 percent or more of the variance of variables 37, 41, 51, and 56. This is an interesting group because we find beef cows, calving percentage, and hay and pasture acres associated in a bi-polar factor.[20] Along with them are variables 6, *total acres including pasture;* 10, *capital invested in livestock;* and 38, *yield of hay.* The contrasting variables, 16, 17, 30, and 66, are *capital* and *value of production per acre, percentage of open land in harvested crop* and *labor charge per PMWU.* This suggests that as the proportion of crop decreases on grain farms the importance of livestock increases and the amount of land under hay and pasture increases. This appears a meaningful factor, especially when we see that value of production is inversely related to the amount of livestock on grain farms. This might be called a "livestock versus crop" factor.

Factor 5 is again bi-polar, having only one variable highly explained by it, *yield of rotation pasture.* Associated are variables 31, 56, 61, 62 and 63. The latter

[20]It has been suggested that the association of these variables is due to an absence of livestock. However a grain farm could have 49 percent of its PMWU occupied in livestock operations so long as less than 33 percent of all PMWU is not associated with any one type of livestock. Therefore this criticism does not appear to be necessarily valid.

three are on a per man basis; from the previous factor we saw calving percentage related to acres and now to yield of rotation pasture and acres of corn. The contrasting variables are 15, 34, 60, 64, 66, 67, and 69. In the labor instances they are presumably the inverse of the per man variables, e.g. 15; however, there may be some significance in an association of *wheat yields* and *machinery costs per $100 of production.* It is not easy to see that this factor has a meaning which can be interpreted in a farm management context so it has not been named.

Factor 6 is just bi-polar. It explains most of the variance of 49 and 50 and 65 percent of that of 46. These factors are *returns above cost of feed, returns per livestock PMWU* and *returns per $100 of feed fed.* Also associated are *30 percent of land under crop;* 47, *value of livestock production;* 5, *return on capital;* 38, *hay yield;* and 10, *capital invested in livestock.* This is a "livestock feed—returns" factor. The opposite variables are returns for land and labor for crop PMWU which seems logical but not the other which is yield of silage. Its position would suggest that silage production on grain farms for livestock feeding is unprofitable, or possibly that little is produced. However, the loading is weak and not too much importance should be attached to it.

Factor 7 is again slightly bi-polar. It explains most of the variance of 71, *machinery and equipment investment per man.* The positively associated variables are *machinery investment* (11 and 70); 69, *machinery investment per $100 of production;* 67 and 68, *machinery and equipment charges,* fixed and variable; 22, *machine cost per acre;* and 41, *acres of rotation pasture.* The opposite variable, 60, *labor charges per $100 production,* suggests an inverse relation between labor and machinery cost but not perhaps as great as one might expect. Is the low relationship due to over-investment in machinery or due to most farms having a fairly uniform relation between man and machine, only a few farms being so highly machanized that there is a distinct drop in labor requirements? This factor would appear to be appropriately called a "machinery" factor.

Factor 8 is bi-polar with each group having a variable highly explained by the factor, which includes variables 36 and 48, *soybean yield* and *value of feed fed.* Weakly associated with soybean yield is *soybean acreage,* 35, and *seed and crop supply cost per acre,* 24. Negatively associated with it is fertilizer cost per acre. The remaining variables are associated with 48 so this negative association raises the query: Is too much fertilizer being applied to soybeans? It appears that seed and chemicals are positively associated so why a negative association with fertilizer?

In conjunction with *feed fed* we find *stocker-feeder cattle, silage acres and tons, capital invested in livestock,* and *value of livestock production.* It is of interest to contrast this with factor six. That factor laid emphasis on livestock returns, this one explains feed cost. Both have a number of variables in common but factor six explains only 5 percent of the variance of 48 and 25 percent of the variance of 47 while this factor explains 85 percent and 66 percent. However, eight explains only 5 percent and three percent of 49 and 50 where factor six accounts for 80 and 84 percent, respectively. Variables 47, 48, and 49 are *value of all livestock production, value of feed fed, and livestock return above feed cost.* Does the low association of 48 and 49 mean that feed costs and livestock returns on grain farms are not related? This possibility is of special interest in view of the silage question raised earlier, because we find factor eight explains 70 percent of the silage yield variance.

The last two factors account for 7.7 percent of the communality variance. They are both bi-polar. In **Factor 9** *number of litters* of *pigs* and *pigs born alive per litter* associate in opposition to *stocker-feeder cattle* and *capital investment per man* (and rotation pasture acres and permanent pasture yields). Does this imply that if we have high labor relative to capital we add a pig unit? This seems a reasonable inference but the factor is not one which is of great importance as measured by its explanation of variance.

Factor 10 places 5, 33, 64, and 65 in opposition to 16, 63, and 67. In association are *return to capital and management, acres of wheat,* and *labor charge per man* and *per farm* while in opposition are *capital managed per acre, capital invested per man and machinery* and *equipment charges for $100 of production.* Again wheat has a surprise appearance with *acres,* not yield, associated with percent return to capital and management and labor costs. A most interesting contrast is that *return to capital and management* and *labor costs* are negatively associated with *capital per acre and per man* and *equipment charges per $100 of production.* Unfortunately, all these variables, except 65, have loadings, and usually higher loadings, upon other factors. Even so, this grouping is suggestive when *return to capital and management* is negatively associated with *capital investment per man* and *equipment charges per $100 of production.*

The factor analysis would seem to group the variables in reasonably meaningful classes, but in some cases variables which might expect to be strongly associated are not, for example, variables 14 and 15, *PMWU and man years of labor* used. Another interesting group is 22, 23, 24, and 25, (which is the sum of 22, 23, and 24). Variables 22, 23, and 25 load 68, 74, and 85 percent of their respective variances on factor two, but 24 has 16, 23, 21, 19, 6, and 15 percent of its variance loaded upon factors 1, 2, 3, 8, 9, and 10, respectively. The smallest maximum loading of any variable in the whole analysis was the 23 percent on factor two mentioned above.

Finally we note that the communality column of Table 2 suggests there may be some variables which either have a high specific loading or considerable error variance. This point will be considered in greater detail after presenting the factor analysis for .remaining groups

Grain and Livestock Farms—Types 02, 03, 04, 05, 06.

There were 10 factors extracted for grain and livestock farms but only nine are shown in Table 3. The tenth factor was dropped because only two variables,

TABLE 3--RESULTS OF FACTOR ANALYSIS FOR TYPE 02 - GRAIN-LIVESTOCK FARMS

Factor	Item (See Table 1)	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	Factor 8	Factor 9	Com. %	Item %
1	14	.90+									98	83
	7	.89+									94	84
	68	.89+									91	87
	20	.88+									95	81
	6	.88+						-.32			95	92
	8	.87+							.27		97	92
	13	.86+									99	75
	64	.84+					-.38				94	92
	15	.84+							-.38		92	92
	18	.84									99	70
	28	.84			-.38						98	85
	29	.82			.34					.26	99	86
	12	.81+		.33							84	91
	70	.81			-.46						93	93
	9	.81							.31		89	84
	11	.80									91	70
	31	.78									87	70
	10	.75					.37	-.42			96	92
	48	.75					.37	.31			89	74
	47	.66		-.34				.24			95	65
2	5		-.91+								93	89
	2		-.90+								96	84
	3		-.90+								98	82
	4		-.80								96	68
	1		-.80								97	66
	49		-.71	-.43							86	81
	50		-.71	-.34							82	87
	46		-.66	-.40							80	75
	61		-.64						.56		99	74
	17		-.50			.45					61	73
	60		.62						-.51		82	79
	69		.64			.38					75	73
	67		.79							.32	89	81
	72		.82								94	78
3	26			.88*							85	93
	27			.84+							86	83
	19			.75		.47					86	91
	21			.72		.56					86	97
	32			.54			-.32			-.29	70	69
	40			.48							39	59

TABLE 3 (Cont'd)--RESULTS OF FACTOR ANALYSIS FOR TYPE 02 - GRAIN-LIVESTOCK FARMS

Factor	Item (See Table 1)	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	Factor 8	Factor 9	Com. %	Item %
3 (Cont'd)	39			.33	-.46		.47	.26			84	74
	12	.81		.33							84	91
	63			-.20					.69		75	80
	50		-.71	-.34							82	87
	47	.66		-.34				.24			95	65
	46		-.66	-.40							80	75
	49		-.71	-.43							86	81
	58			-.44							52	51
	53			-.60							68	64
4	52				-.92*						90	95
	59				-.92*						90	95
	57				-.89*						84	96
	71				-.62				.47		79	77
	70	.81			-.46						93	93
	39			.33	-.46		.47	.26			84	74
	33				-.45		-.31			.39	71	63
	62				-.39				.48		70	54
	28	.84			-.38						98	85
	29	.82			.34					.26	99	79
5	25					.94*					93	95
	22					.82+					84	80
	23					.74+					67	81
	16					.62					67	56
	21			.72		.56					86	97
	24					.53					45	61
	19			.75		.47					86	91
	17		-.50			.45					61	73
	69		.38			.38					75	73
	30					.35		.23		.40	73	45
6.	39			.33	-.46		.47	.26			84	
	54						.44				73	26
	44						.38				39	36
	10	.75					.37	-.42			96	92
	33				-.45		-.31			.39	71	63
	32			.54			-.32			-.29	70	69
	34						-.34			.35	46	52
	35						-.34			.28	48	40
	36						-.36				39	33
	64	.84					-.38				94	92

TABLE 3 (Cont'd)--RESULTS OF FACTOR ANALYSIS FOR TYPE 02 - GRAIN-LIVESTOCK FARMS

Factor	Item (See Table 1)	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	Factor 8	Factor 9	Com. %	Item %
6 (Cont'd)	65						-.56+				42	75
	66						-.60				54	68
7	55							.38+			17	85
	48	.75						.31			89	74
	39			.33	-.46		.47	.26			84	74
	47	.66		.34				.24			95	65
	30					.35		.23		.40	73	45
	56							-.25			43	14
	6	.88						-.32			95	92
	37							-.41		.39	69	48
	10	.75					.37	-.42			96	92
	43							-.63			75	52
	51							-.65			68	62
8	63			-.20					.69		75	80
	61		-.64						.56		99	74
	62				-.39				.48		70	54
	71				-.62				.47		79	77
	9	.81							.31		89	84
	8	.87							.27		97	92
	58			-.44					-.26		52	51
	53			-.60					-.28		68	54
	15	.84							-.38		92	92
	60		.62						-.51		82	79
9	30					.35		.23		.40	73	45
	33				-.45		-.31			.39	71	63
	37							-.41		.39	69	48
	34						-.34			.35	46	52
	67		.79							.32	89	91
	35						-.34			.28	48	40
	29	.84			.34					.26	99	86
	41									-.26	28	24
	32			.54			-.32			-.29	70	69
	42									-.72*	58	89
Per cent Total Variation Exp.												
Column		82	83	77	77	76	76	72	74	66		
Factor		30	18	11	10	9	5	4	5	4		

38 and 30, had sufficiently large loadings to be considered and they explained only 13 percent and 11 percent of factor ten's variance. The nine common factors reported explain 73.6 percent of the total possible variance. Factor 10 would account for 3.0 percent, leaving 23.4 percent due to specific factors and error. Note that 26 variables have a communality greater than .90 forty-one have a communality of .80 or more, and 14 have a communality less than .53. The average communality of the low 14 variables is .34 so they represent 12.5 percent or more than half of the 23.4 percent due to specific factor and error. The variables in this group are 24, 34, 35, 36, 38, 40, 41, 44, 45, 55, 56, 58, 65, and 66[21] which cover seed and supplies, crop, hay and silage acres or yields, pig litters and labor charges. The information available does not permit an analysis of the extent to which the unaccounted variance is due to error or specific factors but it seems possible that variables 38, 40, 41, 44, 45, and 58 may have large errors of measurement. The amount of variance explained by the variables allocated to the factors is 78.7 percent of the communality and 57.9 percent of the total variance.

Factor 1 explains 30 percent of the variance while factors five to ten inclusive explain 31.6 percent of it. Clearly factor 1 is a most important factor. Twenty variables have been allocated to this factor and it explains 75 percent or more of the variance for ten of them. The communality of these variables is greater than .91 except for variable 12. The variables are 6, 7, 8, 12, 13, 14, 15, 20, 64, and 68. Variables 6, 7, 8, 12, 14, 15, 64, and 68 are size measures for inputs and 13 and 20 are measures of output. The remaining variables are 9, 10, 11, 18, 28, 29, 31, 47, 48, and 70. We note that some variables associated with livestock are now present (10, 47 and 48) which were absent in factor one of the grain farms. However, as these are associated with size, the factor may perhaps be called a "size of operation" factor as it is associated with aggregate measures of land, labor, livestock, and feed inputs and measures of total crop and livestock production.

We note that the "income" factor now takes seond place and accounts for 18 percent of the communality. **Factor 2** accounts for most of the variance of variables 2, 3, and 5 and more than 66 percent of variable 1 and 4. It is again a bi-polar factor and the same variables have opposite high loadings. Again the variables associated with this factor have high communalities, most larger than .90, and only two of the 14 are below .80. We note that in this instance variable five has the greatest loading and has the most variance explained by the "income" factor—a distinct contrast to the grain type farms where variable five was allocated to three factors. In association with the five residual income measures are variable 17, 46, 49, 50, and 61. Each of these measures value of production in some form and so would appear to be logically associated with the principle variables. Note that the net crop return measures, 26 and 27, are not present and the income factor explains only 2.0 and 0.9 percent of their variance, respectively.

These two variables are highly related to **Factor 3** and are the only variables for which it explains more than 75 percent of the variance. The factor is bi-polar.

[21]Note that variables 38 and 45 are the only ones not allocated to a factor.

Associated with 26 and 27 are variables 12, 19, 21, 32, 39, and 40. In negative association are variables 46, 47, 49, 50, 53, 58, and 63. The first four of these are various measures of livestock return which suggests that if we have high crop returns livestock returns are low and vice versa. Variables 53, *number of litters;* 58, *pigs alive per litter;* and 63, *capital per man,* were associated in the previous farm type. Also, we have previously noted 49, *yield of silage,* as being bi-polar to 46, 49, and 50 although it was not associated with 26 and 27.

The first three factors explain 59 percent of the explained variance but we may note that factors four and five are about as important as factor 3. The last five factors each explain about 4 percent of the total communality. It would be useful to be able to test the significance of factors which explain so little of the total variance.

Factor 4 explains 95 percent or more of the variance of three variables, each of which has a high communality. The variables are 52, *number of cows;* 57, *milk per cow;* and 59, *total milk produced.*[22] There is a considerable drop in loading to the other variables associated in this factor, 28, 33, 39, 62, 70, and 71. There seems no intuitive reason for this positive association of what appears to be a "dairy" or "milk and cow" factor with crop PMWU, acres of wheat, acres of silage, PMWU per man, machinery and equipment investment per farm and per man. The one bi-polar variable is 29, acres of crop harvested.

Factor 5 explains much of the variance of variables 22, 23, and 25 which are crop costs per acre. In association are 16, 17, 19, 21, 24, 30, and 69. As before, we note that many of these variables have a common element, a divisor—crop acres. Nevertheless, the loadings are high and the communality fairly high so it would seem that 19, 21, 22, and 25 have a closer association than the other variables. *If so we have a close association of crop returns and machinery and total crop costs per acre.* The factor is related to crop *gross* returns and crop inputs but accounts for only 0.08 percent and 3.2 percent of the variance of the crop *net* return measures, 26 and 27. We might also note that factor 3 explains less than 1 percent of variables 22, 23, and 25. Variable 30, *percent of land in harvested crop,* has only 16 percent of its variance explained by factor 5, most of its variance being associated with factors 9 and 10. It has 15 percent or more of its variance explained by each of four factors.

