Personal, social and economic factors conditioning farmers' decisions and resource use on Central Pennsylvania dairy farms

Carroll Vernon Hess  
*Iowa State College*

Follow this and additional works at: [https://lib.dr.iastate.edu/rtd](https://lib.dr.iastate.edu/rtd)

Part of the Agricultural and Resource Economics Commons, and the Agricultural Economics Commons

**Recommended Citation**

Hess, Carroll Vernon, "Personal, social and economic factors conditioning farmers' decisions and resource use on Central Pennsylvania dairy farms" (1953). Retrospective Theses and Dissertations. 13959.  
[https://lib.dr.iastate.edu/rtd/13959](https://lib.dr.iastate.edu/rtd/13959)
NOTE TO USERS

This reproduction is the best copy available.

UMI®
PERSONAL, SOCIAL AND ECONOMIC FACTORS
CONDITIONING FARMERS' DECISIONS AND
RESOURCE USE ON CENTRAL PENNSYLVANIA DAIRY FARMS

by

Carroll Vernon Hess

A Dissertation Submitted to the
Graduate Faculty in Partial Fulfillment of
The Requirements for the Degree of
DOCTOR OF PHILOSOPHY

Major Subject: Agricultural Economics

Approved:

Signature was redacted for privacy.

In Charge of Major Work

Signature was redacted for privacy.

Head of Major Department

Signature was redacted for privacy.

Dean of Graduate College

Iowa State College

1953
INFORMATION TO USERS

The quality of this reproduction is dependent upon the quality of the copy submitted. Broken or indistinct print, colored or poor quality illustrations and photographs, print bleed-through, substandard margins, and improper alignment can adversely affect reproduction.

In the unlikely event that the author did not send a complete manuscript and there are missing pages, these will be noted. Also, if unauthorized copyright material had to be removed, a note will indicate the deletion.
## TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTRODUCTION</td>
<td>1</td>
</tr>
<tr>
<td>OBJECTIVES</td>
<td>3</td>
</tr>
<tr>
<td>REVIEW OF LITERATURE</td>
<td>5</td>
</tr>
<tr>
<td>Review of Theory</td>
<td>5</td>
</tr>
<tr>
<td>Review of Empirical Studies</td>
<td>10</td>
</tr>
<tr>
<td>ANALYTICAL FRAMEWORK</td>
<td>15</td>
</tr>
<tr>
<td>Introduction</td>
<td>15</td>
</tr>
<tr>
<td>Risk and Uncertainty - Imperfect Knowledge</td>
<td>19</td>
</tr>
<tr>
<td>Nature of risk and uncertainty</td>
<td>19</td>
</tr>
<tr>
<td>Economic horizons and uncertainty</td>
<td>23</td>
</tr>
<tr>
<td>Types of uncertainty facing the farmer</td>
<td>25</td>
</tr>
<tr>
<td>Price uncertainty</td>
<td>27</td>
</tr>
<tr>
<td>Technical uncertainty</td>
<td>37</td>
</tr>
<tr>
<td>Technological uncertainty</td>
<td>44</td>
</tr>
<tr>
<td>Adjusting to risk and uncertainty</td>
<td>47</td>
</tr>
<tr>
<td>Diversification</td>
<td>48</td>
</tr>
<tr>
<td>Flexibility</td>
<td>53</td>
</tr>
<tr>
<td>Liquidity</td>
<td>63</td>
</tr>
<tr>
<td>Capital Rationing</td>
<td>64</td>
</tr>
<tr>
<td>Effect of capital rationing on combination of factors</td>
<td>66</td>
</tr>
<tr>
<td>Effect of capital rationing on scale of operations</td>
<td>71</td>
</tr>
<tr>
<td>Goals Other Than Monetary Income (Firm-Household Relationships)</td>
<td>78</td>
</tr>
<tr>
<td>EMPIRICAL ANALYSIS</td>
<td>88</td>
</tr>
<tr>
<td>Introduction</td>
<td>88</td>
</tr>
<tr>
<td>Sampling Procedure</td>
<td>89</td>
</tr>
<tr>
<td>Role of Knowledge</td>
<td>93</td>
</tr>
<tr>
<td>Relationship of knowledge to farming success</td>
<td>94</td>
</tr>
<tr>
<td>Influence of level of formal schooling on farming success</td>
<td>96</td>
</tr>
<tr>
<td>Relationship of knowledge to certain personal characteristics and farmers' actions</td>
<td>98</td>
</tr>
<tr>
<td>----------------------------------------------------------------------------------</td>
<td>----</td>
</tr>
<tr>
<td>Role of Capital</td>
<td>104</td>
</tr>
<tr>
<td>Relationship of investment level to certain personal and business factors</td>
<td>105</td>
</tr>
<tr>
<td>Relationship of investment level to actions</td>
<td>110</td>
</tr>
<tr>
<td>Role of capital rationing in limiting actions</td>
<td>113</td>
</tr>
<tr>
<td>Farmers' implied use of new capital funds</td>
<td>124</td>
</tr>
<tr>
<td>Role of Psychological and Sociological Factors</td>
<td>132</td>
</tr>
<tr>
<td>Influence of farmers' concept of &quot;good&quot; production</td>
<td>133</td>
</tr>
<tr>
<td>Influence of farmers' standard</td>
<td>137</td>
</tr>
<tr>
<td>Influence of operator's self rating</td>
<td>139</td>
</tr>
<tr>
<td>Incidence and influence of over and under-rating</td>
<td>143</td>
</tr>
<tr>
<td>IMPLICATIONS OF THE STUDY</td>
<td>149</td>
</tr>
<tr>
<td>LIMITATIONS OF TABULAR ANALYSIS AND SUGGESTED ALTERNATIVE ANALYSES</td>
<td>155</td>
</tr>
<tr>
<td>ACKNOWLEDGMENTS</td>
<td>162</td>
</tr>
<tr>
<td>APPENDIX</td>
<td>163</td>
</tr>
</tbody>
</table>
Introduction
individual farm operator (his goals or objectives in life, his standard of attainment, etc.) that keeps the farm firm from attaining the simple optimum of static theory. There has been little empirical work to test these several hypotheses or assumptions. It was toward this end, that this study was undertaken.
OBJECTIVES

The research worker wishing to isolate and explain the nature of entrepreneurial decisions and the motivations underlying these decisions is faced with the complexity of entrepreneurial ends or objectives. It is usually assumed in farm planning, as well as in most of our farm management literature, that these goals are profit maximization. Yet, one must interview only a few farmers to discover that profit maximization is not the sole motivating force in farm decisions. A Minnesota study in 1929 pointed out that farmers knowingly sacrifice money income to attain certain other goals.¹ If we were to accord an important place to non-monetary (and perhaps even non-economic) elements in our initial assumptions, the theoretical findings of investigations might be greatly altered. That is, the postulated actions of entrepreneurs in casting their decisions might be quite different within the framework of a new model than within the old model (perfect knowledge, unlimited capital, profit maximizing goal). Entrepreneurial reaction, for instance, may be more or less violent in the new model than in the old.

A thorough explanation of agricultural entrepreneurship would require not one study but several related studies, each of which might necessitate a series of personal interviews to reveal the true nature of the entrepreneur's goal or objectives, the limitations of his knowledge, the factors to which he is responsive, etc. This study deals with a small portion of this phenomena. Its objective may be stated thus:

(1) To determine the factors or conditions responsible for the deviation of the present position of the firm from some "feasible and desirable standard of performance."

(2) To determine reasons why the entrepreneur does not take the necessary steps or measures to improve on his firm's position.

Empirical answers on these problems can be helpful not only to teachers and extension workers in this field, but to research workers as well. Research which gives us some measure of the nature and relative importance of factors other than profit maximization in guiding management decisions will have important implications, both for our theoretical concepts of the management factors and for our educational efforts with farm people.
REVIEW OF LITERATURE

Review of Theory

The role of the entrepreneur to the economy as a whole is an important one. A connecting link of this nature is of particular importance in an economy of ever-expanding division of labor. The entrepreneur becomes this link. As he responds to price mechanism, and initiates the change himself in an effort to maximize profits, the entrepreneur becomes the connecting link of adjustment and creative change in our society.

Dobb\(^1\) states that:

The principle elements of this entrepreneur function, as applied to any economic society will be the capacity for adjustment and innovation; and in the case of the latter, the ability to make correct judgments as to the future is, perhaps, the most important. The elements which compose this function appear to have an essential unity in the fact that they are concerned primarily with deciding rather than doing things, and must, it would seem, fall in the main on the same groups of persons. Any economic society, therefore, if it is to be progressive, will require two main functions which the composite term Entrepreneur Function seems to describe most appropriately.

(1) The need (a) so as to preserve the balance between producing groups that, in general, the marginal utility of supply covers the marginal cost; and (b) so as to regulate the distribution of economic resources between alternative uses so that the marginal yield in all uses is approximately equal.

(2) The need to promote such changes in the condition of supply and technique as to increase the yield of human effort as much as possible, the grouping of resources being speedily and appropriately adapted to such changes in conformity with (1a) and (1b).

---

This definition of the entrepreneurial function is universal; it is universal because it holds for all societies and economic systems, whether for an exchange non-capitalist economy, a capitalist economy, or a communist society. The essence of the entrepreneurial function is Adjustment and Innovation.

Dobb recognizes uncertainty of two types — uncertainty as to the course of events and hence additional possibility of economic adjustment, but does not include uncertainty in his definition. Another school opposes this drift of thought. They make "uncertainty" the kernel of their definition. Professor Frank Knight points out that:

If the conditions of life and people themselves were entirely unchanging, a definite organization would result, perfect in that no one would be under an incentive to change. Thus only supervision and routine duties of coordination of activities of individuals would be necessary. With the introduction of uncertainty, this situation is changed. The actual doing of things becomes secondary. The primary problem or function is deciding what to do and how to do it.

Producers produce a product on the basis of an entirely impersonal prediction of wants, not for satisfaction of wants of producers themselves. The producers (a very small group) take the responsibility of forecasting the consumers' wants. This work of forecasting and at the same time, a large part of the technological direction and control of production are still further concentrated upon this very narrow class of producers, and we meet with a new economic functionary, the entrepreneur.

The Dobb school stresses the fact that there is somebody who performs the integrating function. In the latter school, the stress is on the fact that this somebody makes decisions in an uncertain world, that this inte-

---

gration takes place under the uncertainty resulting from the working of
the uncontrollable economic (social) forces.

Schumpeter states that:

The entrepreneur is the phenomenon connected only with an
economy in which change arises from change in the economic
factors themselves, and hence comes within the range of the
economists realm. The "entrepreneur" is the "innovator." In
novation on the other hand, is the mother of economic
development. The entrepreneur is the one who carries out new combinations. The entrepreneur would be the one who

carries out innovation under conditions of uncertainty and
unpredictability. Carrying out innovation in a routine -
like manner would not be an act of the entrepreneur.

Between the entrepreneurial decision and the realization of
its effects lie the uncontrollable forces of a functioning

economy which operates in a recurrently regular manner, but
which do not allow a clear prediction in any specific case.
These forces consist of everything that we often refer to as
economic laws. 1

Papandreou combined the thinking of the various schools of thought
by defining the entrepreneurial function as one of decision-making 2
toward the goal of maximizing profits under conditions of uncertainty
which arises from the functioning of the economic system. In other
words, he feels that the entrepreneurial function is conceived as the
making of profit maximizing decisions whose outcome is conditioned by
the unregulated forces of the economy. 3

---

1Joseph A. Schumpeter. The theory of economic development. Cambridge,

2Decisions refers to the choice of path of action after taking into
consideration the totality of the situation with which one is confronted.

3Andreas G. Papandreou. Location and scope of entrepreneurial
Kaldor\(^1\) points out in his article the need for adjustment which makes the entrepreneur a necessary factor in production. Quoting from page 65:

For the function which lends uniqueness and determinateness to the firm—the ability to adjust, to coordinate—is an essentially dynamic function; it is required so long as adjustments are required; and to the extent to which it is required depends on the frequency and the magnitude of the adjustment to be undertaken.