Factor 6 is bi-polar and 65 and 66, the variables with high loadings, have a low communality. Associated are 32, 33, 34, 35, 36 (crop acres and yields), 64, 65, and 66 which are labor charge per farm, man and PMWU respectively. The opposing variables are 10, 39, 44, and 54—capital in livestock, silage acres, permanent pasture yield, and stocker-feeder cattle. The association of livestock with noncrop factors in opposition to crop acres and yields appears reasonable—the

[22]Not all farms may have dairy cattle but in some instances they may form an appreciable part of the livestock activities.

high loading of labor with these other variables seems less clear, unless the crop activities require large amounts of labor.

Factor 7 has only one variable for which it accounts for most of the variance. However, this variable, 55, purchased feeder pigs, has a very low communality and so does not seem an especially important variable (in relation to defining a factor). It also has a much lower loading than some of the other variables allocated to this bi-polar factor. Associated with 55 are variables 30, 39, 47, and 48, all of which have less than 10 percent of their variance explained by factor 7. The opposing variables are 6, 10, 37, 43, 51, and 56 (total acres, capital in livestock, acres of hay and permanent pasture, number of beef cows and calving percent.) *Acres of permanent pasture* and *number of beef cows* both have over 50 percent of their variance explained by this factor and seem to be associated and in opposition to percent under crop. It might be argued that variable 6 is present because on large farms there is proportionately less land under crop and more capital invested in livestock.

Factor 8 is bi-polar and associates variables 8, 9, 61, 62, 63, and 71 in opposition to variables 15, 53, 58, and 60. Variables 61, 62, 63, and 71 all have a common divisor and, except for 63, factor 8 explains little of their variance. As 8, 9, and 63 are capital measures their association is logical. As 15 is the divisor for 61, 62, 63, and 71 it is to be expected that it will be opposed to them. The pig litter variables do not appear to have an expected relationship—perhaps that suggested in discussing grain farm is again applicable, especially as it is associated with smaller farms.

The final factor, **Factor 9**, explains most of the communality of 42 (rotation pasture yield), but the communality is small. Weakly associated are acres of rotation pasture and corn yield; corn yield has 12 percent of its variance explained by factor 9. Corn yield has five factors which each explain more than 10 percent of its variance so it does not appear to be a good predictor for this type of farm. In opposition are variables 29, 30, 33, 34, 35, and 67 (acres of crop harvested, percent under crop, wheat acres and yield, soybean acres, and machinery and equipment charges per $100 of production). Does the opposition of corn yield to wheat and soybean acres suggest that growers of these crops do not spend sufficient time looking after their corn? This factor accounts for almost 16 percent of corn yield variance and about 25 percent of wheat variance and 16 percent of soybean acreage variance. Alternatively, it may mean that those who concentrate upon corn raise little wheat or soybeans.

We note that many of the factors show similarities to those in the grain group but that there are also distinct differences, both in the composition of factors and the introduction of the "dairy" factor, factor 4.

Dairy Farms—Type 07

In Table 4 we see the ten factors to which all the variables in the dairy type were allocated. These ten factors account for 80.55 percent of the possible varia-

TABLE 4--RESULTS OF FACTOR ANALYSIS FOR TYPE 07 - DAIRY FARMS

Factor	Item (See Table 1)	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	Factor 8	Factor 9	Com. %	Item %
1	37	.88+									97	80
	28	.79									96	64
	7	.77				-.42					90	85
	29	.70	-.51								98	77
	6	.66					-.38				98	60
	39	.63						-.28			62	77
	41	.52									39	69
	9	.51		.47			-.29				92	61
	20	.49	-.57			-.39		.31			99	61
	18	.44	-.62					.31			98	69
	62	.43					.30	-.48		.41	86	77
	8	.43		.67		-.44					99	83
	12	.40							.34		81	34
	55	-.41		.70	-.47						91	97
2	72		.83								90	77
	60		.72			.40					85	80
	67		.59			-.69					93	89
	33		-.49							.44	61	71
	31		-.54								58	50
	29	.70	-.51								98	77
	20	.49	-.57			-.39		.31			100	61
	18	.44	-.62					.31			98	69
	30		-.63				.35			.40	83	81
	26		-.65				.33				82	64
	27		-.67				.33		.30		88	75
	61		-.69			-.44		-.34		.34	99	92
	1		-.85+								97	75
	5		-.88+								93	82
	4		-.89+								98	82
	2		-.94*								95	93
	3		-.94*								93	96
3	47			.96*							97	95
	52			.96*							99	93
	64			.92*							95	90
	15			.92+							96	88
	14			.92+							100	83
	48			.91+							95	88
	10			.91*							91	92
	49			.84+							95	73
	55	-.41		.70	-.47						91	97

TABLE 4 (Cont'd)--RESULTS OF FACTOR ANALYSIS FOR TYPE 07 - DAIRY FARMS

Factor	Item (See Table 1)	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	Factor 8	Factor 9	Com. %	Item %
3 (Cont'd)	13			.68							100	45
	8	.43		.67		-.44					99	83
	43			.52			-.52		.29		75	82
	59			.52				-.58			78	78
	68			.50		-.70					93	80
	9	.51		.47			-.29				92	61
4	25				.89+						89	88
	19				.83+						86	81
	21				.78						95	64
	24				.71+						66	77
	22				.71						73	69
	40				.70+						66	75
	17				.63						94	41
	16				.56						73	42
	38				.48	-.67					77	89
	23				.48					.47	63	71
	66				.42		-.30	.40			71	60
	55	-.41		.70	-.47						91	97
5	60		.72			.40					85	80
	20	.49	-.57			-.39		.31			100	61
	9	-.51		-.47		-.40					92	61
	7	.77				-.42					90	85
	61		-.69			-.44		-.34		.34	99	92
	34					-.44				+.45	51	77
	8	.43		.67		-.44					99	83
	63					-.64					87	48
	38				.48	-.67					77	89
	67		.59			-.69					93	89
	68			.50		-.70					93	80
	70					-.84+					92	76
	11					-.84+					92	76
	69					-.85+					94	76
	71					-.92+					97	86
6	30		-.63				.35			.40	83	81
	26		-.65				.33				82	64
	27		-.67				.33		.30		88	75
	62	.43					.30	-.48		.41	86	77
	9	.51		.47			-.29				92	61

TABLE 4 (Cont'd)--RESULTS OF FACTOR ANALYSIS FOR TYPE 07 - DAIRY FARMS

Factor	Item (See Table 1)	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	Factor 8	Factor 9	Com. %	Item %
6 (Cont'd)	66				.42		-.30	.40			71	60
	6	.66					-.38				98	60
	46						-.44			-.40	68	53
	50						-.47	-.31		-.31	75	56
	43			+.52			-.51		.29		75	82
	54						-.55				47	64
	56						-.81+				78	84
	51						-.82+				81	83
7	66				.42		.30	.40			71	60
	20	.49	-.57			-.39		.31			99	61
	18	.44	-.62					.31			98	69
	39	.63						-.28			62	77
	50						-.47	-.31		-.31	75	56
	61		-.69			-.44		-.34		.34	99	92
	62	.43					.30	-.48		.41	86	77
	59			+.52				-.58			78	78
	57							-.72			85	66
8	35								.75+		75	75
	36								.60+		45	80
	42								.43		39	47
	32								.36		51	25
	12	.40							.34		81	34
	27		-.67				.33		.30		88	75
	43			.52			-.51		.29		75	82
9	65									.61+	46	79
	23				.48					.47	63	71
	34					-.45				.45	51	77
	33		-.49							.44	61	71
	62	.43					.30	.48		.41	86	77
	30		-.63				.35			.40	83	81
	61		-.69			-.44		-.34		.34	99	92
	44									.31	35	28
	50						-.47	-.31		-.31	75	56
	46						-.44			-.40	68	53
Per cent Total Variation Exp.												
Column		76	78	80	79	79	77	60	59	63		
Factors		12	20	20	11	13	7	5	4	5		

tion if all the variables are considered. After allocating the variables to the factors as shown, 75 percent of the communality is explained or 60 percent of the possible variation. Note that the loss of explanation of variance is much smaller than it was in the first two groups.

We note a rather unusual occurrence in the amount of variance that successive factors explain, in that factors 2 and 3 explain more than does factor 1, and factor 5 explains more than factor 4. This is an effect of rotation because factors are extracted in a manner such that each one accounts for less variance than the preceding factor. We can also observe that the first 5 factors explain the variance fairly equally compared with the preceding groups. As before, the last 5 factors each explain about 4 percent of the communality.

Examining the communality of the variables, we see that in three instances the common factors explain all the variance, that 34 variables have a communality of .90 or higher, 45 variables have a communality of .80 or higher while only 11 have a communality less than .55. The 11 variables are 32, 34, 36 (yield of corn, wheat and soybeans), 41, 42, 44, 45, 53, 54, 58, and 65 and their average communality is .45, much higher than was the case for the grain-livestock group. As noted, every variable was allocated to one or more factors. Along with the communality, we might inspect the proportion of the communality for which we account after allocating the variables. There were three variables for which the group factors explained all the variance 13, 14, and 20. Thirteen has 13, 28, and 45 percent of its variance explained by the first three factors but is only allocated to factor three which is why only 45 percent of its variance is explained. Fourteen has 10.0 and 83.3 percent of its variance explained by factors 1 and 3; it too is only allocated to three but it has nearly twice as much of its variance explained as has 13. Variable 20 has 10 percent or more of its variance explained by five factors so that even though it has been allocated to three of them we have only explained 6 percent of its variance. This shows quite clearly that even though a variable has the maximum possible communality, it may not appear as a specially meaningful or selective variable after considering its factor loadings.

Turning to the factors, not that **factor 1** explains less of the variance than in the earlier instances and that the variables and their order of association are different. Also, only one variable has most of its variance explained by it. The variables present (6, 7, 8, 9, 12, 18, 20, 28, 29, 37, 39, 41, 55, and 62) are of interest in that only one animal variable, 55 (feeder pigs), is present and it has a negative association. The factor becomes a "crop area, crop value, and pasture" factor rather than a "size" factor.

Factor 2 is the "income" factor with all the residual income measures having 75 percent or more of their variance explained by this factor. As before, it is bipolar and has the same variables in negative association. Associated with the residual income measures are 18, 20, 26, 27, 29, 30, 31, 33, and 61. Note that 18, 20, 26, and 27 are all values of crop production. Twenty-nine is area under harvested crop; 31 and 33 are acres of corn and wheat. *It is astonishing that in a diary type farm group there is no livestock return associated with the income factor.* In fact, eight non-livestock variables would enter before 46, *returns per $100 of feed fed,* the first livestock return measuring variable. Variables 47, 49, and 59 (value of livestock production before and after feed fed and total milk produced) have only 1.2; 5.7; and 10.0 percent of their variances explained by factor two.

The livestock variables are highly associated with **factor** 3, eight variables having most of their variance explained by the factor. The eight variables are 10, 14, 15, 47, 48, 49, 52, and 64 and their loadings on factor 3 are all greater than .90 except for 49. The group includes labor, livestock capital, feed and production values, and cow numbers. This appears a logical grouping on a dairy farm which by definition has over 50 percent of the PMWU in the dairy enterprise. The remaining associated variables are 8, 9, 13, 43, 55, 59, and 68, i.e., two capital investment measures, total value of production, acres of permanent pasture, purchased feeder pigs, total milk produced, and machinery and equipment charges per farm. This factor associates number of cows, total milk produced, total value of farm production, gross value livestock production, value of livestock production less feed fed, cost of feed fed but not milk per cow (16 percent of its variance) nor variables 2, 3, or 5. Variables one and four have 16 percent and 12 percent of their variance explained by factor 3.

Factor 4 explains most of the variance of four of its variables, 19, 24, 25, and 40. The communality of 24 is here somewhat higher than previously and 77 percent of its variance is explained by one factor. A marked contrast with the grain group where no factor accounted for more than 23 percent of its variance and each of six factors explained 10 percent or more. Its association with 19 (value of harvested crop) and 40 (tons of sialge) is obscure unless special seed or chemical treatment is needed for crops ensiled. The remaining variables are 16, 17, 21, 22, 23, 38, 55, and 66, a mixture of the old "crop acre" divisor group, tons of hay, bought feeder pigs (in negative association), and labor charge per PMWU. Again, the variables are mainly crop costs and gross production with some new variables.

Factor 5 accounts for most of the variance of 11, 69, 70, and 71 which concern machinery and equipment investment. Associated are variables 7, 8, 9, 20, 34, 38, 61, 63, 67, and 68 with 60 in negative association. The first six of these associated variables are capital and crop or hay variables which may support the proposition that machinery investment is associated with acres of crops, wheat, and hay as well as 67 and 68, involving machinery costs. The positive association with 61 may suggest that mechanization on dairy farms increases output per man. In both of the grain groups, variable 61 was bi-polar with 67 and 69. Factors which explained appreciable amounts of 61's variance did not explain more than 1 or 2 percent of the variance of 70, machinery investment per farm or more than

10 percent of 71. As 71 and 61 have a common divisor, we would expect some association.

The five factors discussed above explain 76 percent of the communality, with factors 2 and 3 somewhat more important and accounting for a little more than half of it. The remaining five factors are of similar value in explaining the remaining variance.

Factor 6 explains over 80 percent of the variance of 51 and 56, after which there is a sharp fall in factor loadings to the remaining associated variables 6, 9, 43, 46, 50, 54, and 66. Variables 51 and 54 are beef cattle numbers and relate to total acres, permanent pasture acres, returns per $100 feed fed and labor charge per PMWU. In negative association are 26, 27, 30, and 62 which suggests that *if beef cattle are present, net crop returns and the proportion of land under crop will be low*, while 62 taken in conjunction with 66 suggests that possibly the PMWU values for beef cattle are out of line.

Factor 7 has no especially high loading variable but there is a close relationship between milk production and milk per cow. Associated are 39, 50, 61, and 62, concerning acres for silage, returns per livestock PMWU, value of production per man, and PMWU per man. In dissociation are 18, 20, and 66 which suggests that *value of crops is negatively associated with milk yield and production.* The latter association adds interest to the prior observation that milk production had little relation to the "income" factor but crop values of production were related.

Factor 8 is not bi-polar and is a crop factor; note the importance of soybean acres and yield, which, in turn are associated with corn and hay production, acres of permanent pasture, and capital invested in seed and supplies. Recall that soybeans have previously shown an association with the last variable.

Factor 9 has one variable for which it explains most of the variance. This is 65, *labor charge per man.* Then, following a sharp reduction in factor loading, come variables 23, 30, 33, 34, 44, 61, and 62. Variables 61 and 63 have a common divisor but it is not clear why the other variables load with 65 unless wheat production has a high labor cost. The opposing variables are 46 and 50, which measure livestock returns. Possibly this indicates lower labor charges where income is generated by livestock.

Finally, we see that 54 percent of the **factor** 10 variance is explained by just three variables, of which two are highly associated, 53 and 58, which concern litters of pigs and pigs born alive per litter. The other variable, government retired acres, has no obvious association unless farms on which pigs are raised are those which have joined the government scheme.

This completes the analysis of the dairy group in which a number of anomalies were observed, as well as differences compared with the two previous farm types studied. We now turn to the general farm group.

General Farms—Types 08, 09, and 10.

Table 5 presents the factor groupings for general farms. Note that factor 10 is again excluded. It explained only 2 percent of the total variance, required 19 variables to explain 79 percent of its variance, and the only variables explaining more than 5 percent of its variance were 56, with 11.6 percent, and 44, with 6.1 percent. This was the first occasion that 51 and 56 were not closely associated. The ten factors accounted for 70 percent of the possible variance, and the remaining nine, for 67 percent of the variance with all variables included. After allocating the variables, about 51 percent of the variance was explained. This is less than for the dairy group where 60 percent was explained and the grain groups where about 57 percent was explained. It appears that the more specific the grouping the better the chance for the factors to explain the variance. We note that only 16 variables have communality of .90 or more; 29 variables have a communality of .80 or more, 39 of .70 or more, and 19 have a communality of less than .55. The average communality of the latter was .32, so that out of the 33 percent of unexplained variance after dropping factor 10, about 18 percent (or more than half) is due to the variables with low communality, even though the communality of all the variables is lower than it was in the other form types. These 19 variables are 23, 24, 32, 33, 34, 35, 36, 38, 39, 40, 41, 42, 44, 45, 53, 55, 56, 58, and 65. All those variables listed in Type 02 (the grain and livestock farms) are here except 66 which would be the next one to enter the low communality group. Variables 32 through 44 are crop or pasture acres and yields. Twenty-three and 24 are crop inputs so it seems that crops and yields are subject to influences which have not been included in the correlation matrix because even on the grain type farms variables 35 through to 45 have a low communality.

Factor 1 resembles the factor 1 of the grain farms rather than that of the dairy farms in that it has many variables for which it explains most of the variance. The variables are 6, 7, 8, 9, 10, 14, 15, 28, 29, and 64. The total capital invested has the highest loading and is associated with investment in land and livestock, total acres, crop acres, PMWU and man years of labor, crop PMWU, acres harvested, and capital per man. Looking at the remaining variables, 12, 13, 18, 20, 31, 37, 43, 48, 51, and 68, we note that value of production and value of crop production are included as are the acre measures 31, 37, and 43. However, cost of feed fed and number of beef cows are present to make the factor meaningful of size generally, including the livestock aspect. Although machinery investment is missing, machinery fixed and variable cost in present.

Factor 2 is a bi-polar *income* factor with the familiar negatively associated variables 60, 67, 69, and 72. Variables 2 and 3 have more than 90 percent of their variation explained; 5 is also high but 1 and 4 are lower than usual. Associated with the residual income measures are 13, 17, 26, 27, 46, 49, 50, and 61, Now we see both the livestock and crop residuals loading with income, in *direct contrast to the previous dairy group where only crop variables loaded with income.*

TABLE 5--RESULTS OF FACTOR ANALYSIS OF TYPE 10 - GENERAL FARMS

Factor	Item (See Table 1)	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	Factor 8	Factor 9	Com. %	Item %
1	8	.95*									96	93
	6	.90+									95	85
	10	.89+									94	85
	29	.86+							-.35		93	92
	15	.86+									89	83
	14	.86+			-.39						97	90
	9	.85+									84	86
	28	.85+							.31		95	86
	7	.85+									93	76
	13	.81	-.48								100	65
	64	.81+					-.29				87	84
	20	.77							-.37		97	75
	68	.75				.42					87	86
	18	.73							-.45		95	77
	43	.72									79	65
	51	.71							.35		78	81
	48	.71			-.58						89	83
	12	.70									71	69
	37	.68									73	65
	31	.63									64	63
2	72		.74+				-.40				81	88
	67		.71							-.33	69	89
	60		.52				-.52				69	79
	69		.43			.54					57	52
	26		-.45	-.56						.38	85	54
	27		-.47	-.38	.34					.38	79	64
	13	.81	-.48								100	65
	17		-.53	-.62	-.36						87	92
	61		-.55				.52				86	65
	49		-.62		-.61						93	81
	46		-.63								60	67
	50		-.67		-.36						68	85
	1		-.76								96	60
	4		-.80								97	66
	5		-.86+								85	87
	3		-.90*								85	95
	2		-.93*								90	96
3	21			-.95*							97	92
	19			-.75						.26	76	83
	25			-.72						-.35	87	74

TABLE 5 (Cont'd)--RESULTS OF FACTOR ANALYSIS OF TYPE 10 - GENERAL FARMS

Factor	Item (See Table 1)	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	Factor 8	Factor 9	Com. %	Item %
3 (Cont'd)	17		-.53	-.62	-.36						87	92
	22			-.61						-.40	72	74
	23			-.50	-.54						54	70
	26		-.45	-.56						+.38	85	54
	32			-.51							45	60
	24			-.47							34	63
	16			-.44				.61			63	91
	27		-.47	-.38	+.34					+.38	79	64
4	47				-.64						92	45
	49		-.62		-.61						93	81
	39				-.58			.37			54	88
	48	.71			-.58						89	83
	54				-.43						67	28
	14	.86			-.39						97	90
	53				-.38	-.29					46	49
	17		-.53	-.62	-.36						87	92
	40				-.36						20	66
	50		-.67		-.36						69	85
	23			-.50	-.30						54	70
	27		-.47	-.38	+.34					.38	79	64
5	70					.79					89	71
	71					.78+	.32				77	94
	69		.43			.54					57	52
	55					.46+					27	80
	68	.75				.42					87	86
	33					.40			-.43		48	71
	34					.31					32	31
	53				-.38	-.29					46	49
	58					-.32				-.28	29	73
6	62						.71				72	71
	63						.55				63	48
	61		-.55				.52				86	65
	71					.78+	.32				77	94
	64	.81					-.29				87	84
	72		.74				-.40				81	88
	60		.52				-.52				69	79
	66						-.66+				57	75

TABLE 5 (Cont'd)--RESULTS OF FACTOR ANALYSIS OF TYPE 10 - GENERAL FARMS

Factor	Item (See Table 1)	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	Factor 8	Factor 9	Com. %	Item %
7	59							.91*			86	97
	57							.80*			68	94
	52							.77*			63	93
	16			-.44				.61			63	91
	39				-.58			.37			73	88
8	36								-.64		28	62
	30								-.55		59	52
	18	.73							-.45		95	77
	33					.40			-.43		48	71
	20	.77							-.37		97	75
	29	.86							-.35		93	92
	35								-.31+		55	75
	28	.85							-.31		95	86
	51	.71							+.35		78	81
9	42									.39*	16	93
	26		-.45	-.56						.38	85	54
	27		-.47	-.38	.34					.38	79	64
	19			-.75						.26	76	83
	41									.26	39	17
	58					-.32				-.28	29	73
	67		.71							-.33	69	89
	25			-.72						-.35	27	74
	22			-.61						-.40	72	74
Per Cent Total Variation Exp.												
Column		82	87	74	67	74	74	86	62	63		
Factor		31	18	12	8	8	6	6	6	3		

Factor 3 is the "crop expense and returns" factor. Value of all crops has 92 percent of its variance explained which, associated with a high communality, makes it a most important variable relevant to the factor. Closely associated with it are "value of harvested crops" and "total crop costs." The remaining associated variables are 16, 17, 22, 23, 24, 26, 27, and 32. We see that all crop costs are associated with the net return variables 26 and 27 and that corn yield has 63 percent of its low communality explained by the factor.

Before discussing the fourth factor we should note that the second and third factors account for as much variance as does the first. Also note that the next five factors, four to eight, are of roughly equal value in explaining the variance but the last two factors are of little value, explaining only 3 percent and 2 percent of the total communality. Factor 9 was retained because it explained 93 percent of the communality of one variable. This may be trivial, as the communality is only .16.

Factor 4 has no variable with an especially high weight. The associated variables are 14, 17, 23, 39, 40, 47, 48, 49, 50, 53, and 54, with 27 negatively associated; we see livestock returns 47, 49, and 50 associated with feed variables 39, 40 (silage acres and yield), and 48 (total feed cost), and PMWU and value of production per acre. Note that 23 would seem irrelevant here but it may be a negative variable to 27 which would seem a logical opposite to 47, 49, and 50. Note that unlike with the type 01 and 02 (grain, grain-livestock) groups, silage has a positive association with feed cost and livestock returns.

Factor 5 explains most of the variance of 55 and 71, which seems an unusual association. The associated variables 33, 34, 68, 69, and 70 are wheat acres and yield, machinery and equipment charge per farm, and (with 71) the three different measures of machinery investment. The opposing variables are litters of pigs and pigs born alive per litter. Perhaps pig breeding is associated with a low capital investment, and pig purchase is the opposite of breeding which gives the unusual juxtaposition.

Factor 6 is uniformly bi-polar and explains 75 percent of the variation of 66, labor charge per PMWU. In association are 60, 64, and 72, all aspects of labor cost; in negative association are 61, 62, 63, and 71 which are all related by a common divisor, man years of labor used.

Factor 7 has three variables with more than 93 percent of their variance explained by it. They are the dairy variables 59, 57, and 52 with which are associated capital managed per acre and acres of silage. Note the strong association of the dairy variables, markedly different from their behavior in the dairy group analysis.

Factor 8 explains 75 percent of the variance of 35, soybean acres, although it has a low loading on the factor. The related variables are 18, 28, 29, 30, 33, and 36 which suggests this factor is a crop return factor. The opposing variable, 57, number of beew cows, shows the usual inverse relation between crop area and beef cattle.

Factor 9, defined by variables 19, 26, 27, 41, and 42, appears to be a mixture of returns per crop acre and rotation pasture acres and yield. The opposing variables, 22, 25, 58, and 67, appear to suggest that to some degree machinery costs are inversely related to crop returns, which seems a logical relationship. Again the returns divisor of 67 may cause the association but the presence of 22 suggests the first inference.

This completes the analysis of the groups. The last analysis was carried out to observe if there were any differences in results when aggregated data were used.

All Farms—1964—Type 99

Table 6 lists the nine factors included for the analysis of all farms. The tenth factor was dropped because it explained only 1 percent of the communality and required 18 variables to explain 75 percent of its variance. Variables 67 and 74 had 10 percent and 11 percent of their communality explained by the factor, but no other variable was over 5 percent. The over-all explanation of variance was 67 percent (or 65.8 percent after dropping the tenth factor), including all the variables, but after allocating the variables as shown in Table 6 only 52.4 percent of the variance is explained (and 79.5 percent of the communality). The factors are slightly better in explaining the variance of "all the farms" than they were in the "general" type despite the slightly lower figure for total communality. They do not do as good a job as they did for the grain and dairy type farms.

Examining the communality of the variables we note that 19 variables have a communality of .90 or more, that 30 have a communality of .80 or more, 40 have one of more than .70, and 21 have a communality of .53 or less. Thus we have nearly twice as many variables over .90 as we did in the general type but about the same number above .70 and .80 and below .53. The latter group have low communality, 31.0 on average, a little below the general group, so that if they had a communality of 1.00 an additional 20 percent of total variance would be explained. The variables in the low communality groups are 16, 23, 24, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 44, 45, 53, 55, 56, 58, and 65 which is identical with the general group except for the addition of variables 16 and 37. There are ten variables not allocated to any of the factors, 33, 34, 38, 41, 40, 42, 44, 45, 55, and 65. The communality of these variables is .53, .30, .16, .26, .17, .16, .13, .95, .08, and .09, suggesting that they are either specific variables or there are large error measurements. However, it is possible that the reason goes deeper—for a number of variables, such as wheat and soybeans, very few farmers grow the crop so we are not using a normal distribution, an assumption upon which factor analysis is based. Also, the variables being studied are not selected in a way which necessarily requires that they have high correlations with other variables. In fact, the maximum simple correlation for the low communality variables is .19, .52, .42, .62.
mum simple correlation for the low communality variables is .19, .52, .42, .62, .56, .59, .56, .52, .53, .28, .55, .47, .43, .14 (43 which has a communality of ,68 has

TABLE 6--RESULTS OF FACTOR ANALYSIS FOR TYPE 99 - ALL FARMS, 1964

Factor	Item (See Table 1)	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	Factor 8	Factor 9	Com. %	Item %
1	28	.92*									91	93
	29	.91*									92	90
	20	.88+								.31	97	91
	18	.87+									95	80
	8	.87+				.33					95	91
	9	.87+									86	87
	7	.85+			-.28						92	87
	68	.83+							-.32		91	87
	13	.81									100	66
	31	.76+									67	87
	6	.70				.57					95	86
	33	.66+									53	74
	11	.61							-.68		90	93
	70	.61							-.68		90	93
	15	.60+		-.29		.28	.36	.43			89	94
	64	.59					.45	.41			85	84
	12	.56									60	53
	14	.56		-.42			.61				95	91
	1	.54	-.74								94	88
	35	.52									44	86
2	2		-.89+								90	88
	3		-.87+								86	89
	5		-.85*								79	92
	4		-.75								92	62
	1	+.54	-.74								94	88
	50		-.65							-.42	64	93
	46		-.59							-.40	62	81
	61		-.56								87	59
	49		-.55	-.29			+.50			-.38	85	92
	60		-.52					.49			76	66
	17		-.46	-.32	.61	-.23					77	96
	69		.48						-.57		62	91
	67		.72								72	71
	72		.76					.32			87	78
3	56			.41		.25					31	77
	36			.41							38	44
	58			.38							32	45
	35			.33							44	86
	53			.31			.50				49	71
	63			.29				-.53			67	55

TABLE 6 (Cont'd)--RESULTS OF FACTOR ANALYSIS FOR TYPE 99 - ALL FARMS, 1964

Factor	Item (See Table 1)	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	Factor 8	Factor 9	Com. %	Item %
3 (Cont'd)	49		-.55	-.29			.50	-.53		-.38	85	92
	15	.60		-.29		+.28	.36	.43			89	94
	39			-.31			.49				43	78
	17		-.46	-.32	.61	-.23					77	96
	14	.56		-.42			.61				95	91
	57			-.84+							81	88
	52			-.86*							78	96
	59			-.86*							79	94
4	25				.87*						84	91
	21				.78					.50	95	91
	22				.73+						73	74
	19				.64					.53	76	90
	23				.63+						47	83
	17		-.46	-.32	.61	-.23					77	96
	16				.56+						40	81
	24				.53+						36	76
	30				.31	-.56					59	69
	32				.31					.47	48	67
	7	+.85			-.28						92	87
5	51					.75+					74	76
	43					.74+					68	80
	10					.58	.64				89	84
	37					.57					52	63
	6	.70				.57					95	86
	8	.87				.33					95	91
	15	.60		-.29		.28	.36	.43			89	94
	56			.41		.25					31	77
	17		-.46	-.32	+.61	-.23					77	96
	30				.31	-.56					59	69
6	48						-.88+				90	86
	47						-.86+				94	79
	10					.58	.64				89	84
	14	.56		-.42			.61				95	91
	49		-.55	-.29			.50			-.38	85	92
	53			.31			.50				49	71
	39			-.31			.49				43	78
	54						.47				60	37
	64	.59					.45	.41			85	84

TABLE 6 (Cont'd)--RESULTS OF FACTOR ANALYSIS FOR TYPE 99 - ALL FARMS, 1964

Factor	Item (See Table 1)	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	Factor 8	Factor 9	Com. %	Item %
6 (Cont'd)	62			-.29			.36	.36			68	80
	15	.60		-.29		.23	.36	.43			82	94
7	66							.66			61	72
	60		-.52					.49			76	66
	15	.60		-.29		.28	.36	.43			89	94
	64	.59					.44	.41			85	84
	72		.76					.32			87	78
	71							-.25	-.78		75	89
	61							-.49			87	59
	63			.29				-.53			67	55
	62						.36	-.65			68	80
8	71							-.25	-.78+		75	89
	70	+.61							-.68		90	93
	11	+.61							-.68		90	93
	69		+.48						-.57		62	91
	68	+.83							-.32		91	87
9	27									.78	90	68
	26									.76	89	66
	19				.64					.53	76	90
	21				.78					.50	95	91
	32				.31					.47	48	67
	20	.88								.31	97	91
	49		-.55	-.29			.50			-.38	85	92
	46		-.59							-.40	62	81
	50		-.65							-.42	64	93
Per Cent Total Variation Exp.												
Column		83	81	77	77	76	81	79	75	76		
Factor		27	16	10	11	7	10	6	5	7		

a maximum correlation of .84), .23, .26, .54, .42, -.26, .54, and .26, respectively, whereas many variables have simple correlations greater than .90.