He defines the firm as a "productive combination possessing a given unit of coordination ability." This given unit of coordinating ability is the entrepreneur. The ability of the entrepreneur to adjust to changes in economic and technical data is a "fixed factor" in production, even in the long run.

Cole\(^2\) of Harvard University stresses the importance of (1) arriving at a common meaning of entrepreneurship and (2) limiting the scope of inquiry before any investigation of the general area is begun.

Knight\(^3\) advances the notion that the entrepreneur is the owner of any business or productive enterprise to which income may accrue as profit. He goes on to point out that:

The entrepreneur's function is leadership or economic pioneering; it is to initiate useful changes or innovations. Doing so, the entrepreneur is simply a specialist in risk bearing or uncertainty bearing.

---


Evans\(^1\) defines the entrepreneur as an economic opportunist. He further proposes that any theory of entrepreneurship must recognize this opportunist characteristic. It must also recognize the motive or motives leading an entrepreneur to act. He criticizes Knight's identification of a theory of entrepreneurship with the theory of profits. Instead he views the remuneration of the entrepreneur as a payment to be associated with the supplying of dynamics to the enterprise rather than with risk bearing. Stauss,\(^2\) on the other hand, concurs with Knight's thesis.

Johnson and Haver\(^3\) have outlined the various situations under which a manager makes decisions and have developed sets of principles to guide him. In addition they have presented an extensive bibliography for those interested in delving into the subject further. Some examples of non-static theories of production may be found in the writings of Gerhard Tintner\(^4\) and that of A. G. Hart.\(^5\)


\(^3\)Glenn L. Johnson and Cecil B. Haver. Decision-making principles in farm management. Kentucky Agricultural Experiment Station Bul. 593, January 1953.


The study supported the general effect of these personal characteristics upon farm operation success and the use of resources. They found that among other things, some factors related to certain attributes of the individual which affected the farm operation were determined. The study was concerned with certain factors believed to produce and perfectionate on the farm a farm worker, (6) and (6) hand work. The study was supported by the general effect of personal characteristics on farm operation success and the use of resources. They found that among other things, some factors related to certain attributes of the individual which affected the farm operation were determined. The study was concerned with certain factors believed to produce and perfectionate on the farm a farm worker, (6) and (6) hand work.
weaknesses of a given enterprise on the farms studied and then attempt to
determine the economic and personal reasons why the operators have not
improved these weaknesses which were clearly limiting income. Neither
did the study go far in the direction of explaining the forces and motives
back of the personal characteristics associated with success. Thus, while
the study was concerned with the same general area of research, the
approach was basically different from that of the project under consider-
ation in this thesis.

Furthermore the study was based on a group of record-keeping farmers
which are above average in respect to capital, education, cooperative
ability, and size and quality of farm. Thus, the study does not apply so
well to the population because the forces conditioning the group's actions
would necessarily be different from forces affecting the average farmer.

Finally the study is restricted to an enumeration of the attributes
which individuals considered as important in affecting their efficiency.
It made no attempt to determine whether farmers had basic knowledge of the
maximizing principles, the nature of the production functions, marginal
productivities of factors, rates of feed transformation, etc. Neither did
it analyze the specific forces of environment such as capital rationing,
risk and uncertainty, effects of technology and other forces which con-
dition a farmer's adjustments.

A very similar study was carried on by Wilcox and Lloyd\(^1\) of Indiana
in 1931. The objective of this study as in the above study, was "an
analysis of the personal history and characteristics of a number of farm

\(^1\)Walter W. Wilcox and O. G. Lloyd. The human factor in the management
of Indiana farms. Indiana Agricultural Experiment Station Bul. 369. 1932.
operators in order to determine the factors responsible for differences in financial progress." The results were almost identical.

F. J. Reiss\(^1\) at the University of Illinois conducted a study in 1948 and 1949 entitled "Measuring the Management Factor." The study grew out of the common practice of most farm management analysis to evaluate the level of management on individual farms as a residual earning expressed as management earnings, operator's labor earnings, rate earned on investment, etc. These measures were thought unsatisfactory by Reiss since they are "after the fact" measures and thus have no prior predictive value. Also these measures reflect windfall profits and losses which are entirely apart from management.

Thus Reiss set up his study so that he would be able to "predict the level of success most likely to result from the personal and situational factors surrounding the individual farm operator."

The procedure was to get terms which were descriptive of "good" and "poor" farmers through the medium of a questionnaire. These questionnaires were filled out by vocational agriculture teachers, Soil Conservation Service work-unit conservationists, fieldmen of the Farm Bureau Farm Management Service, professional farm managers, freshmen and sophomore students of the school of agriculture at the University of Illinois, and by farmers cooperating in the Farm Bureau Farm Management Service. Thus all descriptions were obtained from persons living on farms or working more or less intimately with farmers.

The more than 7,500 descriptive statements obtained were classified and screened until 85 descriptive adjectives, one for each classification were found that seemed adequate to describe either job proficiency or personal characteristics. These terms arranged in such a way as to produce a rating sheet could be used by neighboring farmers to rate a given individual as to his management index.

D. B. Williams\(^1\) concluded from his study of Illinois farmers in 1950 that they consider future prices in terms of a range of possible prices and that the probability distribution of anticipated prices is frequently skewed. Farmers in this study revealed that their own ideas as to expected price levels were unimportant. Rather a comparison of different commodity prices was thought to be a more fruitful interpretation of the way in which farmers think and act. The survey, even though it represented a study of attitudes rather than motivations, did reveal their uncertainty preferences.

The study of Southern Indiana dairy farmers by Willard F. Williams\(^2\) in 1950 described anticipations and plans at two points of time as they applied to various future dates, traced some of the divergences between plans and realizations and attempted to determine the manner in which plans and anticipations were realized or revised and to note the reasons for revisions. Williams draws the following conclusion:


It was in his capacity as director and general manager of a large educational institution that Mr. Smith undertook the present study. 

Also, there is a dearth of both educational and better methods of teaching. The research he has conducted in this area has been very valuable.

Since the latest findings have not yet been included in any of the textbooks, the importance of this research is underscored. Mr. Smith has new and innovative methods of assessing the effectiveness of other social science courses and has developed new models to measure the success of these courses.

In addition to his work in educational administration, Mr. Smith is also a prominent researcher in sociology and has published extensively in this field.
ANALYTICAL FRAMEWORK

Introduction

The theory of the firm is useful to economists as a working hypothesis to be tested by comparison with the real world. Part of this theory has been accepted by farm management workers as a basis for collection of empirical facts. The theory of firm that has been used to establish farm management principles has been based on static conditions.

Early empirical studies in farm management drew attention to the unreality of assuming flexibility of the physical and financial operation of the firm. Farm tenancy, agricultural credit and labor immobility have all been recognized as important influences limiting or at least modifying the application of farm management principles which were developed on the foundation of an economic model which was not realistic. This would imply the need for a gradual improvement in the abstract models so that they will incorporate more of the relationships believed to exist in reality. Progress depends upon narrowing the gap between the internally consistent model on the one hand and reality on the other hand, which the model is designed to interpret. The method will depend upon deductive abstraction to provide the models and inductive reasoning from empirical evidence to improve them.

As the basic laws and principles of any science function as theoretical models to provide the hypotheses which guide the various empirical phases of an investigation, the principles of production (borrowed from economics) provide both simple and complex models in farm management
economics. These production principles serve as the fundamental hypotheses of research and furnish the analytical framework for establishing the appropriate empirical analysis (the nature of the data needed in answering problems, the sample or experimental design, and the appropriate statistical analysis) in solving specific problems of the field. The analytical models that follow have helped to formalize the problem under consideration and have pointed up some of the hypotheses that were tested in this study.

The entrepreneur, in attempting to attain the conditions necessary for equilibrium of his firm, is faced with several important problems. These problems may be classified as "static" and "dynamic." The static problems are those which are characterized by lack of uncertainty while the dynamic problems may be considered as those arising out of price, technical, and technological uncertainties which give rise to change.

A. The static problems are:

1. The level of output to be obtained from (or rate of input applied to) fixed or specialized resources.

2. The combination of resources to produce a given output of product.

3. The combination of enterprises
   a. At a given point in time.
   b. Overtime (timing of operations - seasonal price variations).

4. The optimum scale of operations.

5. The optimum level of resource conservation.

6. The method of obtaining control of the resources to be used in production and the consequent combination of resources.
B. The dynamic problems are:

1. Adjusting to change and uncertainty of the market and production processes and technical progress.

2. Growth of capital (business) overtime.

The tacit assumption of conventional farm management research has been that the entrepreneur was operating under the following conditions:

1. Perfect knowledge of:
   a. Prices of factors and products at any point in the future.
   b. Transformation coefficients of inputs into outputs (production functions).
   c. Marginal rates of substitution between inputs producing a given quantity of some product (product contours).
   d. Marginal rates of substitution between products obtainable from given resources (transformation function).

2. Unlimited capital (equity position such that it does not impinge on any decisions).

3. Indefinite control of resources (secure tenure conditions).

4. Goal of maximizing dollar farm income.

Obviously, these static assumptions remove the farm operator from the conditions of the real world. In reality, he usually finds himself faced with these conditions:

1. Risk and uncertainty - incomplete knowledge as to prices (factors and products), transformation coefficients, and rates of substitution between inputs and outputs.

2. Capital rationing:
   a. Attributable to a pure lack of funds (external).
   b. Hesitancy to invest in light of risk and/or uncertainty (internal).
Only the relevant theory under dynamic assumption will be developed.

Appropriate models which have been developed under static assumptions are developed. It can be assumed that the reader has knowledge of the well-known static models. It is to this end, that the following pages

name in farm management decision-making which have been omitted in the manual.

analytical models can be formulated that take account of the depart-

ant from these decisions that concern us at this stage. What

of the best solution? It is this process of decision making and actions
be applied to the factors and reasons and acts in accord with the judgment
the farmer has problems to which

eral in farm management.decisions. The farmer has problems to find a closer approach to the real variables con-

the problem in farm management research resource itself into

situation. Reading the farmer in the real world.

static analysis, does not provide an answer to many of the problems
degree of the expected knowledge, with differences to assume risks, etc.

foster in their reasoning to think and understand hypotheses upon the


parameter are major.

they may

the process-management model. As a matter of fact, one can see the
the real problems underlain in decision-making parameters, decisions may be
analyzed within the framework of static analysis, can send into light on

parameter in farm management. As a matter of fact, the farmer
making the decisions is forced to face the situation from an ex ante

farm's problem from an ex post position, when actually, the farmer in

therefore, most of our farm management studies have adhered to

2. Does other than management deliver farm income?
Risk and Uncertainty — Imperfect Knowledge

Nature of risk and uncertainty

Johnson and Haver\(^1\) state that:

The most normal things about farming operations are (1) the changes which continually occur and (2) the lack of knowledge concerning conditions affecting individual businesses. Prices, what individual farmers know about production processes, production techniques, weather, health, and government arrangements change rather continuously. Instability appears more normal than stability. Farmers strive continually to improve their knowledge of the conditions that affect their businesses. In fact, lack of knowledge is as normal as change; partial ignorance is universal.

It has only been recently that farm management research workers have entered this field which is concerned with production decisions under conditions of uncertainty. The most important phases of this uncertainty are associated with the passing of time and includes weather, insects and diseases, and cost and price variations. Also included are the more personal aspects such as length of life, health, and in more recent times institutional factors such as the chances of being subjected to certain economic controls.

Farmers\(^1\) attitudes and expectations link the various time periods as well as the entrepreneurial decisions and acts which motivated these decisions. It is these attitudes, decisions and acts which influence the position attained by the firm in later periods. Thus it would appear that a more highly developed theory of risk and uncertainty would be of a great deal more value to the process of decision making than would past empirical studies.