Factor 1 has 11 variables, 7, 8, 9, 15, 18, 20, 28, 29, 31, 33, and 68, for which it explains 74 percent or more of the variance. These are solely crop size and value and capital measures—with no livestock variable. The remaining variables, 1, 6, 11, 12, 13, 14, 35, 64, and 70, do not include livestock measures so there is no livestock variable associated with the factor. Rather, we have crop inputs and outputs, e.g., land, labor, machinery, feed and seed, acres under various crops, and machinery cost. The factor explains about a quarter of the communality, and the variables included explain 83 percent of the variance of the factor. The presence of variable 1 is interesting since none of the residual measures has been previously associated with the first factor.

Factor 2 is, as usual, the "income" factor. Three of the residual measures have more than 75 percent of their variance explained by it. Note that the factor loadings for the five variables are a little lower than we have noted before as, previously, two or more have had factor coefficients of .90 or greater. The usual bipolar coefficients, 67, 69, and 72 are present but one difference is that variable 60 (labor charge per $100 of production) has a positive association. The variables associated with the residual income measures are 17, 46, 49, 50, 60, and 61 which are value of production per acre, the net livestock measures 46, 49, and 50, and value of production per man.

Factor 3 explains most of the variance of the dairy variables 52, 57, and 59. Associated with them are 14, 15, 17, 39, and 49 which include two labor measures, value of production per acre, silage acres, and livestock return after deducting feed costs. The opposing variables are 35, 36, 53, 56, 58, and 63 concerning soybean acres and yield, litters of pigs, calving percentage for beef cows, pigs born alive per litter, and capital invested per man. We might deduce that dairying is associated with high labor, requires silage, and affects net livestock income but is negatively related to soybeans, pigs bred, and capital per man. This factor explains about the same amount of variance as factors four and six. Factors five, seven, eight, and nine explain about half as much. However, they explain four times more than does factor ten, a further reason for excluding it.

Factor 4 explains most of the variance of variables 16, 22, 23, 24, and 25, of which 16, 23, and 24 have a low communality. The associated variables are 17, 19, 21, 30, and 32 which have an acreage divisor except for 30 percent of land in harvested crops. In view of the low loading and communality of 32 it might be misleading to suggest that crop expenses are associated with yield; the factor causing the association might be the divisor. Acres in crops, the main divisor, has a negative correlation, which is to be expected if this grouping is due to the common divisor.

Factor 5 explains most of the variance of 51 and 43, beef cows and acres of permanent pasture. The associated variables are 6, 8, 10, 15, 37, and 56, which are total acres and capital, livestock capital, man years of labor, hay acres, and beef cow calf percent. The opposing variables are value of production per acre and percent of area under harvested crops; again we see the relationship between beef cows and crop intensity.

Factor 6 has a high explanation of variables 47 and 48 but a negative association with 49. The net returns are a residual obtained by subtracting 48 from 47 so that if 48 is small, 49 will be high and vice versa. However, this factor suggests that when 47 is high, 48 is high (and both have a high communality so there is little "unexplained" variance) but 49 is low. If the "right" amount of feed is being fed surely we would expect 49 to be positively related to 47 and 48. The factor, returns above feed cost, also has a high communality and this factor explains one-third of its variance, a little less than factor 2 which explains 35 percent of it. Variable 47 has only 7 percent of its variance explained by factor 2. In the other farm types, 48, 47, and 49 were usually positively associated on one factor although it was usually a weak association. The remaining variables, which contrast, are 10, 14, 15, 39, 53, 54, 62, and 64, concerning capital invested in livestock, two labor measures, acres of silage, litters of pigs, stocker-feeder cattle, PMWU per man, and labor charge per farm. This suggests that labor requirements are lower with a high value of production from livestock and that silage may be undervalued as acres of it are inversely related to feed cost (but also to value of production so perhaps it is a poor feed!). Pigs and stocker-feeder cattle also have a negative association with gross value of livestock production. Such a relation could be caused by poor returns for these enterprises relative to other livestock enterprises. It is of interest that this factor explains 10 percent of the total communality and as such would seem to be significant.

Factor 7 is less important and has no variable whose major variance it explains. It is uniformly bi-polar, the first association being between variables 15, 60, 64, 66, and 72 while the variables in negative association are 61, 62, 63, and 71. The factor is probably "artificial" in the sense that it was created by the method of manipulating the data as the first five variables are labor variables and 61, 62, 63, and 71 have all been divided by man years of labor, variable 15.

Factor 8 has 75 percent of its variance explained by just five variables but only one of them, 71, has most of its variance associated with eight. As 11 is virtually identical with 70 the variables are 68, 69, 70, and 71. The first measures cost of owning machinery per farm, the remaining three are different ways of expressing the capital investment in machinery. As fixed cost is a high proportion of machinery cost, the relationship is to be expected but nevertheless it is a fairly weak one. On no factor do value of production per man and machinery investment per man have a high variance in common; in fact the converse is the case.

The final factor, **factor 9,** is bi-polar and has its highest loading with variables 26 and 27, the residual crop value measures. Positively associated are 19, 20, 21, and 32, the first three being measures of gross crop value and the latter being corn yield. The association of gross crop value and net crop value measures is in contrast to the livestock situation (discussion on factor six), where no factor explained an appreciable amount of the variance of both 47 and 49. The variables negatively associated with the first group are 46, 49, and 50 which are expressions of livestock returns. Considering all farms we have an indication that if crop returns are high, those from livestock are low. This is not an especially strong relationship as factor 9 is associated with 66 percent of the variance of 26 and 27 and with 25 percent, 16 percent, and 28 percent of the variance of 46, 49, and 50. However, with the exception of 49 they have high communalities so it seems reasonable to draw the conclusion that in 1964 the net returns from cropping were negatively associated with the net returns from livestock.

This concludes the presentation of factor analysis results. Before drawing any over-all conclusions let us see if there is an observable pattern in the factors produced by the analysis of the farm types.

Factor Relationships by Type of Farm

Examination of Tables 2, 3, 4, 5, and 6 (which show the results of the factor analysis of type 01, *grain farms*); type 02 (which includes types 03, 04, 05, and 06), *grain farms with livestock;* type 07 *dairy farms;* type 10 (which includes the three farms in types 08 and 09), *general farms;* and type 99, *all farms* suggests that there are five factors which are present in each farm type.[23] The factors and the variables which constitute them are shown in Table 7. This Table depicts the loadings associated with each variable from farm type to farm type. If a variable was present on the factor in at least three farm types it is shown. Absence of a variable in defining a factor is shown by a "—". In some instances a variable is shown although not present in Tables 2 to 6 because it was just below the 75 percent "cutoff" point used to select the variables to define a factor.

For convenience the five factors grouped to give Table 7 are called factors one, two, three, four, and five. They are factors one, two, three, five and six of the grain farms (01); factors one, two, three, five, and seven of the grain and livestock farms (02); factors one, two, three, four, and six of the dairy farms (07); factors one, two, three, four, and eight of general farms (10); and factors one, two, four, five, and six of all farms (99). In all cases they account for 70 percent or more of the explained variance. However, there are three instances where factors explaining more than 10 percent of the variance are not included in the group of "common" factors; i.e., factor four of 02, factor five of 07, and factor three of 99.

The *dairy farm* type seems to be atypical. This is evidenced by the absence of high loadings on factor one and by the fact it does not have many variables in

[23]Note that a sixth factor would be added except for the fact that grain farms did not have a distinct dairy group. See Table 8.

TABLE 7--FACTORS COMMON TO THE FARM TYPES, INDICATING
PERCENT OF COMMUNALITY EXPLAINED
PART A. FACTORS FOUND IN EACH TYPE

Factor	Variable	Identification	Farm TYPE 01	02	07	10	99
One	6	Total acres	+	+		+	
	7	Acres cropland	+	+		+	+
	8	Total capital	+	+		*	+
	9	Capital - land & improvements				+	+
	12	Capital - feed, seed, supplies	0	+			
	13	Total value of farm production			0		
	14	PMWU	+	+	0	+	
	15	Man years of labor used		+	0	+	
	18	Value - harvested crop					+
	20	Value - all crop		+		+	
	28	Crop PMWU	+				*
	29	Total acres crop harvested	+				*
	31	Corn acres	+		0		+
	64	Labor charge - per farm		+	0	+	
	68	Mach. & equip. charge - fixed & var. per $100		+	0		+
Two	16	Capital managed per acre					+
	17	Value of production per acre					
	19	Val. harvested crop per acre	+		+		
	21	Val. all crop on crop land per crop acre				*	
	22	Machinery cost per crop acre	+	+			
	23	Fertilizer cost per crop acre	+	+			+
	24	Seed & crop supplies per crop acre			+		+
	25	Total crop cost (22+23+24) per crop acre	+	*	+		*
	32	Corn yield per acre		0	0		
Three	1	Farm and family earnings	+		+		
	2	Operators labor & management return	*	+	*	*	+
	3	Management return	*	+	*	*	+
	4	Management and capital return	+		+		
	5	Per cent return to man & capital		+	+	+	*
	49	Returns above cost of feed	0		0		
	50	Returns per livestock PMWU	0		0		
	60	Labor charge per $100 of production					
	61	Value of production per man					
	67	Mach. & equip. charge-fixed & var. per $100					
	69	Mach. & equip. investment per $100			0		
	72	Combined labor and mach. cost per $100			+		
Four	6	Acres cropland					
	10	Total livestock capital			0	0	
	30	Per cent open land in harv. crop					
	37	All hay - acres			0		
	43	Permanent pasture - acres	+				+
	51	Number of beef cows	+		+		+
	56	Per cent beef crop	+		+	0	
Five	10	Total livestock capital		0	*		
	27	Returns for land & labor per crop PMWU		+	0		0
	47	Value of livestock production			*		
	48	Value of feed fed to livestock	0	0	+		
	49	Returns above feed cost (47-48)	+		+		
	50	Returns per livestock PMWU					
	53	Litters of pigs	0				
	64	Labor charge - farm	0	0	*	0	0

TABLE 7 (Cont'd)--FACTORS COMMON TO THE FARM TYPES, INDICATING PERCENT OF COMMUNALITY EXPLAINED
PART B. FACTORS NOT ASSOCIATED WITH EACH TYPE

		01	02	07	10	99
Factor shared by 01, 07, 10, 99						
11	Capital invested in machinery & equipment			+		
68	Mach. & equip. charge-fixed & var. cost per farm					
69	Mach. & equip. invested per $100 production			+		
71	Mach. & equip. invested per man	*		+	+	+
Factor shared by 02, 07, 10, 99						
39	All silage - acres					
52	Number of cows		*		*	*
57	Milk per cow		*		*	+
59	Total milk produced		*		*	*
Factor shared by 01, 02, 07						
33	Wheat - acres					
64	Labor charge per farm					
65	Labor charge per man		+	+		
34	Wheat - yield			0		
44	Permanent pasture - yield			0		
Factor shared by 02, 07, 10						
19	Value harvested crops per crop acre					
32	Corn yield					
42	Rotation pasture - yield		+		*	
Factor shared by 10, 99.						
19	Value of harvested crop per crop acre					
21	Value of all crops on cropland					
26	Return to land & labor per crop acre					
27	Return to land & labor per crop PMWU					
46	Return per $100 feed fed.					
49	Returns above cost of feed.					
50	Returns per livestock PMWU					
58	Pigs born alive per litter					

0 denotes the variable was NOT present on that factor.

+ denotes that 74 to 89 per cent of the variables communality was weighted on the factor.

* denotes that 90 per cent or more of the variables communality was weighted on the factor.

common with the other types. It has 33 of the 49 common variables while the *grain farms* have 41 of the 49 variables. These two types are at extremes; i.e. the first has more than half of its PMWU associated with livestock (dairy) while the second has more than half of its PMWU in crop and less than 33 percent in any specific livestock enterprise. The types between, 02, 10, and 99 represent combinations of grain and livestock, with neither one nor the other predominating.

Forty-six of the 72 variables were present, three (49, 50, and 64) being present in two of the five factors. Most of these variables have a high communality but some do not. We see that the most consistent factor is the "income" factor. It has high loadings for the five residual income measures (all above .75 and mostly above .85 unless associated with another factor); explains most of their variance, i.e. of 25 cases seven are greater than 90 percent and 17 greater than 75 percent of variance explained; and has all its variables in common, except for 49 and 50 (the livestock income measures), for the grain and dairy types. Two of the five variables are especially consistent, 2 and 3, operators labor and management income and management income. Nevertheless, there is variation because 12 variables are shown but an average of 15 variables are associated with the factor in the earlier tables. So even in the case of a clearcut factor such as "income" we lose clarity by not looking at the separate farm types.

The most consistent factor from the point of view of variables present was factor 1 (which usually had 20 variables associated with it and here has 18), except for the dairy type which had only 12 variables and none of these with a high proportion of their variance explained by the factor. About half of the variables have most of their variance explained by the factor, and type 99, *all farms,* has two variables highly explained by it. These two variables (Crop PMWU and acres crop harvested) are almost as important on this factor for the grain farms, but for the other types they associate with other factors and so do not rank so high for this factor. Even so, for only one type, *dairy farms,* does their factor loading drop below the high value of .82. In the case of *all farms* they jointly account for 3.37 percent of the communality while if all variables had an equal influence they would explain 0.31 percent of it. (In comparison, the five income variables explain 7.0 percent of the explained variance.)

This discussion is sufficient to indicate that while some useful factors can be obtained by analysis of all the farms, and that by and large the same factors emerge, in the sense that factors with much the same group of variables composing them are isolated, a considerable body of data is lost by not looking at the individual farm types. By and large the crop effects seem to swamp the livestock results so the analysis might be most misleading for some farms.

Table 8 shows the number of separate factors isolated. For the five farm types it is suggested that there are 14 factors. Factors 12 and 14 have a number of variables in common but were separated because the variables which were most highly associated were not common. The numbering at the top has no significance other than that the first 10 are the 10 factors isolated from type 01. Also shown is the amount of variance explained by that factor. In all cases the "size" factor was isolated first and except for the dairy farms it accounts for 25 percent or more of the variance. Except for the grain farms, the "income" factor was the next factor isolated, and it accounts for the next largest part of the variance (except for dairy farms where it accounts for the largest). From this point onwards there is no particular order in which the factors are introduced.

We also see from Table 8 that types 01, 02, 10, and 99 have factor four of 01 in common; that types 01, 07, 10, and 99 have factor seven of 01 in common; that types 01, 02 and 07 have factor ten of 01 in common; that factors eight and

TABLE 8--ORDER OF THE FACTORS AS COMPUTED BY THE CENTROID METHOD

Farm Type	Factor 1	2	3	4	5	6	7	8	9	10	11	12	13	14
01 Grain	1	2	3	4	5	6	7	8	9	10				
Variance*	25	14	17	9	7	7	6	7	4	4				
02 Grain-livestock	1	5	2	8	7	3				6	4	9		
Variance	30	9	18	5	4	11				5	10	4		
07 Dairy	1	4	2		6	3	5			9	7	8	10	
Variance	12	11	20		7	20	13			5	5	4	3	
10 General	1	3	2	6	8	4	5				7			9
Variance	31	12	18	6	6	8	8				6			3
99 All farms	1	4	2	7	5	6	8				3			9
Variance	27	11	16	6	7	10	5				10			7

*Variance shows the percentage of the explained variance which was accounted for by that factor.

nine of 01 do not seem to be related to factors isolated in the other farm types, which is also true for factor 10 of the dairy type. Factor four of the type 02 has a common factor in types 07, 10, and 99; this is the "dairy" factor and is not expressed in 01 as no dairy cows were reported on the grain farms. So with the exception of 01, where it cannot express itself, we could assert that there are six, rather than five, factors which are common to the groups. The factors reported under 12 and 14 also have a number of variables in common which are a mixture of crop and livestock variables. Although the distinction is not clear cut it seems desirable on balance to assume they are different. In any case they explain little variance. Possibly they could be separated more distinctly if the crop-livestock farms had not had added to them the hog and beef farms. As the number of farms available for study increases it would be interesting to look at the separate types of livestock or perhaps to compare an analysis of crop only versus livestock farms.