\(^1\)Johnson and Haver, op. cit., p. 1.
Johnson⁴ points out that:

The existence of uncertainty not only influences the process of decision making but also has its effect on the goals or objectives of the entrepreneur. If expectations are uncertain, it no longer seems realistic to assume, as in the classical theory of the firm, that the entrepreneur is solely interested in maximizing net income over some period of time. Uncertain expectations lead to the acceptance of a more complicated type of motivation in decision making. A firm is confronted not only with the necessity of considering the expected value of the income stream but also with the desirability or necessity of maintaining within limits the capital value of the firm as a going concern. If expectations are uncertain, there arises the possibility that events may force liquidation of the firm.

The goal of the firm thus becomes one of maximizing returns in terms of income and safety, the combination of these depending upon subjective preferences.

The problem is made even more difficult when we consider that, in dynamic economics, expectations cannot be assumed to remain constant if a dynamic economics is to exist at all. If all expectations were correct, the static equilibrium point would be reached as soon as the expectations (correct ones) are formed.

Since expectations change, they can never be one of the "other things" which is considered to remain unchanged as the analysis proceeds. This change in expectations needs to be considered in relation to their effects on plans and actions which the farmer makes.

Lachman² suggests that expectations are the result of economic experience and that economists should accept the responsibility of explain-

---


ing them and their effects. Until empirical studies show the nature of these expectations, it is necessary to assume hypothetical types of expectations and to work out their influence in theoretical terms.\(^1\)

Observable events have meaning only when interpreted in the light of an interpretation which is logical prior to them. The expectations formed by an individual are incidental to a mental picture of the situation in which action is to occur. Different individuals will create different mental pictures (and expectations) even when confronted by the same present events.\(^2\) Interpretation of experience rather than experience itself, becomes the important influence in expectations.\(^3\)

As mentioned previously, the link between successive time periods is clearly expectations which are part of the plan linking the same system but at different times. The plan is in turn part of the general conception of the future position which may prevail.

It becomes obvious that price expectations represent part of these expectations. Since only part of the human action is motivated by the economic aspects of expectations, economists need to incorporate the

---


effects of past (economic) experience and present prices in the analysis
of price expectations. The way in which expectations are made, what they
consist of when made and the way in which they influence action are three
phases of the problem which needs study.1

The following definitions are appropriate at this point.

Risk . . . . implies that anticipations are not single valued,
but that they may be conceived as a single probable
distribution of anticipated prices. The parameters
(mode, median, mean, variance, standard deviation,
etc.) of the probability distribution are known in
the case of risk. Technological risk implies a
known probability distribution of anticipated pro-
duction functions.

Uncertainty. . also implies that anticipations are not single
valued and that they may be considered groups of
alternative probability distributions of antici-
pated prices. The parameters of the probability
distributions are not single valued, however, in
the case of uncertainty.

Risk can be dealt with more easily than uncertainty, for enough is
known to express the chances (probability) of any particular event or
anticipations being realized. Since the probability distribution can be
determined objectively, the firm can insure against risk through com-
mercial firms or institutions provided by society and thereby can in-
corporate it (risk) as a known cost.2

---

of Farm Economics 21:577, August 1939.

2Johnson maintains that the distinction between risk and uncertainty
is of little significance. In these cases when insurance is not available
to the firm, and where there are insufficient cases being experienced at
the same time for the favorable or unfavorable outcomes to offset one
another, this conclusion would appear to be sound. Johnson, op. cit., p. 38.
The passage of time implies that uncertainty will always be present since future expectations cannot be formed precisely enough to enable the analysis (objective determination of probability distributions through the derivation of skewness, kurtosis, variance and other parameters from the relevant distributions, from historic observations) founded on risk situations to be applied to them.

Economic horizons and uncertainty

Lange defines the relationship between risk premium and economic horizon as follows:

As a rule the uncertainty of price expectations is the greater the more distant in the future the planned purchase or sale is (at least from a certain point on). Thus the risk premium which has to be deducted from any given most probable price, increases as the planning of purchases and sales extends farther into the future. Consequently, the effective expected prices of goods to be sold at various future dates decrease while the effective prices of goods to be bought at various future dates increase. This imposes a limit upon the dates for which any sales or purchase are planned at all.¹

The concept of an economic horizon does not imply that no provisions are made beyond it. It defines the period for which specific plans of acts of purchase and sales are at present entertained.

A new approach to problems of uncertainty has been developed by Shackle whose new monograph Expectations in Economics² presents a new model which may be used to interpret the decisions of entrepreneurs. He reduces the expectations regarding an investment to two single values, one of which (the focus gain) is the important favorable outcome, while the

other (the focus loss) is the unfavorable outcome which is all important in the entrepreneur’s mind. Decisions are made by comparing focus gains and focus losses of alternative ventures. These focus gain and focus loss values are functions of two influences which are combined to form what Shackle calls the stimulation function:

1. The actual level of the price expected.
2. The degree of surprise which the realization of this expectation would introduce.

Shackle writes:

The real incentive for embarking on some given venture, whose objective results will not develop and their character become known until some date in the future, is the immediate mental experience which the decision to embark on this venture will give us, namely, the enjoyment by anticipation of a high level of success.

He then defines his two postulates:

First that....hypotheses representing different levels to success will differ from each other in their power to afford the individual enjoyment by imagination to stimulate him agreeably; and that hypotheses representing different levels of misfortune or disaster will differ from each other in their power to cause him distress by imagination, to stimulate him disagreeably. Secondly, that the power of mutually exclusive hypotheses of success to afford enjoyment by imagination is not additive and that, therefore, the power of the entire set of hypotheses of success associated with any source of action to afford enjoyment by imagination is simply that no one alone amongst these hypotheses, whichever has this power in higher degree than any of the others; and similarly that the power of the entire set of hypotheses of misfortune associated with this course of action is simply that of the most powerful amongst these hypotheses.\(^1\)

\(^1\)Shackle, op. cit., pp. 15-16.

\(^2\)Ibid., p. 17.
Shackle has rendered a service in drawing attention to the shakiness of an unqualified acceptance of the probability approach in dynamic economics. Nevertheless, as Carter\(^1\) suggests, there is much in common between Shackle’s presentation and probability analysis, as the latter should be used in this particular application.

Types of uncertainty facing the farmer

A farmer viewing his decisions for the production period ahead has under his control a given quantity of resources in terms of land, machinery, equipment, livestock, labor and cash or near-cash balances and some knowledge of his borrowing capacity. At that moment he is confronted with two major types of judgments: (1) what will be the prices of products and factors in alternative lines of investment and output when decisions made now materialize into marketable products, and (2) what will be the physical productivity of the factor inputs employed? If both of these judgments could be made with certainty, then the really important entrepreneurial function would disappear.

The entrepreneur in deciding what products or combination of products to produce, the proper intensity of production, and the most efficient method of production must estimate the probable output that will be forthcoming from a particular factor combination, level of factor input, and the course of factor and product prices throughout the production and marketing period. The first involves estimates that are both technical and technological in nature. Assuming no change in technology throughout

the production period, the problem is one of estimating technical production relationships involving "technical uncertainty." However, since one may expect probable development of new techniques or new methods in production which most likely will result in producing a more or less permanent change in the rates of physical transformation, the question of "technological uncertainty" must also be dealt with.

In agriculture, the entrepreneur cannot determine in advance just what the prices of factors and products will be at some distant point in the production period. Production in agriculture takes time, sometimes an extended period of time, during which time changes may occur. This produces the difficult problem of anticipating the effect that these changes will have on product and factor prices. The firm must, on some basis, perhaps only a hunch or guess in many cases, arrive at some comparative relationship between prices of products and factors. This situation describes what will be referred to throughout as "price uncertainty." It is a short term for describing a situation in which decisions must be based upon incomplete knowledge of future prices.

The farmer then is faced with three types of uncertainty, namely: (1) price uncertainty, (2) technical uncertainty, and (3) technological uncertainty. The following section will be devoted to the formulation of some economic models describing farmers' decisions under each of these three types of uncertainty.

In the development of these models, some criterion for measuring the effect of uncertainty on resource allocation must be determined. Johnson introduces the following criterion which is quite acceptable for this
discussion: "Is the allocation of resources the same one which would have resulted if the farmer had correctly anticipated the prices and yields and known in advance that his expectations were correct?"\(^1\)

**Price uncertainty**

Major emphasis will logically be placed upon price expectations since yield expectations change only moderately with time while price expectations fluctuate more or less from year to year. The extent of resource misallocation will depend upon the errors in price expectations and the elasticity of the respective supply functions. If the supply function is quite elastic (supply curve \(S_2\) in Figure 1) then even slight errors in price expectations\(^2\) (error of \(OP_1\) to \(OP_2\) in price estimate) will result in considerable misallocation of resources with regard to shifts in outputs (range of \(OB_1\) to \(OB_2\)). If, on the other hand, the elasticity of supply is low (denoted by supply curve \(S_1\), in Figure 1) then misallocations due to even considerable errors in price expectations will be small since shifts in output are slight under these conditions (range of \(OA_1\) to \(OA_2\)).

Let us assume the case illustrated graphically in Figure 2 where the farmer had developed in his mind a probability distribution of expected prices. Only three of these levels of expected prices are shown on the

---

\(^1\)Johnson, op. cit., p. 44.

\(^2\)The term "price expectations" will be used throughout as reference to both product and factor prices. Product prices, however, play a greater role than factor prices except perhaps in hog or broiler production where factor prices (feed) are highly important in decision making.
Figure 1. Effect of elasticity of supply on resource misallocation for given error in price expectations.

Figure 2. Possible marginal revenue and marginal cost curves, each with a different probability of occurrence.
graph with the probability of expectation for each level noted.  

(Assumption is made that the nature of production function is known with certainty.)

The entrepreneur most likely will operate at output OA under these anticipated prices. However, if he is limited somewhat on capital or places considerable emphasis on safety, he may decide to operate somewhere (between OD and OA. Only the ultra-conservative entrepreneur because of extreme limitations on capital or aversion to risk) would operate at output OD. On the other hand an individual, who is quite optimistic about that one chance in five of an extremely favorable relationship between product and factor prices, may attempt output at the OC level.

The degree to which the optimum level of output is attained will depend upon the accuracy of the farmer's estimates of expected prices of both factors and product. If for instance, the farmer assumed prices of factors to be low denoted by MC₃ with anticipated high product prices, denoted by MR₁, he would then operate at OC intensity of output. If the realized product price was quite low, say at the MR₃ level, (assume expected factor prices to be realized) a loss equivalent to the cross-hatched area would be suffered, representing a misallocation of resources attributable to an inaccurate estimate of product prices caused largely by existing uncertainty of future conditions on the part of the producer.²

¹The notation 0.5, for example, indicates that the entrepreneur feels that the chances are five out of a possible ten that this level of prices will occur.

²Misjudgments on expected product prices are the most common since factor prices are usually announced (formally or informally) by holders of these factors (warehousesmen, machinery dealers, fertilizer salesmen, etc.) in advance of the production period.
Another important decision facing a farmer is the optimum combination of factors to produce a given quantity of a particular product. Assuming that the iso-product (product contour) function is known with certainty, the optimum combination of factors is thus dependent upon the relative prices of the factors.

Figure 3 illustrates the various combinations of factors "X" and "Y" that would produce quantity "Z" of product "A" under three different anticipated factor price ratios each with its assigned probability of occurrence. The least cost combination of factor "X" and "Y" will be considerably different under each of these assumed price relationships. Suppose that the entrepreneur anticipated factor prices to be such (illustrated by price line P₂L₂) that the least cost combination would be that denoted by position "L", his production process will be set up to utilise Q₁ quantity of factor "Y" and Q₂ quantity of factor "X." Let us assume that conditions change such that the price of factor "X" increases while the price of factor "Y" decreases to the point where the new factor price ratio is of the nature illustrated by price line P₁L₁. Since the factor combination had already been determined at the beginning of the production plan, according to P₂L₂ the cost outlay would be greater under the anticipated factor prices than under the realized prices. This is true because a price line P₃L₃ intersecting point L parallel to P₁L₁ would represent a greater total cost outlay than would the factor combination at point J, the optimum combination under the realized prices.

This miscalculation by the entrepreneur on factor prices means that resources are not allocated in such a way as to equate the marginal rates
Figure 3. Effect of errors in anticipated factor prices on resource use

Figure 4. Possible combinations of products under various anticipated product price ratios, each with a different probability of occurrence
of substitution for the two factors with their price ratio. To accomplish this goal, more of factor "X" and less of "Y" should have been used in producing product "A", than was employed under the production plan as put into force under the anticipated prices, thus a higher cost combination resulted than would have resulted under certainty conditions.

A firm producing more than one product faces an even more complex problem. Not only must the entrepreneur anticipate certain factor prices but he must develop at the same time certain anticipations as to relative product prices in the future as a basis for deciding how to allocate given resources under his control among alternative products.

To simplify the analysis, let us assume that the nature of the iso-resource (transformation) function is known with certainty. The only question unanswered for the farmer, is what combination of products will prove most profitable under anticipated prices for the next production period?\(^1\) As illustrated in Figure 1, the optimum combination of products will depend upon which of the alternative, anticipated product price ratios will be chosen as a basis for decision. Each price ratio will usually have a different probability of occurrence in the mind of the farmer. Suppose he responds as if the most probable ratio will exist

---

\(^1\)The production period under consideration will, of course, differ for different products. If the problem is one of deciding what combination of livestock (hogs, feeder cattle, poultry) would make the most profitable use of a given quantity of feed and labor available, the production period may be considered to be perhaps a year in length. However, if the question is one of what combination of grain and forage is most profitable in the rotation for at least one complete cycle of the rotation, then the production period is longer and thus involves estimating future prices of forage and grain with a lower degree of certainty.
Income, this aspect of price underestimateness deserves some attention.

Income, this aspect of price underestimation deserves some attention.

Income, this aspect of price underestimation deserves some attention.

Income, this aspect of price underestimation deserves some attention.

Income, this aspect of price underestimation deserves some attention.

Income, this aspect of price underestimation deserves some attention.

Income, this aspect of price underestimation deserves some attention.

Income, this aspect of price underestimation deserves some attention.

Income, this aspect of price underestimation deserves some attention.

Income, this aspect of price underestimation deserves some attention.

Income, this aspect of price underestimation deserves some attention.

Income, this aspect of price underestimation deserves some attention.

Income, this aspect of price underestimation deserves some attention.

Income, this aspect of price underestimation deserves some attention.

Income, this aspect of price underestimation deserves some attention.

Income, this aspect of price underestimation deserves some attention.

Income, this aspect of price underestimation deserves some attention.

Income, this aspect of price underestimation deserves some attention.

Income, this aspect of price underestimation deserves some attention.

Income, this aspect of price underestimation deserves some attention.

Income, this aspect of price underestimation deserves some attention.

Income, this aspect of price underestimation deserves some attention.

Income, this aspect of price underestimation deserves some attention.

Income, this aspect of price underestimation deserves some attention.

Income, this aspect of price underestimation deserves some attention.

Income, this aspect of price underestimation deserves some attention.

Income, this aspect of price underestimation deserves some attention.

Income, this aspect of price underestimation deserves some attention.

Income, this aspect of price underestimation deserves some attention.

Income, this aspect of price underestimation deserves some attention.

Income, this aspect of price underestimation deserves some attention.

Income, this aspect of price underestimation deserves some attention.

Income, this aspect of price underestimation deserves some attention.

Income, this aspect of price underestimation deserves some attention.

Income, this aspect of price underestimation deserves some attention.

Income, this aspect of price underestimation deserves some attention.

Income, this aspect of price underestimation deserves some attention.

Income, this aspect of price underestimation deserves some attention.

Income, this aspect of price underestimation deserves some attention.

Income, this aspect of price underestimation deserves some attention.

Income, this aspect of price underestimation deserves some attention.

Income, this aspect of price underestimation deserves some attention.

Income, this aspect of price underestimation deserves some attention.

Income, this aspect of price underestimation deserves some attention.

Income, this aspect of price underestimation deserves some attention.

Income, this aspect of price underestimation deserves some attention.

Income, this aspect of price underestimation deserves some attention.

Income, this aspect of price underestimation deserves some attention.

Income, this aspect of price underestimation deserves some attention.

Income, this aspect of price underestimation deserves some attention.

Income, this aspect of price underestimation deserves some attention.

Income, this aspect of price underestimation deserves some attention.

Income, this aspect of price underestimation deserves some attention.

Income, this aspect of price underestimation deserves some attention.

Income, this aspect of price underestimation deserves some attention.

Income, this aspect of price underestimation deserves some attention.

Income, this aspect of price underestimation deserves some attention.

Income, this aspect of price underestimation deserves some attention.

Income, this aspect of price underestimation deserves some attention.

Income, this aspect of price underestimation deserves some attention.

Income, this aspect of price underestimation deserves some attention.

Income, this aspect of price underestimation deserves some attention.

Income, this aspect of price underestimation deserves some attention.

Income, this aspect of price underestimation deserves some attention.

Income, this aspect of price underestimation deserves some attention.

Income, this aspect of price underestimation deserves some attention.

Income, this aspect of price underestimation deserves some attention.

Income, this aspect of price underestimation deserves some attention.

Income, this aspect of price underestimation deserves some attention.

Income, this aspect of price underestimation deserves some attention.

Income, this aspect of price underestimation deserves some attention.

Income, this aspect of price underestimation deserves some attention.

Income, this aspect of price underestimation deserves some attention.

Income, this aspect of price underestimation deserves some attention.

Income, this aspect of price underestimation deserves some attention.

Income, this aspect of price underestimation deserves some attention.

Income, this aspect of price underestimation deserves some attention.

Income, this aspect of price underestimation deserves some attention.
The probability of the occurrence of an event is determined by the number of possible outcomes and the number of which actually occur. The probability of an event is the ratio of the number of favorable outcomes to the total number of possible outcomes. However, the probability of an event can also be determined by the number of times the event occurs in a series of trials. The probability of an event is the ratio of the number of times the event occurs to the total number of trials.

If an event occurs in a series of trials, the probability of the event is the ratio of the number of times the event occurs to the total number of trials. The probability of an event is the ratio of the number of times the event occurs to the total number of trials. However, the probability of an event can also be determined by the number of times the event occurs in a series of trials. The probability of an event is the ratio of the number of times the event occurs to the total number of trials.

The probability of an event is the ratio of the number of times the event occurs to the total number of trials. However, the probability of an event can also be determined by the number of times the event occurs in a series of trials. The probability of an event is the ratio of the number of times the event occurs to the total number of trials.

If an event occurs in a series of trials, the probability of the event is the ratio of the number of times the event occurs to the total number of trials. However, the probability of an event can also be determined by the number of times the event occurs in a series of trials. The probability of an event is the ratio of the number of times the event occurs to the total number of trials.

The probability of an event is the ratio of the number of times the event occurs to the total number of trials. However, the probability of an event can also be determined by the number of times the event occurs in a series of trials. The probability of an event is the ratio of the number of times the event occurs to the total number of trials.

If an event occurs in a series of trials, the probability of the event is the ratio of the number of times the event occurs to the total number of trials. However, the probability of an event can also be determined by the number of times the event occurs in a series of trials. The probability of an event is the ratio of the number of times the event occurs to the total number of trials.

The probability of an event is the ratio of the number of times the event occurs to the total number of trials. However, the probability of an event can also be determined by the number of times the event occurs in a series of trials. The probability of an event is the ratio of the number of times the event occurs to the total number of trials.

If an event occurs in a series of trials, the probability of the event is the ratio of the number of times the event occurs to the total number of trials. However, the probability of an event can also be determined by the number of times the event occurs in a series of trials. The probability of an event is the ratio of the number of times the event occurs to the total number of trials.

The probability of an event is the ratio of the number of times the event occurs to the total number of trials. However, the probability of an event can also be determined by the number of times the event occurs in a series of trials. The probability of an event is the ratio of the number of times the event occurs to the total number of trials.

If an event occurs in a series of trials, the probability of the event is the ratio of the number of times the event occurs to the total number of trials. However, the probability of an event can also be determined by the number of times the event occurs in a series of trials. The probability of an event is the ratio of the number of times the event occurs to the total number of trials.

The probability of an event is the ratio of the number of times the event occurs to the total number of trials. However, the probability of an event can also be determined by the number of times the event occurs in a series of trials. The probability of an event is the ratio of the number of times the event occurs to the total number of trials.

If an event occurs in a series of trials, the probability of the event is the ratio of the number of times the event occurs to the total number of trials. However, the probability of an event can also be determined by the number of times the event occurs in a series of trials. The probability of an event is the ratio of the number of times the event occurs to the total number of trials.

The probability of an event is the ratio of the number of times the event occurs to the total number of trials. However, the probability of an event can also be determined by the number of times the event occurs in a series of trials. The probability of an event is the ratio of the number of times the event occurs to the total number of trials.

If an event occurs in a series of trials, the probability of the event is the ratio of the number of times the event occurs to the total number of trials. However, the probability of an event can also be determined by the number of times the event occurs in a series of trials. The probability of an event is the ratio of the number of times the event occurs to the total number of trials.

The probability of an event is the ratio of the number of times the event occurs to the total number of trials. However, the probability of an event can also be determined by the number of times the event occurs in a series of trials. The probability of an event is the ratio of the number of times the event occurs to the total number of trials.

If an event occurs in a series of trials, the probability of the event is the ratio of the number of times the event occurs to the total number of trials. However, the probability of an event can also be determined by the number of times the event occurs in a series of trials. The probability of an event is the ratio of the number of times the event occurs to the total number of trials.

The probability of an event is the ratio of the number of times the event occurs to the total number of trials. However, the probability of an event can also be determined by the number of times the event occurs in a series of trials. The probability of an event is the ratio of the number of times the event occurs to the total number of trials.

If an event occurs in a series of trials, the probability of the event is the ratio of the number of times the event occurs to the total number of trials. However, the probability of an event can also be determined by the number of times the event occurs in a series of trials. The probability of an event is the ratio of the number of times the event occurs to the total number of trials.

The probability of an event is the ratio of the number of times the event occurs to the total number of trials. However, the probability of an event can also be determined by the number of times the event occurs in a series of trials. The probability of an event is the ratio of the number of times the event occurs to the total number of trials.

If an event occurs in a series of trials, the probability of the event is the ratio of the number of times the event occurs to the total number of trials. However, the probability of an event can also be determined by the number of times the event occurs in a series of trials. The probability of an event is the ratio of the number of times the event occurs to the total number of trials.

The probability of an event is the ratio of the number of times the event occurs to the total number of trials. However, the probability of an event can also be determined by the number of times the event occurs in a series of trials. The probability of an event is the ratio of the number of times the event occurs to the total number of trials.

If an event occurs in a series of trials, the probability of the event is the ratio of the number of times the event occurs to the total number of trials. However, the probability of an event can also be determined by the number of times the event occurs in a series of trials. The probability of an event is the ratio of the number of times the event occurs to the total number of trials.

The probability of an event is the ratio of the number of times the event occurs to the total number of trials. However, the probability of an event can also be determined by the number of times the event occurs in a series of trials. The probability of an event is the ratio of the number of times the event occurs to the total number of trials.

If an event occurs in a series of trials, the probability of the event is the ratio of the number of times the event occurs to the total number of trials. However, the probability of an event can also be determined by the number of times the event occurs in a series of trials. The probability of an event is the ratio of the number of times the event occurs to the total number of trials.

The probability of an event is the ratio of the number of times the event occurs to the total number of trials. However, the probability of an event can also be determined by the number of times the event occurs in a series of trials. The probability of an event is the ratio of the number of times the event occurs to the total number of trials.

If an event occurs in a series of trials, the probability of the event is the ratio of the number of times the event occurs to the total number of trials. However, the probability of an event can also be determined by the number of times the event occurs in a series of trials. The probability of an event is the ratio of the number of times the event occurs to the total number of trials.