Regression Analysis Using the Factors

The final part of the factor analysis was an attempt to predict the "income" factor by using the remaining factors as independent variables. This was done by standardizing all the variables for each farm by using equation (1), page 10. Then the value of each factor on each farm was obtained by summing the standarized variables allocated to each factor, and these values were used in a multiple regression.

The results of the initial attempt are shown for dairy farms, 07, and all farms, 99, which gave the worst predictions. A study of the correlation matrix showed

TABLE 9--REGRESSION RESULTS*

Type	Dependant		Independant Variables	R^2
01	F_3	=	$.000036 + .34\ F_1 - .35\ F_4$	.55
02	F_2	=	$.00451 + .35\ F_1 - .45\ F_2$	.21
07	F_2	=	$.0737 + .47\ F_3 - .32\ F_5$	
			$+ .71\ F_8 + .7\ F_9 - 1.61$ Variable 65	.56
	F_2	=	$.07 + .43\ F_1 - 1.23\ F_7 + .87\ F_8 + .89\ F_9$	.72**
10	F_2	=	$.00165 + .71\ F_4 - .25\ F_5 - .86$ Variable 66	
			$+ .52\ F_8$	.26
99	F_2	=	$.009 + .54\ F_1 + .38\ F_5 - .86\ F_7 - .41\ F_8$	.28
99	F_2	=	$.009 + .4\ F_1 + .42\ F_3 + 14.F_4 - .45\ F_5$	
			$+ .24\ F_6 - 1.05\ F_7 - .6\ F_8$	.48**

* All variables are significant at the 5 per cent level, many at the 1 per cent level.

**These are the results before the factors were modified by deletion of variables which were income measures.

that some of the standardized factors were fairly highly correlated (see Table 10). Examining the variables which were associated with the factors which showed a high R^2 showed that frequently income measures were present; e.g., in the dairy farms (07) factor 1 has variables 18 and 20; factor seven includes variables 18, 20, 50, and 59 and factor nine includes variables 46 and 50.

Therefore the factors were modified by excluding such variables as 13, 17, 18, 20, 26, 27, 46, 47, 49, and 50. Further the "income" factor was defined solely by variables 1, 2, 3, 4, and 5. The latter account for little less than half of the total variance of the "income" factor. However, the variables excluded because they measure income also reduce the amount of variance explained so that well over half of the total variance is explained or about 75 percent of that which is explained by the variables allocated to the factor. The factors were further modified by using only those variables which had most of their variance explained by that factor. If such variables were on both sides of a bi-polar factor the factor was split into two parts.

The effects of these changes was to markedly reduce the correlations between the standardized factors (see Table 10). They also had the effect of markedly reducing the R^2 value of the multiple regression equations. Nevertheless, it is felt that the final solutions are more meaningful expressions than were the previous

TABLE 10--CORRELATION ANALYSIS BETWEEN THE COMMON FACTORS - TYPE ALL.

Unadjusted

Factor	1	2	3	4	5	6	7	8	9
1	1.00	.40	-.13	.19	.54	.58	.60	.41	.03
2		1.00	.19	.26	.06	.34	-.02	-.10	.0007
3			1.00	.21	-.17	.20	.03	.001	-.005
4				1.00	-.26	.07	.09	.23	.0009
5					1.00	.60	.41	.07	.0004
6						1.00	.53	.11	-.001
7							1.00	.38	-.003
8								1.00	-.0009
9									1.00

Adjusted

	1	2	3	4	5	6	7	8	
1	1.00	.38	-.17	-.03	.26	.32	-.04	.39	
2		1.00	.03	-.07	.008	.26	-.21	-.12	
3			1.00	.26	-.22	.13	-.25	-.003	
4				1.00	-.26	.05	.09	.24	
5					1.00	.31	-.09	-.01	
6						1.00	.36	.04	
7							1.00	.04	
8								1.00	

ones. The value of R^2 for types 01 and 07 is significant at the 5 percent level, but it is unlikely that there is a significant relationship for the other farm types. This part of the analysis seems unrewarding, as it does not seem to provide any better information than multiple regression on the variable. It is interesting to note that the two types which gave a high R^2 were the *cash-grain* and the *dairy farm* types, but where grain and livestock were mixed together the results were not encouraging. It seems surprising that the crop factors, 8 and 9 which explain little of the dairy communality, were most significant (over 1 percent) in the regression equation, while factor 3 (cow numbers, feed and labor cost) and factor five (variables 67-71, representing machinery cost) were just significant at the 1 percent level.

Analysis of a Simple Correlation Matrix

McQuitty[24] has devised a method of examining the matrix of simple correlations between a set of variables which shows graphically the relations between them. In fact the method can be extended to produce an elementary factor analysis. The method is to examine the matrix and mark the highest correlation shown by each variable. The highest correlation is selected and the two variables which possess it are noted. Then for the first variable we look along the row to see if there is any other variable which has its highest correlation with it. If so, we note it, and any others which may have their highest correlation with the first variable. The same is done for the second variable. Suppose our initial highest correlation was between variables C and D, that no other variable had a highest correlation with C but that G and H showed ther highest correlation with D. We would draw

```
G⇌D ←G
  |
  H
```

showing C and D have the highest correlation and that G and H both have their highest correlation with D, but it is lower than the correlation between C and D.

We now examine row G and see if any variables (other than D) have their highest correlation with G. Suppose that A and E are so correlated. We note this and look along row H. Suppose there are no variables having their highest correlation with H. We now examine rows A and E. If neither has a variable, other than G, with which it shows highest correlation we have ended our search and the first relationship could be finally written:

```
C⇌D ←G←A
  |  |
  H  E
```

We would then re-examine the matrix and find the highest simple correlation amongst the variables not used and repeat the process.

Figure 1 shows the relationship between the variables using McQuitty's method for type 10 farms. Figure 1b shows the variables which were in the factors specified for type 10, in so far as they could be simply distinguished on the linkages shown in Figure 1a. The graphical relationship gives one considerable aid in understanding how the individual variables which constitute a factor relate to one another. A similar relationship between the variables as displayed by McQuitty's methods and the factors was demonstrated for all the types. In one in-

[24]McQuitty, Louis L. "Elementary Factor Analysis" *Psychological Reports* 1961, 9, pp. 71-78.

stance, that of the grain types, a most complicated structure resulted (see Figure 2). However even here a close relationship could be found between the structure and the factors which were derived. The factors are not drawn in because the lines would confuse but by checking with Table 2 the reader can easily note that the relationship exists.

The brief presentation above of McQuitty's technique was included to suggest a way in which the relationship of the variables could be indicated in a simpler and more understandable form, for a lay audience, than the usual complex factor analysis tables. The next section briefly summarizes the conclusions to be drawn from the factor analysis.

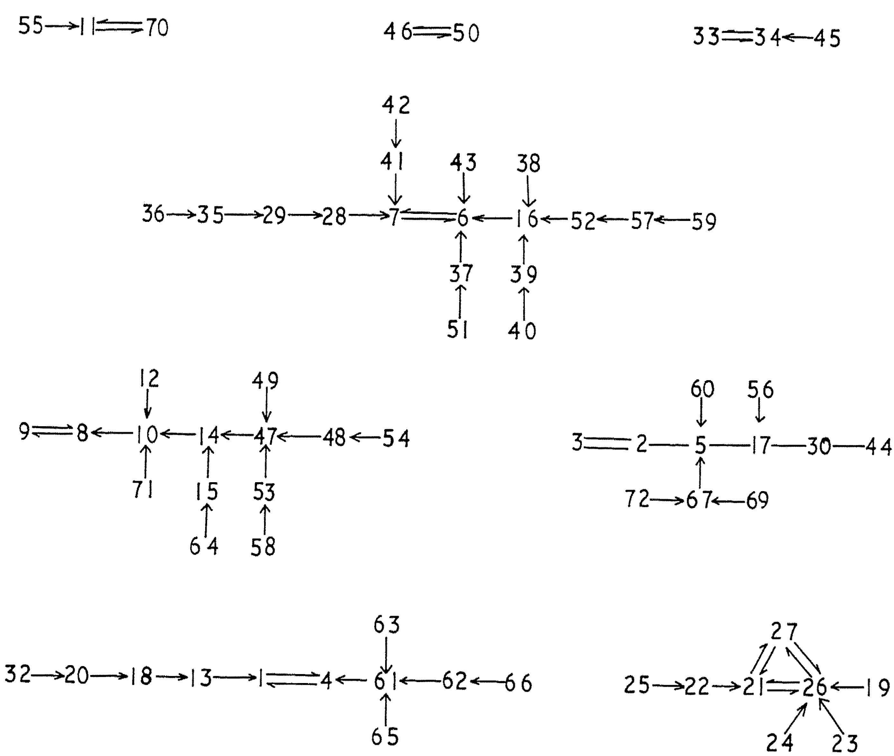

Fig. 1a

Relationship Between the "General Farm" Variables, Pairing Those with Highest Simple Correlation.

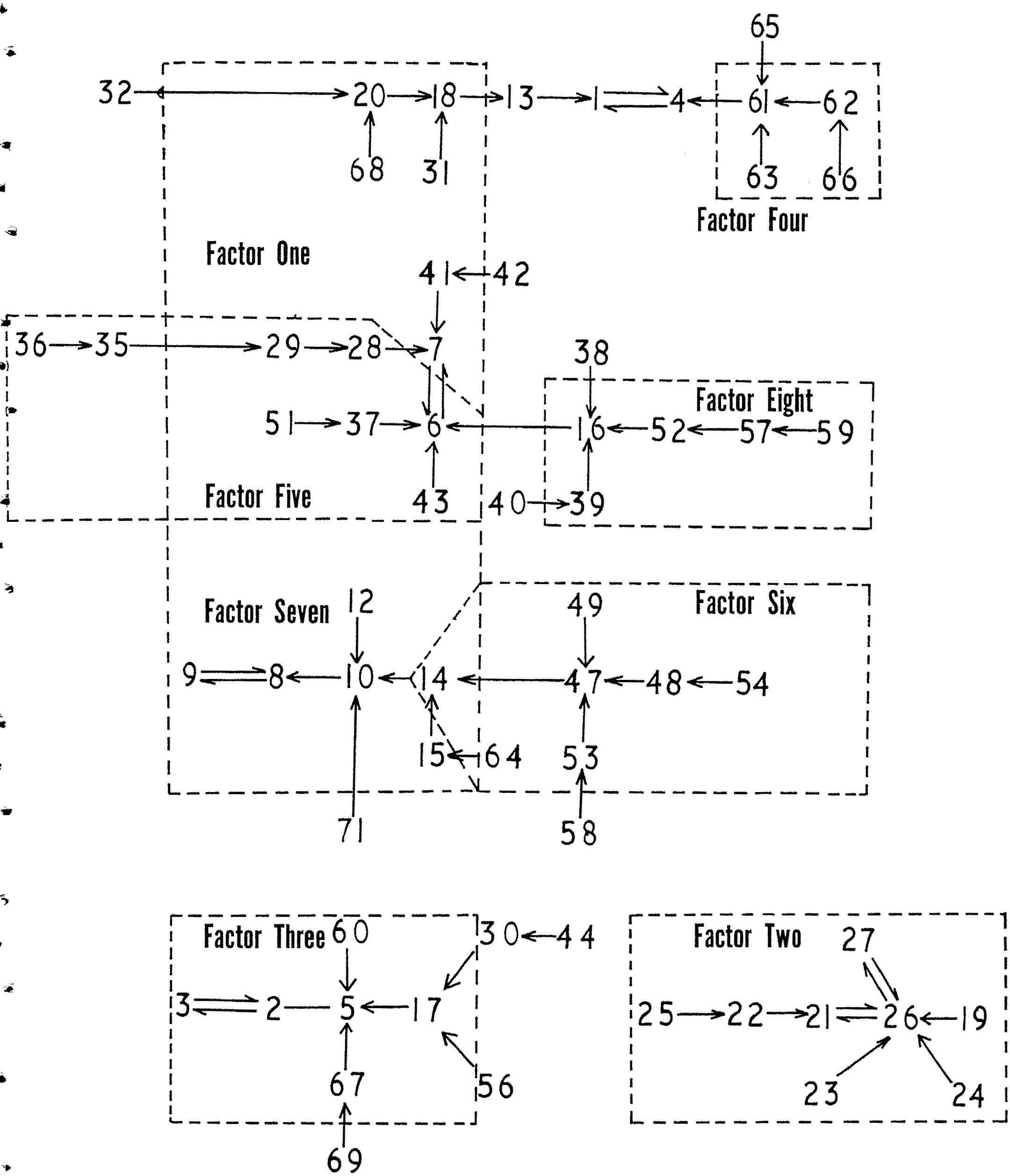
Factor One
Factor Two
Factor Three
Factor Four
Factor Five
Factor Six
Factor Seven
Factor Eight

Fig. 1b

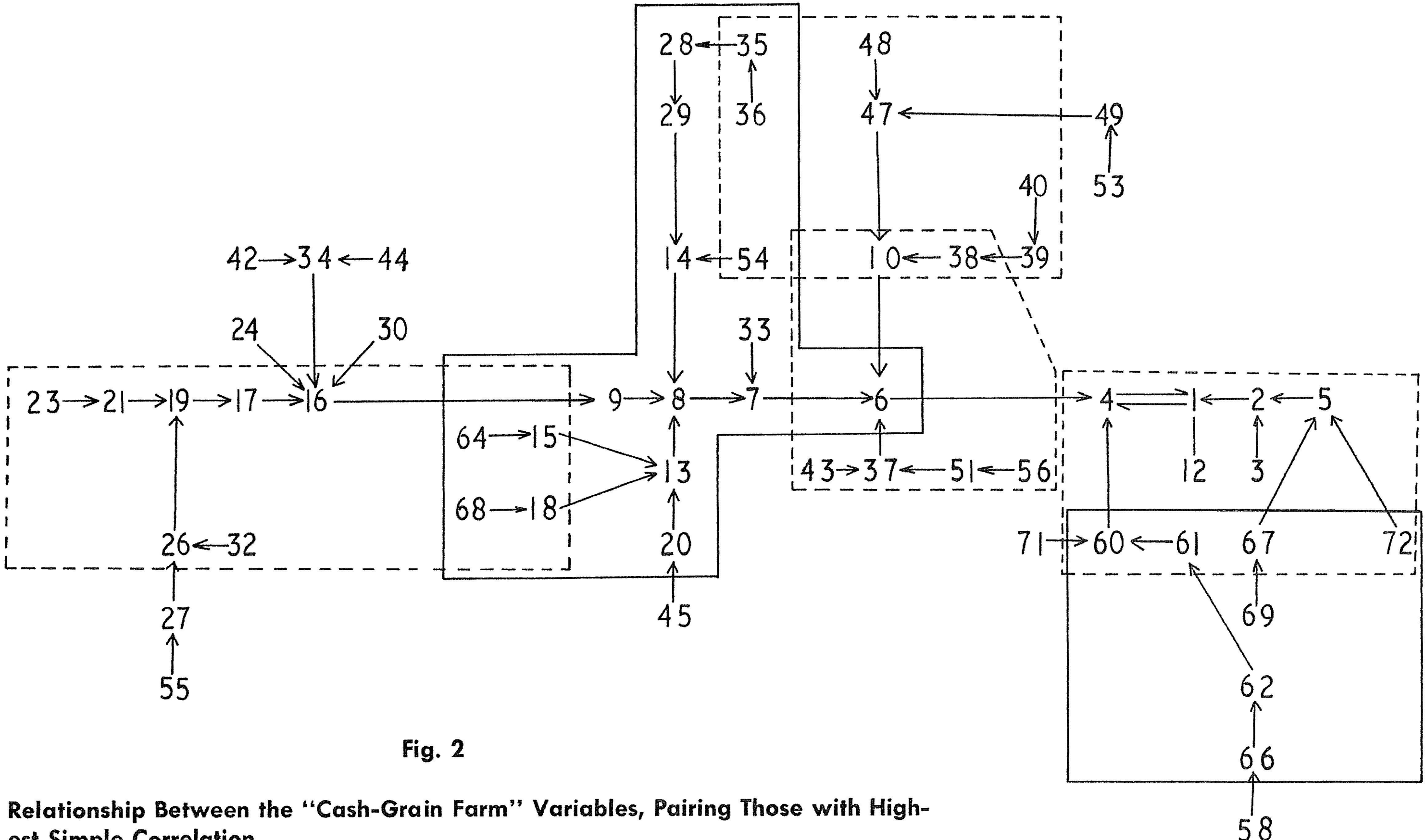

Fig. 2

Relationship Between the "Cash-Grain Farm" Variables, Pairing Those with Highest Simple Correlation.