The probability of an event is the ratio of the number of times the event occurs to the total number of trials. However, the probability of an event can also be determined by the number of times the event occurs in a series of trials. The probability of an event is the ratio of the number of times the event occurs to the total number of trials.

If an event occurs in a series of trials, the probability of the event is the ratio of the number of times the event occurs to the total number of trials. However, the probability of an event can also be determined by the number of times the event occurs in a series of trials. The probability of an event is the ratio of the number of times the event occurs to the total number of trials.

The probability of an event is the ratio of the number of times the event occurs to the total number of trials. However, the probability of an event can also be determined by the number of times the event occurs in a series of trials. The probability of an event is the ratio of the number of times the event occurs to the total number of trials.

If an event occurs in a series of trials, the probability of the event is the ratio of the number of times the event occurs to the total number of trials. However, the probability of an event can also be determined by the number of times the event occurs in a series of trials. The probability of an event is the ratio of the number of times the event occurs to the total number of trials.

The probability of an event is the ratio of the number of times the event occurs to the total number of trials. However, the probability of an event can also be determined by the number of times the event occurs in a series of trials. The probability of an event is the ratio of the number of times the event occurs to the total number of trials.

If an event occurs in a series of trials, the probability of the event is the ratio of the number of times the event occurs to the total number of trials. However, the probability of an event can also be determined by the number of times the event occurs in a series of trials. The probability of an event is the ratio of the number of times the event occurs to the total number of trials.

The probability of an event is the ratio of the number of times the event occurs to the total number of trials. However, the probability of an event can also be determined by the number of times the event occurs in a series of trials. The probability of an event is the ratio of the number of times the event occurs to the total number of trials.

If an event occurs in a series of trials, the probability of the event is the ratio of the number of times the event occurs to the total number of trials. However, the probability of an event can also be determined by the number of times the event occurs in a series of trials. The probability of an event is the ratio of the number of times the event occurs to the total number of trials.

The probability of an event is the ratio of the number of times the event occurs to the total number of trials. However, the probability of an event can also be determined by the number of times the event occurs in a series of trials. The probability of an event is the ratio of the number of times the event occurs to the total number of trials.

If an event occurs in a series of trials, the probability of the event is the ratio of the number of times the event occurs to the total number of trials. However, the probability of an event can also be determined by the number of times the event occurs in a series of trials. The probability of an event is the ratio of the number of times the event occurs to the total number of trials.
Figure 5. Extremes in variance of probability distribution of expected prices for products or factors

Figure 6. Positively and negatively skewed distributions of price expectations
distribution of product prices is positively skewed (skewed to the right) then the farmer interprets this as meaning that the outlook is good for that product (beef) as shown in the left diagram of Figure 6. On the other hand, if the distribution is negatively skewed (skewed to the left) the outlook is interpreted as being less favorable for that product (pork) since the likelihood of a price below the modal price is greater than if the skewness were to the right. However, if OK is the price necessary to break even in the respective enterprises, then beef is more risky than pork since the probability of a loss is much greater for beef than for pork even though the distribution function might indicate beef to be less risky if we ignore the minimum price necessary to make a profit.\footnote{Analysis taken from course in Production Economics, taken at Iowa State College under Dr. E. O. Heady, in 1948.} The cross-hatched area in Figure 6 represents a loss zone.

Johnson has outlined the following models or procedures that farmers may use in formulating price expectations:\footnote{Johnson, op cit., p. 74.}

1. Project the current price into the future. Most supply responses are based on this assumption (Gobweb Theorem).

2. Project the trend of prices over some past period. If prices have been falling, there is reason to believe that they will continue to fall at approximately the same rate.

3. Assume prices will be normal in a sense that prices in the future will approximate the average of some past period.

4. Believe that future prices will be more nearly "normal" than present prices but that there will be still a fairly high correlation with present prices. In other words, if present prices are above normal, it is anticipated that prices will fall but will remain above the long-run normal.
5. May select some time period in the past as a basis for formulating expectations and disregard the time period before or afterward. This method is particularly important when some unusual event such as a war or severe drought occurs.

6. May base forecast on basis of statistical techniques (or accept forecasts of someone who uses such techniques). This technique assumes that certain variables in the economy will affect future prices. Used by large corporations having a marketing or economic research organization. In agriculture the technique is used by very few farmers.

**Technical uncertainty.** A second type of uncertainty facing the firm is technical uncertainty. This describes a case in which decisions are made under conditions where the output from a given factor (or combination of factors) cannot be predicted with certainty. This type of uncertainty gives rise to the problem of which innumerable production functions will exist for the coming production period (Figure 7). Since the exact nature of the production function in crop production is dependent upon the elements of weather, diseases, insects, etc., it is impossible to predict with any degree of accuracy the anticipated output from given inputs (seed, fertilizer, lime, cultivations, and other management practices). Likewise, in livestock production, the exact nature of input-output relationships are uncertain since they are dependent upon the quality of the feeding ration, feeding schedules, sanitary conditions, diseases, and other management practices.

For given prices of factors and products, the optimum level of output for each specialized resource (cow, hen, steer, acre of land, etc.) will depend upon the slope of the production function involved since this is reflected in the position and slope of the marginal cost curve. If
Figure 7. Possible production functions, each with a different probability of occurrence.

Figure 8. Effect of technical uncertainty on resource efficiency.
one anticipated an input-output relationship as illustrated by curve A in Figure 7, then application of the variable factor should be carried out to the \( OX_1 \) level (Figure 8). If the realized production relationship is more of the curve "C" type (lower production function) then the most profitable (optimum) level of output would have been at the \( OX_2 \) level. The output \( OX_1-OM_2 \) was produced at a loss to the operator because he was too optimistic concerning the anticipated output forthcoming from a given level of factor inputs, and thus employed the variable factor beyond the most profitable level.\(^1\) Had the operator been pessimistic and anticipated production response similar to curve "C" (Figure 7), when realized output response was that of curve "A", then he would have applied factor inputs short of the optimum level, to \( OX_2 \) rather than \( OX_1 \) level (Figure 8) thus foregoing a potential profit. This also represents a loss to society from the viewpoint of inefficient use of resources.

On most farms, the cropping program is one in which some combination of grain and forage is produced as feed for the livestock enterprises. The size of the livestock enterprise, particularly the roughage-consuming livestock, is usually dependent upon the anticipated feed production. Therefore, the operator has to make some sort of an estimate concerning the relative quantities of the various feeds forthcoming from given resource inputs. Weather alone may produce considerable variation in the

\(^1\)Too often milk producers who are striving for high records, or who overestimate the inherent producing ability of their herd, feed beyond the most profitable level. In some cases the premium price received for surplus stock based on the dam's records, may more than offset the loss suffered by the "too heavy" feeding.
output of both grain and forage as illustrated by the several possible iso-resource (transformation) functions in Figure 9. Curve "J" may represent a "poorer than average" weather year when either $OX_1$ of grain or $OX_1$ of forage or any combination as shown by the curve is possible. Curves "K" and "L" may represent progressively better weather years.

However, the case is over simplified here since the iso-resource curves are parallel to each other demonstrating that grain and forage output varies in the same proportion. This is not usually the case (Figure 10). The left diagram shows a case where grain yields are more variable than are forage yields, whereas the right diagram illustrates the opposite situation.

Under given grain-forage price relationships as shown by the price line PL, if one anticipates weather to be quite favorable to grain yields (curve "O", left diagram) then the cropping program should be set up to produce $OX_2$ quantity of grain and $OX_1$ quantity of forage. If, however, weather conditions are such as to reduce grain yields (curve "M", left diagram) then the most profitable combination of grain and forage would be considerably different ($OX_1$ of grain and $OX_2$ of forage).

In a case where weather usually produces greater variations in yields of grain, the safest assumption by the farmer would be that production relationships similar to that of curve "N" would exist and livestock numbers could be maintained accordingly. In "good grain" years, quantity $OX_2$-$OX_3$ could be stored for years when weather was less favorable to grain to make up the grain requirement deficit, $OX_3$-$OX_1$.

The analysis is very similar for the case where forage yields are much more responsive to weather than grain yields. If weather is expected
Figure 9. Possible iso-resource (opportunity) functions facing the entrepreneur in determining the optimum combination of products.

Figure 10. Influence of weather uncertainty in determining optimum combination of products.
to favor forage, then rotation would be such as to produce $OX_1$ of grain (right diagram of Figure 10) and $OX_2$ of forage. If weather turns out to be less favorable, let us say producing product relationships as illustrated by curve "P", then the planned rotation falls short of producing the optimum quantity of grain ($OX_2$) and instead is producing too much forage by the amount of $OX_2-OX_1$. Thus due to imperfect expectations resulting from technical uncertainty, too many resources were allocated to forage and too little to grain production, representing a loss both to the farmer and to society. As in the case illustrated with regard to grain variations, the producer would do well to assume production relationships represented by the middle transformation function $Q$, and store surplus forage for deficit forage years.

The farmer must decide in what proportion grain and forage should be combined so as to reduce the variability resulting from weather to a minimum so that income "over time" can be kept at a maximum. The problem is partly solved when he adopts management practices (tiling, terracing, drought-resistant varieties, etc.) which tend to reduce the yield variability despite weather fluctuations. Adoption of these practices may produce a certain amount of technical uncertainty in themselves, in so far that they will change the original position of the iso-resource curve. The uncertainty arises when one tries to ascertain the position of the new function. Will it approximate $IR_2$ or be more like $IR_3$ (Figure 11)? The optimum rotation under given price relationships will depend upon one's ability to forecast the relative effects of these management practices upon the shape of the transformation function.
Figure 11. Possible iso resource functions resulting from the application of various management practices.
In attempting to formulate weather expectations for the coming production period, one or a combination of the following schemes or models might be used:

1. Assume same weather and conditions to exist this year as existed last year.

2. Use mean yields or average of conditions for last 25 years.

3. Use modal yields or modal conditions for last 25 years. Extend (2) and (3) into the future.

4. Use advance weather prediction based on cyclical weather conditions over some past period:

   Mean \pm some correction in rainfall
   Mode \pm some correction in rainfall

Bear in mind that the best model will depend upon the region (Corn Belt vs. Great Plains).

Technological uncertainty. Thus far in the analysis we have assumed a "status quo"—no change in technology. Yet technological developments produce one of the most potent forms of uncertainty facing the farmer today. This type of uncertainty arises when newly adopted methods and techniques produce a more or less permanent change in the marginal physical rates of transformation because of the influence that the innovation has on the relative productivity of factors.

An innovation is defined as any change in production which will produce a shift in the nature of the production function. An innovation must increase the effective profit (discounted future profit) either by decreasing the cost per unit of output or by decreasing the degree of technical uncertainty and risk. For these reasons, farmers stand ready to adopt most technological developments, capital and knowledge permitting.
The uncertainty arises in attempting to estimate the effect the
innovation will have on previously established production relationships.
A technological change may give rise to a new and different iso-product
contour if the innovation is of the factor-saving type (Figure 12).
$P_1C_1$ represents the product contour before the adoption of the innovation
(a labor-saving technique) while $P_2C_2$ represents the situation after the
adoption. It becomes quite obvious that the innovation has changed con-
siderably the marginal rates of substitution of labor for capital. Under
the new technique, less of both factors are required to produce the same
quantity of the product, but a much greater reduction in labor than in
capital resulted.

A technological change of the output-increasing type may give rise
to a new and different iso-resource curve. Figure 13 shows the effect
that the adoption of hybrid corn has on the transformation function for
grain and forage. The effect has been to shift the slope of the function
in favor of grain due to the increase in yields from the hybrid seed corn.
The optimum combination after the adoption of hybrid corn is $OX_1$ of
forage, a slight decrease, and $OX_3$ of a grain, a considerable increase.
However, the aggregative effect of an almost universal adoption of hybrid
corn would be to increase the supply of corn to the point whereby, assuming
no change in demand for corn, the price would decline. Under the lower
corn price, the optimum combination may swing in favor of an increased
output of forage as indicated by the tangency of the new price line $P_2L_2$
Figure 12. Effect of labor saving innovation on optimum combination of labor and capital

Figure 13. Effect of adoption of hybrid corn on optimum combination of grain and forage in rotation before and after universal adaption
with the new transformation curve after the adoption of hybrid corn.¹

These are the various types of uncertainty under which the decision-making process must function. They represent the realistic, dynamic conditions under which management decisions must be made. The succeeding analysis deals with measures which farmers may take as means of offsetting or cushioning the effects of risk and uncertainty.