General Conclusions From the Factor Analysis

The analysis revealed that factors could be derived from the farm record material, and that the variables composing the factors remained relatively constant, irrespective of farm type. Despite the last comment, the loadings of the variables with the factors, the presence of some variables which did not always appear, and the presence of factors of importance to only one or two farm types cause sufficient change to state that misleading results could appear by applying factor analysis to farms which are diverse in nature. For example, consider the variables 47, 48, 49, 52, 57, and 59 which are value of gross livestock production, feed cost, livestock production less feed cost, number of dairy cows, milk per cow, and total milk production, respectively. In the dairy group, one factor explains 95 percent, 88 percent, 73 percent, 93 percent, 17 percent, and 35 percent, respectively, of these variables, suggesting a strong relation between value of livestock production, feed cost, and number of cows but with milk yield having surprisingly little relationship with feed inputs. The factor most closely associated with milk yield explains the variance of the six variables in the following proportions; 2.5 percent, 0.5 percent, 5.9 percent, 0.02 percent, 61 percent, and 43 percent, respectively. This leads to the conclusion that herd size and feed have little to do with output per cow. If we look at type 99, all farms, we again find a livestock production factor and a milk factor. The variance explained is 2.1 percent, 0.2 percent, 10.0 percent, 96 percent, 88 percent, and 94 percent on one factor and on the other it is 79 percent, 87 percent, 30 percent, 1.1 percent, 0.4 percent, and 0.3 percent. There is a complete contrast here as herd size and livestock production less feed cost are closely associated with yield so advice given to a dairy farmer if based on the over-all analysis could be most misleading.

The variables on the factors which associate usually seemed to have a logical relationship but in some cases this might not have been obvious *a priori*. There is no doubt but that the factors do give helpful insight into the relationship which exists between the various farm standards. The insights are not only into which variables associate but extend to the degree of association. Consideration of the communality also gives some suggestions on which variables may not be useful because of measurement error. Such variables of course may be unique—perhaps corn yield is such a one as it frequently has a low communality but may be an important variable in predicting income. Other variables may have a high communality but be spread over so many factors that they are not precise analytic tools. In some instances a variable which is spread over many factors in one farm type may be highly associated with only one factor in another farm type.

The strongest association observed was on the "income" factor where the income measures usually had very high loadings and a very close relationship (refer back to Table 8). Two income measures were especially consistent, "management return" and "operators labor and management return," while the least consistent was "percent return to capital and management." So consistently were the five residual income variables related that it would seem arguable that almost any one of them would present a reasonable picture of farm earnings. If one had to select only *one* measure the author inclines to operators' return to labor, capital, and management because it avoids the complications of estimation of wage or interest rates.

One reason for using the analysis was to see if it would be possible to reduce the number of variables calculated. It appears that only in the case of income could one hope to make an "across the board" selection, as in no other instance does a variable have most of its communality explained by a factor for all four types of farm (assuming now that one would not lump all farms together).

For the cash-grain and grain-livestock types the "crop cost and return" factor indicated a close relationship between variables 22, 23, and 25. Variable 23 is the sum of 22, 23, and 24 but, although 22, 23, and 25 have a high communality, that of 24 is low and usually spread over several factors. It appears we might gain about as much information just by using 25 because the separation of the expenses does not appear to give a meaningful association with anything which would aid our decision making. For type 01, corn yield has about half of its variance on this factor and 40 percent on the income factor but, for type 02, it has only 14 percent of its variance with the crop cost factor and this may be due to the common "per acre" divisor. As most of the fertilizer variance is on the crop cost factor, we do not find any significant relation elsewhere between fertilizer cost and crop yields.

Variables 6, 7, 8, and 9 are also ones which closely associate. As they are total acres, crop acres, total capital, and capital in land and improvements it is not surprising and it would seem that if one wished to present only a few key variables, three of these could be dropped with little loss.

In some cases the fact that variables are associated is of little significance. Thus 51 and 56 associate to a high degree on types 01 and 07 but as one presumably would not have a cow herd without having calves it is difficult to know whether the relation has much meaning. Considering the other variables with which these two are associated it seems plain that the association means little more than that a cow is likely to have a calf! Only in the case of type 99 were the main variance components of 51 and 56 loaded upon different factors.

The final conclusion is that the method may be of considerable value in aiding the extension worker to gain meaningful insights into farm business relationships. But the application of factor analysis to farm record work is beset by several problems—the variables may not have a normal distribution, there may be errors of estimation, and manipulation of the data may produce spurious factors, e.g., cases where all the variables have a common divisor. Nevertheless, further study of the method would seem to be rewarding.

REGRESSION ANALYSIS

Regression analyses were carried out for each farm type to get an indication of the extent to which some of the farm standards were useful in predicting "operators' labor and management return" and "percent return to capital."

The purpose of the multiple regression analysis was not entirely to obtain a set of variables which would predict the independent variables; it was also to get some idea of the importance of some variables in explaining the measures. For instance, it the case of dairy farms it was found that number of cows and milk per cow were not significant predictors of the two return measures but acres of corn and yield of corn could be. In fact, if yield of corn and value of livestock production were in the same equation it was the latter which had the lower "t" value. In another case a set of variables was found which were all highly significant but they only explained a small part of the variation.

Since we are concerned with the associations of variables, and not only with their predictive power, in a number of regressions variables are present which have a low "t' value. In other words, the variable was expected to be important and was worth reporting even though there was a good chance that it was not statistically significant. Recalling that the five farm types had sizes of 35, 41, 33, 128, and 237 respectively, shown below is the "t" value associated with varying degrees of freedom. By and large, it would be a reasonable approximation to regard "t" values of 1.30, 1.70, 2.00, and 2.70 as being associated with the 20 percent, 10 percent, 5 percent, and 1 percent level of significance, respectively. See Table 11.

TABLE 11--LEVEL OF SIGNIFICANCE FOR "T"

Degrees of Freedom:	.20	.10	.05	.01
25	1.32	1.71	2.06	2.79
28	1.31	1.70	2.05	2.76
30	1.31	1.70	2.04	2.75
40	1.30	1.68	2.02	2.70
120	1.29	1.66	1.98	2.62
230	1.28	1.65	1.96	2.58

Because the number of variables was small, "adjusted" R^2 rather than R^2 has been used. If it were not for this, some of the equations would seem to account for rather more of the variance. Nevertheless, in a number of instances, very high R^2 figures are obtained.

Some care is needed in selecting the predicting variables. To some extent, an attempt was made to exclude those variables which were inputs. However, to carry this to its logical conclusion one would need to fit production functions and this study was not intended for that route. Therefore, it was finally decided to exclude such variables as 1, 2, 3, 4, and 5 when trying to estimate variables 2 or 5 but not to exclude some of the other variables which are related to "net" returns such as 49, Livestock production—feed cost. The reason was that we were trying to establish which variables were useful for predicting returns and if a variable such as 49 is not useful this is an important result. Variables expressed "per $100 of production" were likely to have high predictive power. But this was not entirely due to the association with gross output as one of them, 67, usually had a much higher "t" value than did the others.

There are numerous combinations of the variables which will produce an R^2 of .4 or thereabouts, but not so many which will materially improve the result. It was also found that a combination of variables could be highly significant but have a low R^2.

A number of regressions were run in an attempt to find the combination of variables which would give the highest R^2 for a given farm group. Once the equation was decided upon, it was used with each of the other groups. The reason for doing this was to show how different the result might be if just one combination of variables were to be used for all farm types. Recall that variable 25 is the sum of variables 22, 23, and 24. In some instances, 22, 23, and 24 were not found significant but 25 was, so we see that on some occasions 25 is split and in others it is not. One comment resulting from factor analysis was that as most of the variance of 22 and 23 was upon the same factor as 25 there seemed little point in splitting them up. This conclusion does not appear to be substantiated by the regression analysis.

Table 12 shows the results of the analysis in estimating variable 2, "Operator Return to Labor, Management, and Capital." The mean values of this variable are $3,816; $542; $1,801; $1,002; and $1,450 for types 01, 02, 07, 10, and all farms respectively. Reading across Table 12 we observe the results of applying a given set of regression variables to each type of farm. Note that the R^2 may not be the highest value for that type which it "fits best," e.g. the dairy variables show a greater R^2 on the grain type or on type 99, all farms, where the R^2 is higher for grain, grain-livestock, and general type farms than it is for all farms. In the latter instance seven of the nine variables are significant at the 1 percent level (or considerably more) while in the other types as many as five of the variables do not even reach the 20 percent level of significance.

There are a few surprising relationships. Consider the first type, 01. Variable 32, corn yield, is highly significant for all types except grain and livestock. Because grain is still a highly important enterprise the result is unexpected, especially when it has a high value for the diary type. Equally unexpected is the behavior of

TABLE 12--REGRESSION EQUATIONS USED TO ESTIMATE "RETURN TO OPERATORS LABOR"

Farm Type	Variable	Cash-Grain		Grain-Livestock		Dairy		General		All Farms	
		b	t	b	t	b	t	b	t	b	t
01 Grain	23	-486.4	-2.52	-190.4	-.92	82.1	.52	-245.1	-2.47	-145.3	-1.96
	24	-1135.7	-2.77	-417.3	-.92	-489.2	-1.40	72.5	.36	-242.4	-1.49
	32	180.0	4.74	-35.7	-.71	51.0	2.41	61.0	3.49	57.2	4.26
	49	.911	2.77	.51	3.87	.09	.64	.46	5.51	.35	5.94
	67	-260.9	-3.16	-276.0	-2.91	-274.6	-3.4	-193.7	-5.49	-246.0	-8.29
	Constant	8897.8		11452.9		6834.3		3541.0		6183.5	
	R^2	.649		.59		.42		.52		.47	
02 Grain-stock	25	-201.4	-1.69	-237.4	-3.63	-46.4	-.98	-96.3	-2.22	-123.3	-4.15
	30	-23.8	.28	141.8	3.34	139.8	3.46	4.2	.16	74.	3.9
	32	191.5	4.2	-35.8	-.97	33.1	1.79	65.6	3.67	64.2	5.0
	49	1.02	2.39	.56	5.09	.35	1.66	.6	6.02	.53	8.09
	51	-4.13	-.07	-17.2	-1.19	-62.2	-.49	-9.38	.83	-9.54	-1.14
	64	-.58	-1.13	.55	-1.74	-.06	-.13	-.56	-2.1	-.68	-4.0
	67	-217.2	-2.05	-248.7	-3.4	-148.1	-.13	-159.1	-4.07	-195.3	-6.46
	Constant	8243.3		10190.3		-4642.2		5636.4		4611.1	
	R^2	.63		.785		.57		.54		.54	
07 Dairy	31	-31.3	-3.81	-2.8	-.22	65.6	3.35	-22.1	-3.03	-18.1	-4.20
	61	.85	5.50	.74	3.02	.33	1.47	.657	7.69	.72	10.30
	65	-2.42	-1.04	-1.3	-.60	-2.76	-1.64	-.916	-.89	-1.55	-1.95
	67	-268.2	-3.10	-233.2	-2.60	-275.4	-5.27	-211.7	-6.65	-230.8	-8.64
	Constant	8368.7		691.7		10646.5		3229.0		4400.1	
	R^2	.649		.47		.643		.57		.56	

TABLE 12 (Con't'd)--REGRESSION EQUATIONS USED TO ESTIMATE "RETURN TO OPERATORS LABOR"

Farm Type		Cash-Grain		Grain-Livestock		Dairy		General		All Farms	
	Variable	b	t	b	t	b	t	b	t	b	t
10 General	25	-229.9	-1.98	-188.4	-2.46	1.46	.03	-82.6	-2.15	-72.8	-2.64
	32	194.7	4.20	19.9	.44	32.0	1.35	38.4	2.18	45.2	3.41
	36	41.9	.43	-21.6	.30	13.4	.09	126.4	3.67	97.7	3.42
	48	.51	.26	.095	1.26	-.004	-.02	.076	-1.85	-.05	-1.81
	49	.86	.23	.68	5.43	-.06	-.23	.676	6.99	.56	8.58
	64	-.51	-.96	-1.48	-3.09	.44	.60	-.393	-1.53	-.58	-3.36
	67	-209.8	-1.90	-238.5	-2.72	-375.8	-3.30	-168.9	-4.73	226.6	-7.65
	71	.16	.64	.486	2.15	.58	1.60	.302	2.59	.32	3.61
	Constant	4386.7		11624.1		5231.9		3570.2		5797.8	
	R^2	.62		.70		.39		.610		.56	
99 All farms	25	-212.8	1.82	-74.4	-1.2	16.5	.31	-85.6	-2.15	-62.6	-2.31
	28	-2.1	.21	32.3	4.69	17.8	1.51	6.97	1.06	11.4	3.62
	32	178.7	3.63	12.9	.36	18.9	.76	38.8	2.19	44.4	3.42
	36	22.5	.25	21.6	.38	70.2	.50	123.6	3.53	78.86	2.78
	49	.98	2.77	.76	7.74	.12	.40	.66	6.83	.64	9.55
	64	-.56	.54	2.43	-5.70	-.13	-.19	-1.07	-2.76	-1.36	-6.08
	66	-204.3	.44	331.1	1.33	20.5	.04	269.9	1.65	325.5	3.05
	67	-271.5	-1.74	213.9	-3.04	-295.5	2.51	-180.6	-4.97	-229.8	7.85
	71	.23	.89	.03	.13	.20	.49	.29	2.32	.24	2.51
	Constant	4961.7		7120.8		3283.8		1823.1		3235.5	
	R^2	.62		.82		.44		.60		.581	

Note that adjusted R^2 has been used in all instances. Mult. R^2 would give considerably higher values.

variable 49, livestock production less feed cost, which is significant on even the cash grain farms but not on the dairy farms! In fact, although present in four of the five sets of equations, it does not get above a "t" value of .64, except in the grain-livestock grouping where it approaches the 10 percent level of significance, when used to estimate the dairy type returns. It even has a negative coefficient when associated with the general type variables. Fortunately, the "t" level is so low that we can say the "b" value is not different from zero and not have to offer an explanation of such an anomalous result! An equally anomalous result occurred with corn yield in the grain-livestock regression on grain-livestock but again we can assume a zero "b."

The expenses variables, 22, 23, 24, and 25, usually have negative coefficients because they are expense items. Note that the dairy farms on three separate occasions show one of them having a positive coefficient. In no case is it significant but that it should appear on three of five possible occasions seems interesting, especially as it has negative coefficients in every instance on the other four groups.

It would be tedious to comment upon all the relationships in detail. The reader can seek out those relations which he believes to be important and meaningful for his purposes.

In reading Table 12 down the page rather than across the page we gain some insight into how the variables are affected by being associated in different groupings. We again note that type 99, all farms, shows one R^2 higher than the "best fit," e.g. the grain-livestock. The difference is small and there is an altered grouping of variables which changes the "t" values, e.g. variable 24 from -3.63 to -1.2, and introduces a new significant variable, 28 (crop PMWU). Despite the disparity of variable groupings the R^2 for the grain type is more than .62 for each regression which is in marked contrast to grain-livestock type where the value varies from .47 to .785.

The grouping of the variables can markedly affect the "t" value, e.g. the grain type has variable 49 on four occasions; three times it is greater than 2.39 and once at .23. In this instance only three variables had significant "b" values, crop cost per acre, corn yield, and machinery cost per $100 of production. The partial correlations are (t value in brackets):

$r_{2.23}$	-.06	(- .36)	$r_{23.24}$	.04	(.25)
$r_{2.24}$	-.32	(-1.95)	$r_{23.25}$	.76	(6.83)
$r_{2.25}$	-.28	(-1.71)	$r_{23.32}$	.39	(2.40)
$r_{2.32}$	.45	(3.00)	$r_{23.67}$	-.01	(3.14)
$r_{2.49}$	.32	(2.11)	$r_{25.32}$	.46	(2.99)
$r_{2.67}$	-.58	(-4.13)	$r_{25.67}$	.37	(2.32)
			$r_{32.67}$	-.23	(-1.34)

Again the reader is left to his own resources for a detailed analysis of the results. However, there are some general observations to be made. The first of these is the importance of factor 67. Is this due to its being related to production or to a very important relationship with farm returns? In all cases it is negative. The constant for grain farms is a little over double the mean value, for grain-livestock it is 20 times greater, for dairy six times, for general 3.5 and for all farms a little more than double. Does this suggest that the negative influence has more importance in the grain-livestock and dairy than it does in the others, while the other factors are of similar importance?

The other variables which seem to be important in most cases are the crop costs (23, 24, 25), labor costs (28, 64, 65, 66), corn yield, and net value of livestock production. Selecting the best set of predicting values gives an average R^2 of .653. The lowest prediction occurs when all the farms are taken together despite the extra variables in the regression and the much higher average "t" value.

Table 13 shows the regression equations used to predict variable 5, percent return to capital. The mean returns to capital are 5.98, 3.14, 3.78, 3.55, and 3.87 percent for 01, 02, 07, 10, and all farms, respectively. We note that 67 again is a highly significant variable except where it was deliberately excluded at the cost of obtaining a much lower R^2. Note that the R^2 values are generally much higher than in the previous table and that the variables are somewhat different, 22, 23, and 24 being used more than is 25. As before, 49 is important in the regressions.

The findings of the previous regressions are confirmed: Corn yield does not appear in the grain-livestock regression and where it is present in that data the coefficient is anomalous, i.e. negative. Variable 49 is significant for all farms except dairy farms; variable 52, number of cows, is significant for grain-livestock and all farms. Note that on all farms it has a *negative* coefficient, which it also has on the dairy farms in both the grain-livestock and all farms regressions. While not significant it does seem quite incredible that number of dairy cows could have a negative coefficient in the dairy type.

There is more variation between the highest and lowest R^2 on a column than was evident in the previous table. Also more variables were used, several of them being accepted at the 20 percent level. This is a genuine difference and not due to bias on the part of the investigator in the sense that the difference in "t" value tended to be more distinct in the first set of regressions.

In view of the fact that so many of the predicting variables were results, rather than factors under the direct control of the farmer, it was decided to use stepwise regression to test the relationship between some independent variables and other variables. The variables are shown in Table 14 and it is clear that they are of little value when obviously highly related variables are allowed to enter the regression. Nevertheless, in a few instances, the relationships provide some insight, e.g. the variables present in predicting corn yield on cash grain farms. It would seem to be worth while to follow this procedure but exclude from the anal-

TABLE 13--REGRESSION EQUATIONS USED TO ESTIMATE "PERCENT RETURN TO CAPITAL"

Farm Type	Variable	Cash-Grain		Grain-Livestock		Dairy		General		All Farms	
		b	t	b	t	b	t	b	t	b	t
01 Grain	23	-0.309	-3.82	.147	1.39	-0.103	-0.99	-0.227	-3.58	-0.109	-2.53
	24	-0.387	-2.25	-0.354	-1.60	-0.222	-0.92	-0.053	-0.42	-0.186	-1.97
	32	.084	4.78	-0.029	-1.16	0.030	2.12	.050	4.36	0.036	4.51
	49	.00039	2.46	.00014	2.22	.00004	.43	.00024	4.57	.00017	4.74
	62	.013	2.24	-0.0011	-0.22	-0.0129	-2.11	.0068	2.11	-.00025	-.11
	63	.0002	-1.73	0.7	0.04	.00009	1.77	0.0	.01	.000004	.67
	67	-0.230	-5.69	-0.385	-7.92	-0.374	-6.12	-0.175	-7.84	-0.252	-14.31
	71	.0002	1.98	.00019	1.16	.00037	1.58	.00021	2.57	.000279	.20
	Constant	8.30		14.20		12.24		3.82		8.03	
	R^2	.82		.81		.64		.67		.65	
02 Grain-stock	22	0.253	2.31	.309	5.03	.031	.40	.167	3.29	0.148	4.35
	23	-0.337	-2.17	-0.092	-1.19	-0.227	-1.84	-0.276	-3.85	-0.216	-4.41
	24	-0.460	-1.79	-0.586	-4.23	-0.436	-1.38	-0.054	.40	-0.278	-2.80
	30	-0.047	-1.28	-0.028	1.35	.053	1.37	.036	2.18	.056	4.86
	38	0.068	.15	.420	1.27	1.118	1.36	.207	.75	0.197	1.01
	42	-0.394	-0.61	-0.471	-1.70	.028	.15	-0.027	-0.10	-0.111	-0.91
	49	.00064	3.04	.00011	2.56	.00018	.81	.00016	2.91	0.00014	3.53
	52	0.0	0.0	.0709	2.08	-0.0387	-0.98	.035	.64	-0.0317	-2.90
	66	-0.134	-1.00	-0.213	-2.32	.1487	.36	-0.418	-4.65	-0.213	-3.45
	67	-0.370	-6.81	-0.416	-15.26	-0.355	-3.44	-0.234	-8.49	-0.292	-14.47
	Constant	20.87		12.30		11.08		10.77		10.57	
	R^2	.71		.93		.49		.64		.64	
07 Dairy	25	-0.028	-0.76	.089	2.05	-0.0528	1.42	-0.018	-0.74	-0.0032	-.21
	31	-0.0097	-2.18	-0.0070	-1.19	.0187	1.31	-0.0027	-0.57	-0.0060	-2.30
	40	.025	.30	-0.001	-0.14	.2069	2.38	.032	0.76	0.036	1.18
	61	.00036	4.39	.00032	2.93	.00054	3.31	.00044	7.58	0.00042	10.04
	65	-.00017	.14	-0.0011	-1.11	-0.00425	-3.41	-0.0021	-3.06	-0.0019	-4.08
	67	-.235	-4.86	-0.357	-8.58	-0.2002	-5.14	-0.186	-8.25	-0.227	-13.66
	Constant	9.92			9.06	13.71		9.66		10.4	
	R^2	.78			.71	.75		.66		.68	

TABLE 13 (Cont'd)--REGRESSION EQUATIONS USED TO ESTIMATE "PERCENT RETURN TO CAPITAL"

Farm Type	Variable	Cash-Grain		Grain-Livestock		Dairy		General		All Farms	
		b	t	b	t	b	t	b	t	b	t
10 General	25	-0.092	-1.74	.0706	1.72	-0.0092	-0.26	-.0446	-1.72	-.015	-.91
	32	.066	3.05	-.0411	-1.68	.0288	1.83	.0512	4.44	.038	4.56
	36	.024	.58	-.0123	-0.31	.136	1.64	.0730	3.10	.081	4.48
	49	.00061	3.79	.00014	2.07	.00045	2.79	.00036	5.99	.00025	6.51
	64	-0.00023	-0.99	-.00003	-0.13	-0.00096	-2.80	-0.00042	-2.99	-.00038	-3.90
	67	-0.235	-4.68	-.407	-8.47	-0.191	-3.79	-0.1605	-6.60	-.224	-12.13
	Constant	11.24		14.38		8.52		6.51		8.54	
	R^2	.75		.80		.60		.65		.64	
99 All Farms	22	-0.183	-1.84	.193	1.30	-0.078	-1.17	-.094	-2.17	-0.0990	-2.91
	23	-0.153	-0.92	-.139	-.68	0.142	1.00	-.116	-1.61	-0.0083	.51
	24	-0.715	-2.45	-.869	-2.26	-0.138	.37	-.0325	-.23	-0.187	-1.60
	32	.116	5.04	.134	3.47	0.0217	1.05	-.0618	5.16	-0.0623	6.53
	36	.0458	.82	.085	1.12	0.19	1.82	.0585	2.32	0.0712	3.11
	48	-0.000087	-0.74	.00010	1.09	0.000082	-.38	-.00011	-3.11	-.00012	-4.29
	49	.00058	2.58	.00042	3.86	0.000822	3.76	.00050	7.49	.00046	8.91
	51	-0.032	-0.92	.00204	.13	-0.221	-1.17	-.0138	-1.81	-.015	-2.33
	52	0.0	0.0	.167	1.82	-0.0541	-.56	.0229	.39	-0.060	-3.92
	64	.00039	1.38	-.00064	-1.07	-0.000587	-.59	.00038	1.54	0.00034	2.06
	66	-0.449	-2.89	-.180	-.55	-0.0756	-.13	.585	-4.93	-0.491	-5.32
	Constant	9.96		-3.12		3.33		6.79		6.26	
	R^2	.64		.49		.35		.61		.492	

Note that adjusted R^2 has been used.

TABLE 14--RESULTS OF USING STEPWISE REGRESSION TO ESTIMATE SOME OF THE INDEPENDANT VARIABLES

Farm Type	Fertilizer Cost per acre		Seed and supplies		Total Cost per acre		Corn Yield per acre		Machinery and Equipment per man		Per cent in harvested crops		Feed, seed, supplies		Machinery Cost per acre	
	Variable	t	Variable	t	Variable	t	Variable	t	Variable	t	Variable	t	Variable	t	Variable	t
01	22	-45.8	22	-29.6	22	112.0	10	3.2	11	16.3						
Grain	24	-36.2	23	-36.2	23	66.9	14	2.8	15	-2.5						
	25	-67.0	25	35.5	24	35.5	20	11.2	64	-2.2						
							22	4.0								
							29	-8.0								
							37	4.0								
							39	-6.1								
							55	4.2								
02	22	-9.1	22	-7.1	14	-8.7	20	4.3			12	7.1	20	9.1	23	-9.1
Grain-	24	-6.5	23	-6.9	15	7.5	22	-3.7			29	6.8	23	2.5	24	-7.3
stock	25	15.5	25	9.4	22	39.1	24	3.4			51	-16.4	52	-2.1	25	22.2
	32	2.5	32	4.2	23	26.8	29	-3.8			56	-5.0	54	3.1	38	7.0
			44	2.4	24	14.2	34	2.2					65	3.2	62	-2.8
					58	2.4										
					62	9.3										
					66	2.2										
07					Total Cost per acre				Silage Yield		Acres Corn					
Dairy					22	100.0			25	4.9	20	6.0				
					23	100.0			35	2.9	33	-2.0				
					24	38.0			62	-2.4	37	-4.1				
											63	4.8				
											70	-3.1				
	Fertilizer Cost per acre				Total cost per acre		Corn Yield per acre		Soybean Yield		Feed Cost					
10	22	-116.6			8	-16.0	20	7.3	32	2.5	6	2.9				
General	24	-62.5			22	52.7	29	-5.7	35	6.7	12	4.9				
	25	154.9			23	39.6	30	2.7	39	-2.4	14	18.2				
	38	2.9			24	17.0					29	6.4				
					37	-12.9					41	4.4				
					55	20.1					46	-3.9				
					63	18.6					50	2.8				
											52	-6.1				
											53	2.9				
											54	5.2				
											55	3.3				

ysis variables which are of necessity highly related, e.g. 22, 23, and 24, when estimating 25.

One other use of the stepwise regression routine was to select the variables which would have a significant "b" coefficient for forecasting value of farm production, management and labor return, management return, management and capital, percent return on capital, and net earnings per $100 of expenditure for all dairy farms recorded in 1961, 1962, and 1963. The independant variables were 8, 9, 10, 11, 16, 18, 19, 22, 25, 39, 32, 43, 52, 59, 60, 61, and 63. The resulting "t" values are shown in Table 15.

The variables present in all the regression equations were 11, 60, 61, and 63. Despite the fact we are using dairy farms, number of cows, and total milk production were only significant in two of the six regressions.

The signs of the variables are what we might expect, perhaps, for the negative capital coefficient for land and livestock investment. If the dairy group is heterogenous, the result may be due to too high a price being paid for land in the one case and in the livestock investment case because the income is due to crop rather than to cows. The author's lack of familiarity with the Missouri farm type prohibits further discussion, but the results are presented in the hope that they will help extension workers support or reject their intuitive understandings of the relationships.

TABLE 15--"T" VALUES FOR VARIOUS RETURN MEASURES ON DAIRY FARMS

Variable	Value Farm Production	Management and Labor Return	Management Return	Management and Capital Return	Per Cent Return on Capital	Net Earnings/ $100 Expense
8	2.13	3.18	3.11	3.44	1.91	
9		-3.55	-3.51	-3.58	-1.97	
10	2.08	-3.11	-3.01	-3.09	-1.96	
11	-2.48	-3.54	-3.66	-3.66	-2.48	-1.98
16		2.40	3.03	3.01		
18	4.12		2.40	2.10		
19	0	0	0	0	0	
22		3.10	2.90	2.82	2.84	2.25
25		-4.06	-3.66	-3.59	-3.89	-3.57
29	-1.9					
32		-2.02				
43		3.54	3.96	4.03		
52	3.07	2.76				
59	3.36	-2.13				
60	-2.29	-4.48	-4.57	-4.02	-4.88	-4.67
61	6.97	3.64	2.72	3.40	2.14	2.20
63	-6.78	-3.86	-3.84	-4.39	-3.05	-2.74

COMPARISON OF THE REGRESSION RESULTS AND FACTOR ANALYSIS

In the previous section we noted that some variables were usually excluded from the regression equation becaue they were associated with output. One of the variables so excluded was 72, combined labor and machine cost per $100 of production. If all other things were equal, using the base of "per $100" would standardize the results and it would not necessarily mean that total value of production and "per $100 of production" would have much correlation.[25] If so we could just as legitimately claim the variable as a predictor as we could fertilizer cost or number of cows.

By excluding 72, a highly significant variable was excluded as its "t" value was often above 10 and as high as 15 or 16. One example is:

$$X_5 = 13.76 - .02 X_{25} + .03 X_{27} - .001 X_{28} - 0.1 X_{51} \div 0.1 X_{52} - 0.04 X_{66} -$$
$$(-1.4) \qquad (2.58) \qquad (-.6) \qquad (-2.78) \qquad (1.42) \qquad (.47)$$
$$.195 X_{72} \qquad R^2 = .66$$
$$(-13.07)$$

where despite a number of doubtful variables the R^2 is appreciably higher than the .49 of the equation used in Table 13.

Discussion of this point is required because 72, without exception, had the highest opposite loading to the income measure on the "income" factor. Variable 67 which also had a high opposite loading on the "income" factor was present in all of the equations of Table 12 and 13 except where it was deliberately excluded because it reduced the significance of the other variables. (The justification was that we need to see the relationships between the variables rather than just put a large value for R^2.)