Adjusting to risk and uncertainty

In light of uncertainty of expectations, the farmer is not only interested in the mean or modal value of future income, but is also concerned about the time distribution of that income. In other words, a favorable mean expected future income, say for a 10 or 15 year period, is not the only consideration in making certain investments. A series of unfavorable incomes for the first few years could bring the entire decision process to a halt by forcing a disinvestment of the original investment to zero. Or, if borrowed funds had been utilized, repayment of this loan may bring about bankruptcy or foreclosure. If the firm is no longer able to continue, then the value of expected future incomes are zero. Therefore, it becomes important for the entrepreneur to take certain precautionary measures to reduce the possibility that the nature of the expected income flow will be such as to force liquidation of all or part of the capital assets of the firm.

¹The effect being to allocate fewer acres to corn and more to forage. This change has been more noticeable in the East because of the shift in comparative advantage in favor of the Midwest resulting from greater responses to hybrid corn in that area.
Johnson\(^1\) classifies these precautionary measures as to two types: (1) measures which will reduce the dispersion or range of possible results and (2) measures which will increase the firm's ability to withstand unfavorable contingencies. It should be pointed out that measures which will contribute to one may also contribute to the other.

Of the measures taken to reduce the dispersion of possible results, diversification, insurance, and contractual arrangements are perhaps the most important. Flexibility and liquidity are measures that may be taken to increase the firm's ability to withstand losses. Three of these measures will be discussed in the following pages.

**Diversification.** As contrasted with flexibility, diversification is a decision to allocate resources now in such a manner as to reduce the dispersion of a series of future incomes; i.e., the production of several different products by a firm so that their uncertainties will be offsetting, thus reducing uncertainty. Diversification is the most common advice given to farmers because seldom will the price of all products drop at once, therefore, the one selling at a higher price will offset the other commanding a lower price. Here, then, is the basis for the ancient adage that you should "never put all your eggs in one basket" or another which states "there is safety in numbers." However, if the degree of uncertainty (variance) of the prices involved is the same, the firm will have a better expectation of net receipts if it chooses that commodity which does not involve heavy capital commitments until near the date of sale.

\(^1\)Johnson, op. cit., p. 40.
Diversification can be viewed from two dimensions: (1) the production of several products at a given point in time, and (2) the production of a specific product at different points in time (timing of production). An example of the latter would be the twice-each year farrowing system in pork production so that the hogs are marketed at two different periods during the year, thus lessening the effect of low prices at one of the marketing dates. Three or four "batches" of broilers each year is another example.

The basis for product diversification as pointed out by Johnson\(^1\) lies in the fact that the "variations in aggregate value of several products will be less than the average variation for each product taken separately." This reduction in variation, he points out, is due to the effect of diversification on variations in price and yield. He classifies the reasons for diversification as follows:

1. Diversification will lead to the selection of commodities which have lower variation in yields or prices when taken as a group than the average variation of the commodities making up the group when each is considered separately.

2. Diversification will permit the attainment of a more even seasonal distribution of receipts.

3. The possibility of producing some crops or livestock product with a very high degree of price and income stability (e.g., wholesale fluid milk). Producing a product of this nature increases the ability of the farm to withstand unfavorable contingencies affecting the remainder of the production.

4. The effect of production complementarity of many farm enterprises upon costs of production.

----

\(^1\)Johnson, op. cit., p. 48.
The ideal compensation in the production process moderate (25-30 per cent) and the reduction in income variance to gather some very much together and the reduction in income variance to gather even or equally as seen by the compensation some the process

Dwight after positive correlation in the process of the companies

which develop greater income stability for the firm. If there exists a product that develops greater income stability for the firm, the producer may introduce a product that develops greater income stability when the processor is less than the variance of any one significant except when the process for two reasons: First, the variance of the mean of two or more processors can be a variance in an effective value of several processors. This is the time

Another time it was stated that differential product leads to a reduction in the

long-run price tactics

of the product under consideration has not decreased too far from the
distance have already done, i.e., where the merged rates of substitution

have already been done to take place on the basis of the merged rates. The

performed by farm management practitioners is aimed at this objective.

a great deal of the workload. A great deal of the workload of the farm management practitioners is aimed at the productive

expectations. It would depend partly upon the practical procedure expected

The fourth reason would expect differences of the nature of practice

the year.

there would be no incentive to reduce the differential of research

where would be no incentive to reduce the differential of research

prices show a negative or very low positive correlation (prices either move in opposite directions or the price of one product lags behind the other considerably in its movement). In such a case, the reduction in variation may be as high as 50-75 per cent. However, a study of price movements over time for various products tend to show a rather high positive correlation.\(^1\)

The same set of considerations will apply to yield variances as to price variances. It is to be expected that there are greater opportunities for reducing output in some areas than in others. For example, for drier areas, such as the "wheat belt," where moisture is the major limiting factor yields of alternative crops are likely to be very closely related. On the other hand, in an area such as the corn belt where there are a number of limiting factors (rainfall, temperature, soil differences, insects, pests, etc.) crop yields would not likely be highly correlated. In this case, diversification offers greater opportunities for reduction in yield variations.

It is interesting to note the interrelationship between the effect of diversification on output and price variances. If the output on any one farm does not affect the price received (usually the case under perfect competition in agriculture), the farmer who reduced both price and yield variation by a fifth will have reduced income variation by one-third.\(^2\)

---

1Johnson, op. cit., p. 52.
2Ibid., p. 53.
A discussion of this nature would not be complete without listing
the limitations of diversification. It was noted above that diversification
will reduce income variance but is not too effective on reducing the range
of incomes. This is true because prices tends to move up and down together
since demand exerts a greater force on prices of agricultural products
than does supply. Diversification could do little to reduce the range of
income fluctuations during the 1929-1932 period. Likewise, diversification
could do little to reduce yield variation during the favorable production
period of 1942 or the unfavorable years 1934 and 1936. Thus diversifi-
cation is effective in reducing income variability when demand and weather
conditions do not deviate too far from some given norm. It is not
effective during abnormal price and production periods.

In view of these limitations, then one must resort to the fourth
reason given for diversification (the complementarity in production afforded
by diversification). One may now conclude that diversification is not
motivated solely by the desire to reduce profit or income dispersion but
is also utilised to minimize costs because of the complementarity existing
between various enterprises in the use of the important cost items (labor,
machinery, buildings, etc.). For this reason, diversification may be
carried too far for "safety" sake. From the standpoint of society, it
may mean that output could be increased by shifting some resources to the
production of some other product, but this becomes the cost of diversifi-
cation in response to uncertainty.

Thus far, the analysis has neglected the role of technological
uncertainty in producing diversification. The analysis has been couched
in terms of how diversification might reduce price and yield variances within a given state of technology. However, the effects of technological uncertainty on diversification are very similar to that above. Diversification is no more effective in reducing technological uncertainty during abnormal price and production periods than for reducing price and yield uncertainty during these abnormal periods.

**Flexibility.** We are fairly certain that farmers work out in their minds a fairly definite production plan (or plans). Length of such plans will depend upon the technical conditions at the time and the period of time which is expected to elapse before conditions change such that a new production plan must be formulated, or the present plan altered. The question posed here is: how much leeway does a farmer have in altering the time span of his plans? This type of flexibility becomes extremely important as the degree of uncertainty increases. As uncertainties increase beyond a certain stage, a state of "planlessness" is approached since these uncertainties place a premium upon a shorter time span or upon greater flexibility in production.

A definition of flexibility and diversification as set out by G. L. Johnson emphasizes the effects on present efficiency of the desire to be flexible so as to meet the uncertainties of the future. His analysis emphasizes that differences in entrepreneurial ability depend upon the skill displayed in choosing the best alternatives rapidly when faced with uncertainty.¹

Flexibility is an allocation of resources now which enables an entrepreneur to reallocate his resources more effectively later on the basis of improved information, i.e., so as to raise his expected future income in an uncertain situation.¹

Diversification, which is a minimax principle, by contrast, is a decision to allocate resources now so as to reduce the dispersion of a series of future income but not so as to affect the expected dollar-value of the series by more than the additional value of the more stable income.²

When adaptability is partial only, outputs in excess of the optimum imply higher marginal costs. Diversibility of productive resources facilitates flexibility, as does a general reduction in the proportion of fixed to variable services used in the firm. The farmer who prefers small pieces of machinery, worked to full capacity or perhaps beyond full capacity, may be an example of this principle.

Stigler³ has shown that the existence of uncertainty leads to a diminution of productive efficiency, in that entrepreneurs uncertain of future demand, make their firms adaptable (flexible firms) to various rates of output rather than specialize them to a small range of output rates. Diagrammatically, this can be seen from Figure 11, where AC₁ is the average cost curve for a firm "more adaptable" (more flexible) than that for which AC₂ is the average cost curve (call it firm 2).

For outputs less than OA₁ and greater than OA₂, the average cost with firm 1 (flexible firm) will be less than it would be with firm 2. However, for outputs between OA₁ and OA₂, the reverse will be true.

¹L. L. Johnson, op. cit., pp. 43-44.
²Ibid., p. 44.
Figure 14. Nature of cost function for flexible and inflexible firms
Under pure competition, with uncertainty assumed to be absent, the existence of a long-run equilibrium implies that firm 2 would be the most efficient; for the price would be EP and average cost could be covered only by firms producing OB output. However, the existence of uncertainty may lead the entrepreneur to operate as firm 1. If he could be guaranteed that he would always be maximizing his profit at an output between (say) OA_1 and OA_2, he would choose instead to operate with the less flexible plant (one more adaptable to a restricted range of output).

There are cases where the entrepreneur is forced to make decisions concerning future output based solely on present expectations. However, the usual case is that the entrepreneur anticipates that he will be receiving additional information concerning the markets at future dates long before he is forced to make decisions affecting future output. His decision may be postponed or advanced according to the circumstances. The entrepreneur's fundamental means of meeting uncertainty in these cases is the postponement of decisions until more information comes in. This type of flexibility is referred to as "time flexibility."

A different type of flexibility than those just discussed is "enterprise flexibility." The problem revolves largely around the choice of a plant (buildings and facilities) that lends flexibility to the firm's choice of livestock enterprises. For example, the farmer may decide to construct a "pen-stabling" type of barn rather than the conventional "stanchion" barn. If he decides to shift resources to beef production, the pen-type barn will permit him to readily do so. Likewise, he can more readily expand the size of the dairy enterprise with the pen-type barn.
Figure 15. Influence of the degree of adaptability of plant on resulting production relationships.
hogs in the next decade or so. This is illustrated in Figure 16 of two short-run plants of the same total resource outlay. The iso-resource curve (transformation curve) $M_1N_1$ represents the inflexible plant while $M_2N_2$ represents the flexible plant of equal investment and cost outlay. It becomes apparent that the inflexible plant is more efficient for an output combination falling between the segment $AB$ on either of the curves. For example, an output of $OY$ of poultry permits on output of $OX_2$ of pork under the inflexible plant while the same output of poultry permits only $OX_1$ of pork under the flexible plant. However, the inflexible plant is more efficient for output combinations which lie outside the segment $AB$.

In spite of the apparent advantage in efficiency that the inflexible plant has, it may be that the entrepreneur would choose the flexible plant if he thought that poultry and hog prices may vary considerably from one period to another. Figures 17 and 18 illustrate the two extremes in slopes of iso-revenue curves as related to price variations. Figure 17 represents a case in which product prices change in the same ratio and in the same direction (correlation coefficient of change in prices of the two products of $+1.0$). Figure 18, on the other hand, illustrates a case in which product prices change in equal proportions but in opposite directions (correlation coefficient of change of $-1.0$).

Under price change conditions illustrated by Figure 17 ($r = +1.0$) the firm would obviously choose the best adapted, inflexible plant such as $M_1N_1$ in Figure 16. If prices fall (or rise) the price ratio remains the same and the firm will continue to produce the products in the same proportion, except that the income will now be less (or more) than previously.
Output of poultry

Output of pork

Figure 16. Iso-resource functions illustrative of an adaptable and a flexible plant

Figure 17. Iso-revenue functions illustrative of positively and negatively correlated price relationships
Under the price change conditions as illustrated in Figure 18 when there are wide fluctuations in prices \( r = -1.0 \), the firm would best choose the flexible plant such as \( M_2N_2 \) in Figure 16. Under a flexible plant, the product combinations can be geared more easily to future price changes.

The above analysis does not, however, establish limits within which the flexible and inflexible plants should operate. The particular conditions under which the two plants are equally efficient is shown geometrically in Figure 19. The points of tangency \( (A,B,C,D) \) between price lines \( P_1L_1 \) and \( P_2L_2 \) and iso-resource functions \( M_1N_1 \) and \( M_2N_2 \) are combinations of poultry and pork that are equally efficient, because it is at these points of tangency that the ratio of product prices is equal to the rates of substitution of poultry and pork, thus an equilibrium combination of the two products. Since both \( P_1L_1 \) and \( P_2L_2 \) are tangent to the iso-resource curve for both the flexible and inflexible plant, equal revenues and equal outlays exist at the tangency points for each price line. The firm is thus indifferent between constructing the flexible or inflexible plant, assuming that the price ratio would always vary exactly as that indicated by \( P_1L_1 \) to that indicated by \( P_2L_2 \). If this were to hold true, then net revenue over time would be identical under either the flexible or inflexible plant for either of the two price relationships illustrated.

The flexible plant, however, is more efficient for price ratios that fall outside the limits imposed in Figure 19. A price line (iso-revenue line) with a slope less than \( P_1L_1 \) cannot lie tangent to \( M_1N_1 \) and \( M_2N_2 \).
Figure 19. Influence of anticipated price fluctuations on the choice of a flexible or inflexible plant.
simultaneously. If a price line with a slope less than $P_1L_1$ lies tangent to $M_1N_1$, then a price line of the same slope lying tangent to $M_2N_2$ must lie higher in the plane. Thus a higher total revenue is represented by the flexible plant. Likewise for a price line with a slope greater than $P_2L_2$ would result in a higher total revenue to the flexible plant.

The same reasoning applies for price ratios denoted by price lines falling between those of $P_1L_1$ and $P_2L_2$. While price lines with all these possible slopes (greater than $P_1L_1$ but less than $P_2L_2$) can be tangent to $M_2N_2$ and $M_1N_1$, but those tangent to the iso-resource curve for the inflexible firm will lie on a higher plane and thus represent a higher total revenue than for the flexible plant.

Any firm which expects to vary its combination of pork and poultry from (a) a large poultry and small pork enterprise, to (b) a large pork and small poultry enterprise should employ the flexible plant, i.e., for such varying price relationships which would produce price lines whose slopes would exceed that of $P_2L_2$ or be less than $P_1L_1$, the flexible plant would make the most efficient use of available resources.\(^1\)

**Liquidity.** In addition to flexibility, another type of reaction or adjustment which a firm might make to increase its ability to withstand unfavorable contingencies is "liquidity"—the maintenance of cash or near cash balances on hand in excess of the needs for transactions under conditions of certainty.\(^2\) The function of liquidity is to permit the firm...

---

\(^1\)Analysis is based largely on article by Dr. E. O. Heady. Uncertainty in market relationships and resource allocation in the short-run. Jour. of Farm Economics 32:2:240-257. May 1950.

\(^2\)D. Gale Johnson, op. cit., p. 56.
to take advantage of favorable opportunities, to make adjustments which may mean additional capital outlays or to reduce the possibilities of unfavorable circumstances which may lead to a loss of assets. Capital rationing necessitates the holding of excess liquid funds because it may be difficult to borrow the necessary funds to make those additional capital investments or to prevent liquidation if events turn against the firm.

The effect of liquidity is to increase the proportion of total assets that are in liquid form (non-producing) and decreasing the proportion in the invested form (producing). If certainty existed, a higher proportion of total assets could be maintained in the invested form (real assets).

Capital Rationing

Economic analysis of long-term alternatives available to the firm suggests that flexibility of the physical and financial operations of the firm is assumed to be possible. This sort of analysis may be used to describe the long-term aggregate response for a group of firms but care must be used in using it as a basis for interpreting individual responses. In practice, capital rationing becomes an important limitation to the expansion and modification of scale even in the long run. It is particularly important to the farmer who has already borrowed to the limit as defined by his willingness to borrow (a form of internal capital rationing) or by his creditor's willingness to lend (external capital rationing).¹

¹The term "capital rationing" will be used here as implying external capital rationing unless indicated otherwise.
Capital rationing is represented by the inability of the borrower to obtain all the capital funds desired at the going rate of interest. It is assumed that the borrower is acting in good faith and that the borrowed funds will be utilized in such a way as to meet interest and principal payments. The existence of capital rationing is usually associated with uncertainty. The lender is faced with the possibility that the borrower is not acting in good faith, i.e., he may not intend to repay the loan. The lender must also face the uncertainty of the borrower utilizing the funds in an efficient manner. In addition, the lender is faced with the same uncertainty as the borrower in appraising the profit prospects of the particular investment. Since the lender must have a knowledge of many economic situations, his feeling of subjective uncertainty is somewhat greater since he does not have the specialized knowledge of the borrower.

As a result of these uncertainties, lenders do not usually loan funds in large enough quantities so as to equalize the marginal rate of return with the interest rate. Instead limitations are placed on borrowed funds so that the ratio of borrowed to owned capital is kept below some prescribed level and so that the rate of return is kept at a high level. Both are safety features in favor of the lender. A farmer with heavy debts secured on his property is considered a "poor risk" and is thus subject to rationing of funds or to higher interest rates. Such a farmer may be unable to secure capital even though the intended investment may yield a marginal return in excess of the interest rate.
In the case of farmers in debt, the risk of being made insolvent in the early stages of the immediate future is an added factor to be considered by both borrower and lender. Thus the phenomena of risk aversion and capital rationing are closely related; risk aversion being the reaction of the entrepreneur himself (the borrower) with capital rationing representing the reaction of some outsider (the lender).

Capital rationing may affect the efficiency of resource allocation in two ways: (1) by affecting factor combination; and (2) by affecting scale of operations.

**Effect of capital rationing on combination of factors**

It should be noted that capital rationing does not affect all factors to the same extent. Some factors may be used in the desired quantities, while others, particularly those requiring considerable cash outlay, may be somewhat restricted in use. Probably the prime example of this in agriculture is the use of labor. On farms where much of the labor is family labor, the existence of capital rationing does not limit the firm in its use of labor. As a result, the relative employment of labor is higher than would be the case if capital rationing did not exist (Figure 20). On farms where most of the labor is hired, capital rationing may limit the amount of labor being used since the hired labor would be chargeable at a somewhat higher rate than the rate at which family labor is charged off. This would result in the factor price line $P_1L_2$ tangent to the product contour at point $J$ with $QX_1$ of labor and $QX_2$ of capital representing the optimum combination.
Figure 20. Effect of capital rationing on combination of labor and capital in agriculture
However, in a case of little or no hired labor, capital rationing would not limit the amount of labor being used (family labor being a relatively free agent charged off at a low rate\(^1\)) thus a new combination of labor and capital would result (point K), \(OY_2\) of labor and \(OX_1\) of capital. The effect of capital rationing is to bring about a greater use of labor in agriculture than would be true if alternative employment were sought for family labor or if scale of operations in agriculture were large enough to utilize more effectively this oftentimes unemployed labor resource.

Capital rationing, operating through institutional requirements and rules of thumb by lending agencies, may produce other than the optimum combination of factors. For instance, certain types of investments are often frowned upon by lending institutions while under certain circumstances, others (e.g., feeder cattle operations in the corn belt) are blessed with abundant capital funds. Also where farmers are avoiding the effects of capital rationing in part by leasing land, it frequently occurs that the proper investments are not made in livestock, machinery, fertilizer, etc., depending upon the leasing terms. There is a tendency on many farms, (owner-operated and tenant-operated) to utilize certain factors short of the most profitable level as a result of an attempt to avoid risks through borrowing.

Capital rationing will also influence the time span under consideration for entrepreneurs in formulating plans. For instance, an owner--

\(^1\)The alternative off-farm employment of this family labor is ignored in the analysis.
operator with a low equity or a tenant with insecure tenure. The owner-
operator in a strong capital position would more than likely formulate
his income expectations over a sufficiently long production period to
permit the full effects of complementarity to exert themselves between
various products as discussed under diversification in a previous section.
Probably the best example of this lies in a cropping program where the
farmer in a strong capital position would proceed to plan a rotation that
would include enough forage to permit the full effect of complementarity
on grain yields. Whereas for the owner-operator with a smaller equity or
the tenant with insecure tenure, he must formulate plans over a much
shorter period, one in which complementarity may not be given a chance
to exert itself. The horizon of expectations for the latter two cases
may be only one production year or perhaps two, three, or four years at
the most. It is the nature of the stream of surpluses during the next
few years which determines whether these persons can remain solvent or
not. Whereas, the person with higher equity can withstand heavier losses
and still remain solvent. Thus, for the owner-operator with nearly full
equity, he will more than likely operate as if his expectations were of
a single valued nature, i.e., he may operate on the basis of the modal
prices since if the one chance in 10 of a lower price occurs, it is not
likely to make him insolvent. He may be willing to take a loss in some
years if it will enable him to average higher returns over time. In the
case of technical rates, he probably would operate on basis of mean yields
since this would represent the average over time.
The person with limited equity or the tenant with insecure tenure is more apt to pay closer attention to whether the probability distribution of his expectations were positively or negatively skewed. Products with a negative skewness would be given little consideration since if plans were based on modal values, and these values were not realized, the chances of a lower price occurring would be great. This may prove disastrous for these persons in a limited capital position.

For this reason, a firm in this capital position would not operate on the basis of modal values but rather that some price less favorable than the modal price will occur. This means sacrificing some profit and resource efficiency for the sake of safety. In view of the limited time span, yield expectations would more than likely be based on modal values since they are more likely to occur in a short period than are the mean values.

If extreme price fluctuations are anticipated, the person with limited capital is more likely to discard a production plan which would maximize the social net product and return to him over time in favor of one which would take advantage of the relative favorableness of current prices. This often means exploitation of certain resources such as land, cows, etc., before a break in prices occur. It becomes a choice between this action or taking a chance of bankruptcy in the less favorable period ahead in light of heavy financial commitments on a previously acquired debt. Thus capital rationing will usually produce a combination of factors other than the one which would result in the greatest resource efficiency.
effect of centralization on scale of operations

- 75 -
The size of the firm in practice are very largely dynamic elements; it is, therefore, not surprising that static theory has had so much trouble over the matter.\textsuperscript{1}

Keynes' concept of the marginal efficiency of capital perhaps states the problem of scale of operations in agriculture better than has been done before.\textsuperscript{2} His marginal efficiency of capital device illustrates quite satisfactorily the amount an investor will put into a fixed investment or capital asset of any character (Figure 21). When investing in fixed capital, the entrepreneur in effect is buying himself a series of future incomes. The relationship between the prospective yield of each additional unit of investment in any one line and its supply price or replacement, is defined by Keynes\textsuperscript{3} as the "marginal efficiency of capital." Figure 21 (based on Kalecki\textsuperscript{4}) illustrates the optimum level of investment (scale) to occur at the OQ level of investment, the intersection of the marginal efficiency of capital curve. (\textit{EK}) and the prospective rate of return, curve RR'. In an industry, subject only to increasing returns, the marginal efficiency of capital curve would be upward sloping. Obviously, there would be no unique answer to the optimum scale; it would be an indefinite scale. If a producer could alter his scale without affecting the marginal efficiency of capital, then again there would be no unique


\textsuperscript{3}Ibid., p. 135.