Therefore, we find that variables which were associated with the "income" factor have a very significant relationship when we attempt to evaluate the farm returns, although this is not necessarily obvious from the tables above.

However, useful variables were not confined to those associated with the "income" factor which but also could be found in association with other factors. Variable 67 is of interest in this regard in that it was a complex variable in some instances and fairly simple in others; e.g. it was associated with factors 3, 5, 7, and 10 to account for 70 percent of its communality of .76 on the grain farms while for all farms 71 percent of a communality of .72 was explained by one fac-

[25]In fact, the partial correlation coefficients for the five groups are;

Type	r	t
01	-.43	-2.7
02	-.59	-4.6
67	-.37	-2.2
10	-.54	-7.2
99	-.53	-9.6

tor, "income." In other instances it is associated with two factors, and more of its communality is explained.

The grain farm variables of Table 12 and 13 are 23, 24, 32, 49, 62, 63, 67, and 71. Of these, 23 and 32 have fairly high loadings upon factor 2; 23 and 24 have weaker loadings of opposite sign on factor eight; 63 is complex, loading on factors 1, 5, 9, and 10 (on one occasion in opposition to 67 and the other in association). Sixty-two has the highest loading upon factor 5, and a further weak association with 67 on factor 10, while 71 has a very high loading upon factor 7. We note that factors 1, 2, 3, 5, 6, 7, 8, 9, and 10 are represented and that for factors 3, 5, 6, 7, and 10 the variable has the highest loading for one end of the bipolar factor.

The grain and livestock variables were 22, 23, 24, 25, 30, 32, 38, 42, 49, 51, 52, 54, 66, and 67. The final five were all on one factor, factor 5, and the first four were simple, not being associated with the other factors. Variable 30 was present also in factors 7 (weakly opposed to 51) and 9 where it weakly associated with 67 and opposed 32 and 42. Variable 32 was present in factors 3, 6, and 9, being weakly associated with variable 64 and opposed to 49. Factors 1, 2, 3, 4, 5, 6, 7, and 9 were represented, with factors 4, 5, 6, 7, and 9 each having as one of its representatives either the highest or second highest variable. A difference was the association of 22, 23, 24, and 25 on one factor.

The dairy variables were 25, 31, 40, 61, 65, and 67. The most complex variable was 61 with its loading upon factors 2, 5, 7, and 9. In its usual atypical fashion the dairy group has no associated variable for four of the nine factors (though it was effective in the factor regression). In factors 4 and 9 the variables had the highest loading but in many of the other factors there were variables with much higher loadings than those of the regression variable.

The variables used in the general type regression equation were 25, 32, 36, 48, 49, 64, 67, and 71. The variables had loadings on all the nine factors except 7. Variables 25 and 32 associate on three factors and 25 and 67, on nine. On factor one, 64 had a high loading although well down the list; on factors 2, 3, 4, 5, and 8, the variable had a loading which was either second or third highest. No factor had more than two of the variables loaded upon it.

Finally, we note that for the type *all farms* there were many variables, some with fairly low "t" values. The variables were 22, 24, 25, 28, 32, 36, 48, 49, 51, 52, 64, 66, and 67. The most complex variable was 49 with its loading upon four factors (2, 3, 6, 9) followed by 64 loading upon 1, 6, and 7, and 32 loading upon 4 and 9. In no case did two of the variables have loadings on more than one factor. Only factor 8 has no variables from the regression loading upon it. Factors 2, 3, 4, 5, 6, and 7 each had a variable with either the highest or second highest loading.

The discussion above shows that the regression variables had associations with most of the factors extracted with the exception of the dairy farms, and usually the variable had either a high loading on the factor or else it was a complex variable with several factors associated. In some cases both remarks are true, e.g. 62 in the *all farm* type.

Therefore, apparently there is no anatagonism or conflict in the results obtained using multiple regression and factor analysis. In fact the factor analysis would assist in deducting the variables which would be worth applying in a regression. It may not be so clear which variables from a bi-polar factor will give the best fit.

CONCLUSIONS

The objectives of the study were:

1. To see if the farm record analysis for different types of farm could be factored into common groups.
2. To see if there were a few standards which could be used to predict farm income, and whether or not such standards were variables which the farmer could influence.
3. To test the hypotheses of Black regarding the appropriate size of an "above average" group using the Missouri data.

The work relative to the third objective has not been reported because there was not time to complete the study. The preliminary results suggested that the data did not support Black's findings. However, there were only about 40 farms for which complete information was available for four consecutive years. These farms had changed appreciably in size and they also belonged to different farm types. Therefore, the point must be considered unproven one way or the other. It would be a most worthwhile point to research, as soon as data for four or five consecutive years is available for sufficient farms in any one farm type.

The first objective was fulfilled, although the data were only studied in detail for one year. It was clear that factor analysis would separate out meaningful factors. Some five of these factors were common to each farm type (as defined for this study) except that the dairy farm group fitted the poorest. In all, some 14 factors were isolated, although ten factors were sufficient to calculate for each farm type. The first four factors extracted explained more than 60 percent of the explained variation in each type. These four were not all common to the five types, but in each case the first factor, which approached most closely to being a general factor, was the *size* factor. The *income* factor was either the second or third factor extracted. However, after that considerable variation occurred, e.g. factor 4 of the cash-grain type corresponded to factor 8 of the grain-livestock type.

The 10 factors extracted explained from 70 to 80 percent of the variance of the 72 variables. The variables usually showed a high communality except for a group, fairly common to all the types, which exhibited an average communality of about .34. This group accounted for a large part of the variance which was due to specific factors or error. A number of variables showed they were likely to have high error of measurement, e.g. yield of hay silage, permanent pasture. However, variable 32, yield of corn, was a member of the group so it may be that it should be thought of as a specific factor. Others of this group of variables, such as wheat and soybeans, were frequently not grown on farms. So they may affect the analysis, which is based on the concept of a normal distribution. In further development of this work it may be wise to exclude from the analysis variables which measure performance of activities which are present on a limited number of farms. It was noted that variables with low communality usually had very low simple correlations. An arbitrary method of selecting the variables, *for an analysis of this type,* might be to exclude any variable which did not have a simple correlation greater than .50.

The factors were such that they would assist an extension worker in comprehending the importance and relationship of the variables for each farm type. They demonstrated that these relationships changed from one type of farm to another. In Appendix A it is shown that for one type of farm the variables seem to have fairly similar relationships from one year to another; also, that if the same variables are subject to factor analysis in different years, similar factors emerge with variables showing much the same order of weighting on the factor.

The second objective was to test the relationship between some of the variables and two measures of returns. It was possible to formulate equations with an R^2 of .98. Such equations, however, had as their most significant variables, variables which were measures of returns. After excluding some of these variables it was possible to estimate the returns with an adjusted R^2 ranging from 0.5 to 0.8. Examples of the variables which were significant were fertilizer cost per acre, seed and supplies per acre, number of beef cows, labor cost per farm, crop PMWU, and (for all types) fixed and variable machinery costs per $100 of production. Number of cows had a negative coefficient which no doubt was due to the low returns from cattle feeding in 1964. Clearly, these equations must be treated with care. The relationships may not hold from year to year. Nevertheless the fact that some inputs are highly correlated with returns should be of value in extension. Perhaps these figures could be highlighted in future reports. Presumably, fertilizer response is not linear and it may be that Cobb-Douglas type estimates should be run as part of the record analysis and used to support appropriate levels of fertilizer expenditure.

The factor analysis showed that many variables would cluster on one factor. When these variables were used to replace one another in the regression analysis, frequently, while the estimate was not as good, the variable would still be significant. Therefore, it would seem quite possible to reduce the number of standards and relationships calculated in the records analysis. In particular, the extent that data which is applicable to relatively few farms should be circulated and used as averages over the whole group should be reconsidered.[24] Only 22 of the 67

[26]It should be noted that in 1965 the Missouri record analysis did show the number of farms which had reported each item.

variables (deducting the five net income measures) were used. It may be that quite different reports should be issued, one to farmers which highlights the results of their group and has a minimum of standards shown and another version, perhaps similar to the existing report, which could be made available to the county agents. It may be worth the duplication of effort of presenting the abbreviated type reports as given to the farmer as appendices to the general report.

Finally, this work is exploration. No firm recommendation could be made without at least a further year's analysis to ensure that the factors are consistent and that the relationships do hold from year to year. Presumably, climate, with its effect on yields, will cause changes in some of the factors. Furthermore, the numbers in the different groups were small and it may be that efforts should be made to check the results by using a larger sample, either by a special survey or by interstate cooperation.

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APPENDIX A.

Prior to the 1964 data's becoming available some analyses were made of the dairy farm type for the years 1961, 1962, and 1963. Only this type was analyzed because there were insufficient farms in the other groups for a meaningful analysis. Also it was believed that the dairy farms constituted a more homogeneous group. At this time the computer available could only handle up to 49 variables for factor analysis. The initial work was carried out to check if factor analysis appear to be a useful tool. It appeared that it was, which lead to the program reported above being carried out.

To obtain sufficient numbers of farms it became necessary to aggregate the data for several years. One factor analysis for the combined years was made using 35 variables which had appeared most likely to be meaningful for the dairy farms. The same variables were factored using the 1964 data. Table 16 shows the comparison between the two analyses. In each case the same variables tended to have similar weights on the six factors. One outstanding difference is variable 26, return to land and labor per crop acre, which for the 1964 data weighed heavily on factor two, the "income" factor, but in the other case was associated with factor three. If 26 is excluded the rank correlation of factor three is .715, but this reduces to .58 if it is included. Variable 59 occurs in the first factor in both instances but weakly in 1964. If it is excluded, the rank correlation of factor 1 is .94 but if included the correlation falls to .79. The rank correlation of the second factor is .70.

It is clear that the basic factors seem constant but that some individual items may have substantial changes in their weighing on a factor. Note that because of the reduced number of variables the factors are not necessarily directly comparable with the factors which appear when all the variables are present; e.g. factor 1 of Table 16 appears to be a composite of factors one and three of Table 4.

One item of interest was that the simple correlation between the variables for the years 1961, 1962, and 1963 were calculated. After aggregating the data there was a decline in the simple correlation. Nevertheless, considering changes due to weather and prices from year to year, and that there were different farms reporting in the various years the constancy speaks well of the consistency of relations between the variables. Some of the variables are shown in Table 17. The first of the return measures was selected and its correlation was calculated with the remaining variables for the individual years 1961 and 1964, and the combined years 1961 and 1963; 1961, 1962, 1963; and 1961-1964, inclusive. It is evident that the relationship with crop production measures fluctuates considerably. This is, no doubt, a weather effect. The numbers of farms reporting were 38, 26, 35, and 33 from 1961 through 1964.

TABLE 16--A COMPARISON OF THE FACTOR LOADINGS OF 35 VARIABLES ON SIX FACTORS FOR DAIRY FARMS FOR YEARS 1961, 1962, 1963, and 1964.

VARIABLE		FACTOR											
No.	Name	One		Two		Three		Four		Five		Six	
		a*	b	a	b	a	b	a	b	a	b	a	b
8	Total capital managed	.76	.66			.57	-.68						
9	Capital - land & improvements	.68	.46			.62	-.74						
13	Total value farm production	.83	.67			.45	-.63						
14	PMWU	.95	.91										
15	Man Years of labor used	.89	.93					-.36	.24				
39	Acres of silage	.48	.19										
47	Value all livestock production	.95	.97										
48	Value of feed fed to livestock	.88	.90										
49	Return above feed cost	.83	.86										
52	Number of dairy cows	.91	.94										
59	Total milk produced	.93	.55										
64	Labor charge per farm	.92	.91										
68	Mach. & equip. charge per farm	.74	.48			.54	-.67						
2	Operators labor & management			-.89	-.93								
3	Management return			-.89	-.95								
4	Man. & capital return			-.75	-.85								
5	Per cent return to capital			-.97	-.92								
25	Crop cost per crop acre			.21	-.02								
61	Value of production per man			-.51	-.52	.61	-.57	.46	-.39				
18	Total value of harvested crop					.51	-.60					.34	.26
26	Return to land & labor per crop acre				-.77	.71	-.10					.58	.34
29	Total acres of crop harvested					.79	-.69						
63	Capital invested per man					.85	-.78						
68	Mach. & equip. cost per farm	.74	.48			.54	-.67						
62	PMWU per man							.76	-.90				
44	Permanent pasture - yield									.30	.13		
57	Milk per cow									.63	.68		
32	Corn - yield per acre											.46	.45
38	Hay - yield per acre											.37	.63
40	Silage - yield per acre											.50	.57

* a - Factor loading for years 1961-62-63.

b - Factor loadings for 1964.

TABLE 17--SIMPLE CORRELATION BETWEEN "MANAGEMENT AND LABOR RETURN" AND OTHER VARIABLES

VARIABLE	YEARS				
	1961	1964	1961 & 63	1961, 62, 63	1961, 62, 63, 64
Management Return	.98	.98	.96	.97	.97
Management and capital return	.79	.95	.85	.85	.88
Per cent return on capital	.80	.86	.82	.84	.84
Net earning per $100 invested	.80	.93	.84	.84	.87
Crop P M W U	.40	.42	.21	.24	.28
Acres crop harvested	.36	.51	.17	.19	.27
Management and labor return to capital	.70	.81	.78	.80	.80
Value harvested crop	.42	.70	.28	.22	.32
Value harvested crop per acre	.52	.28	.29	.28	.28
Machine costs per acre	.08	-.03	-.03	-.22	-.14
Fertilizer cost per acre	.04	.21	.04	-.03	.00
Seed, supplies cost per acre	.22	.05	-.06	-.17	-.11
Total cost per acre	.11	.06	-.02	-.22	-.13
Return to land and labor p/a	.49	.71	.47	.50	.54
Corn Yield	.32	.36	.20	.14	.21
Corn acres	.27	.53	.04	.06	.19
Silage acres	.22	-.13	-.30	-.16	-.14
Sileage yield per acre	.04	.21	.19	.09	.14
Rotated pasture - acres	-.02	-.23	-.06	.05	-.06
Rotated pasture - yield	.04	.19	-.09	-.06	.04
Permanent pasture - acres	.12	-.12	-.14	-.09	-.10
Permanent pasture - yield	.07	.32	.07	.04	.12
Livestock P M W U	.36	.15	.08	-.07	.00
Value of livestock production	.45	.26	.18	.12	.14
Value of feed fed to livestock	.35	.18	-.04	-.12	-.05
Returns after feed cost	.50	.34	.46	.42	.39
Return per livestock P M W U	.53	.33	.51	.55	.47
Return per $100 feed fed	.40	.25	.41	.46	.41
Hay acres	.03	.19	.00	.06	.09
Hay yield	.01	.06	.14	.15	.11
Labor per P M W U	-.19	-.13	-.30	-.16	-.14
Labor per $100 production	-.56	-.60	-.63	-.65	-.62
Capital per man	.26	.12	.14	.17	.14
Production per man	.66	.57	.55	.57	.57
Harvested crop acres per man	.25	.23	.15	.18	.19
Mach. & equip. cost per crop acre	.03	-.13	.03	-.19	-.09
Mach. operating cost per farm	.34	.15	.16	.16	.15
Mach. operating cost per crop acre	.06	-.13	-.02	-.23	-.20
Mach. operating cost per $100 prod.	-.56	-.58	-.56	-.54	-.55
Farm returns per P M W U	.59	.83	.15	.78	.81
Total labor	.26	.36	-.02	-.07	-.01
Labor cost per man	.21	-.13	-.16	-.16	-.16
Milk per cow	.22	-.28	.18	.24	.07
Milk produced	.42	-.26	.17	.09	.01
Number of cows	.39	.20	.07	-.05	.01