\textsuperscript{4}Kalecki, op. cit., pp. 98–99.
Figure 21. Determination of optimum investment or scale of operations
answer to the problem of scale.¹ But for the reasons mentioned, diminishing returns to management and the operation of increasing risk, the marginal efficiency of capital curve does slope down beyond a certain point in investment and thus we have a unique answer to the scale problem.

The foregoing analysis was worked out on the basis of certain expectations as to prices and rates of production. In agriculture, these expectations are subject to uncertainties, for which some appropriate allowance must be made. The means of allowing for it must, as we shall see, be one which considers the increase in uncertainty with increases in scale.

Uncertainty works as an increasing function of scale in these several ways: (1) the entrepreneur's equity position is threatened in case of unfavorable expectations being realised. This holds true only to the extent that the entrepreneur had funds invested in the business; (2) the liquidity position of the entrepreneur becomes less favorable as investments increase which may make it more difficult to meet unfavorable contingencies which require sudden expenditures; (3) the rate of interest charged is usually inversely proportional to the liquidity position of the entrepreneur.² The operation of these forces can be seen quite readily


²With respect to these points, Hart states: "If markets are very uncertain it will pay to avoid heavy commitments of capital (which must be left idle or operated at a loss when markets are unfavorable) even though they would promise to pay under a scheme of price anticipation with the same expectation values but less dispersion." He says further that the extent to which it will pay to sacrifice economy (in the event a market develops according to expectations) to security in the event that it does not will depend on the degree of dispersion of anticipations. See his Anticipations, business planning, and the cycle. Quarterly Jour. of Economics 51:273-297. 1937.
Thus, the tenderer, by the curve of the discount function, can determine the optimal quantity of currency to tender at the discount rate. If the tenderer is willing to pay the discount rate, the tenderer will tender the optimal amount of currency that maximizes his expected profit. However, if the tenderer is not willing to pay the discount rate, he will tender a smaller amount of currency, which will result in a lower expected profit. Therefore, the tenderer will tender an amount of currency that maximizes his expected profit, given the discount rate and the expected return on the tendered currency. This is the optimal quantity of currency to tender at the discount rate.
Prospective rate of return and Cost of additional capital

Figure 22. Determination of optimum investment under conditions of increasing risk to lender and borrower

Output (Scale of operations)

Figure 23. Determination of optimum scale under increasing risk conditions
the lending agency stands ready to loan up to quantity OR. Instead the borrower stops short his investment at the OP level due to discounting marginal productivity in view of uncertainty and of a lower equity in his business. If the entrepreneur were not able to borrow any capital and assuming that OS of the investment represented the entrepreneur's own capital, then OP-OS represents a pure lack of funds (external capital rationing).

If this analysis is carried to the optimum scale analysis as presented by Stigler\(^1\) the effect would be to raise the long-run average cost curve more sharply beyond the minimum point (Figure 23). It may even cause it to rise earlier depending upon the level of investment at which the entrepreneur must begin to borrow outside funds. Thus the optimum scale occurs now at OA\(_2\) level, short of the previous level OA as determined under static conditions.

A suggested pattern or scheme to get farmers to expand use of resources up to the most profitable level might be as follows:

1. A varying interest rate depending upon the integrity of the individual and safeness of investment.

2. Amount of funds loaned will depend upon the type of security offered.

3. Size of loan and interest from the lender's viewpoint will depend upon the equity of the borrower.

Goals Other Than Monetary Income
(Firm-Household Relationships)

It has only been recently that any concerted attention has been given to the interdependence of the producing unit (the firm as one decision-making unit) and the consuming unit (the household as the other decision-making unit) in explaining the behavior of individual economic units in allocating resources in a most efficient manner. It is common knowledge that the firm and the household in agriculture are more closely knit than in any other industry. The two units are knit not only physically but also in respect to source of resources and the decision-making process. Yet this close relationship has been grossly neglected in much of our farm management research. Too often it has been assumed that maximization of monetary income is the sole motivating and conditioning force behind entrepreneurs' action in agriculture and that some monetary measure (labor income, farm income, etc.) would be an appropriate criterion of efficiency within the firm. If this were true, how do we explain farmers not working longer days, not putting up silage or hay by hand when a machine is not economically feasible on their small acreage? The answer obviously lies in the fact that somewhere along the line in their working day, the farmer decided that dollar income was not the only goal in life. Instead, he was willing to sacrifice some of the potential money income, which could be used to purchase certain consumption

---

goods; and spend more time in leisure, fishing, hunting, etc. Economic tools are available to explain this sort of rationale. Figure 24 demonstrates that some compromise is made between leisure and money income by each entrepreneur depending upon his indifference function. The curve PP' represents an iso-resource function showing the production possibilities from a given quantity of resources. All the resources can be employed to produce OP of monetary income, or they can be devoted to direct utility (spending the capital funds, using available labor for hunting, fishing, etc.) or some combination of these two alternatives are available consistent with the curve PP'. The curves lying tangent to PP' are indifference curves which illustrate the different combinations of money income or direct utility to which the entrepreneur (and his family) are indifferent. Each of the three indifference curves may represent the same farmer at different stages in his farming life or they could represent three different farmers, each with a different system of values.

Curve I<sub>1</sub>C<sub>1</sub> would typify the value system of a young ambitious farmer who probably has a small equity in his farm and is perhaps rearing a family. This means that he is hard pressed for funds to meet these financial commitments, and thus will stress maximization of monetary income and will forego many of the pleasures in life. He will then direct his efforts toward the production of OY<sub>3</sub> of monetary returns and will indulge in only OX<sub>1</sub> of leisure, etc., because it is this combination which maximizes total satisfaction for the individual or family.
Leisure, fishing, hunting or other direct utility from resources

Figure 24. Determination of optimum use of resources under different systems of values
As he grows a little older, approaching a stage in the family cycle where the debt has been retired to a satisfactory level and the children are producing more than they are consuming by working on the farm, his system of values change to that illustrated more by indifference curve $I_2C_2$. The tangency of the curve with $PP'$ shows a shift in emphasis within the farmer's mind to more of the "leisurely things" in life and less stress on dollar income; the new combination is $OX_2$ of money income and $OX_2$ of leisure, etc. Such a stage in farming is evidenced by a slight shift (hardly noticeable on many farms) to increased mechanization, to improved facilities for the handling the stock, etc., all of which is designed to take "some of the work out of farming." This stage in the life cycle of the family is usually the stage of greatest resource efficiency within the firm because of the better balance between labor and capital. During the first stage discussed, the firm is likely to be short on capital and long on labor, mostly operator's labor because of his long days and ambitiousness. It is quite obvious that on most of these "first stage" farms that there is not the most efficient balance between capital and labor.

Later on, we find this same farmer passing into a later stage of the family cycle, when his system of values have slowly shifted to where he places even greater emphasis on leisure and less (relatively speaking) on money income (denoted by curve $I_3C_3$). We refer to this stage as the "semi-retirement" stage. By now the farm is probably clear of debt, a nice "nest egg" laid aside, the children are married or in college and no longer represent such a financial burden as formerly. It is in this
stage that the farm reaches its most advanced stage in mechanization, a
situation thought by younger farmers to represent over-mechanization.
It is now that the operator wants the self-propelled combine, the pick-
up bailer, automatic gutter cleaner, power manure loaders, etc. It is
now that he wants the machine to take practically all the work out of
farming. Thus we find a large amount of capital and a small amount of
labor being used. This situation perhaps represents as inefficient a
combination of labor and capital as existed in the early stage when he
could not afford this machinery. It becomes obvious that even in light
of 100 per cent equity in the business and under conditions of certainty,
the entrepreneur may prefer to use his resources in a non-optimum manner
because of the conditioning influence that the non-economic motives
have on the farmers' decision-making processes.

The farm not only will be highly mechanized in this latter stage,
but the choice of enterprises within limits will be of the capital-
intensive type (feeder cattle) rather than of the labor-intensive type
(dairy cattle, poultry, tomatoes) as would be expected in the earlier
stages of farming. This, too, may represent an inefficient use of
resources, depending upon the physical and economic factors regarding
the particular farm.

One need only to retrace his thinking through these three stages in
the family cycle of farming to find the answer to the forces conditioning
the entrepreneur's decision with regard to resource use. It is very often
non-economic motives which underlie many decisions within the agricultural
firm.
Indifference curve $I_3 C_3$ (Figure 24) could also represent the subsistence farmer who places much greater interest perhaps on coon hunting or fishing than upon a nice farm house, automobile, college education for the children, etc., which is made possible only through greater emphasis on the monetary goal. He is happy with a lower income. Hence the present use of his resources represents an optimum since it is this combination $OX_1$ of monetary income and $OX_3$ of leisure, etc. which maximises the satisfactions to him and his family.

Perhaps the relationship between these various stages and resource efficiency can be explained more clearly by referring to Figure 25. Here, in stage I, when the farm is heavily in debt and the family is very young, there is the maximum competition between the household and the firm for the limited capital. It is in the stage that we recognize more than ever that the firm and the household are both physically and economically related. The important question facing the operator and his family at this point is what is the optimum accumulation of capital by the firm (through repaying the debt ahead of schedule, purchasing machinery or livestock and/or for making soil and building improvements) as compared to current consumption of income by the household. Capital formation in agriculture, of which little is known, is perhaps explained best by Figure 26. Here we permit the horizontal axis to represent rate of consumption during some very current time period (say this coming production year) denoted by $t_1$ while the vertical axis represents rate of consumption during some later period (say 10 to 15 years hence) denoted by $t_2$. The curves represent the consumption opportunities
Stage I: Getting started in farming
Stage II: Children growing up
Stage III: Semi-retirement

Figure 25. Influence of stage in life cycle for farm family on resource efficiency
Figure 26. Opportunities available to family in consumption of previously earned income

Figure 27. Determination of optimum level of consumption
available to the operator and his family. The family may spend (consume) all of last year's income $OX_1$ now, and they can borrow some more money $OX_2-OX_1$ to use for consumption purposes. Or they can reinvest all of $OX_1$ income and produce $OX_1$ income in time period $t_2$ or with borrowed funds in addition (borrowed for productive purposes) can produce $OX_2$ income to be consumed in some later period. These choices obviously represent the two extremes. The realistic decision would be to take neither of the above actions but to consume some of this year's income $OX_1$, reinvesting the remainder of $OX_1$ to produce income for some future period. In effect, this is what the farmer is doing when he is building up a herd, building his soil, adding a silo, building up a more complete line of machinery, etc.

The big question still remains: how much shall we invest out of today's income to produce future income and how shall we consume today of this year's income? To answer this question, we need to return again to indifference curve analysis which indicates relative rates of consumption between two time periods to which the farmer and his family are indifferent.

The slope of the indifference curve depends upon the family's goal in accumulated wealth. This will affect resource use throughout the period of active farming. If the operator and his wife wish to retire "royally" they will likely consume sparingly during their active farming days so that they have much to reinvest back as a nest egg for their retirement days.

Figure 27 illustrates the optimum combination of consumption during each of the two time periods for two families each with a different
outlook. \( I_1C_1 \) represents the indifference curve for a family that is more concerned about consumption during \( t_2 \) than during \( t_1 \) (i.e., they are willing to sacrifice today to have something for tomorrow).\(^1\) Thus they are willing to spend only \( OX_1 \) of this year's income \( OX_3 \) and reinvest \( OX_3 - OX_1 \) so that they may consume at the rate of \( OX_2 \) in some later time period, \( t_2 \). This family then is willing to do without many of the luxuries in life so that the capital position of the firm is built up more rapidly.

Indifference curve \( I_2C_2 \) represents a family that places greater emphasis on spending today, typified by the old adage, "eat, drink, and be merry, for tomorrow we may die." This family prefers to spend most of this year's income (\( OX_2 \)) very soon while reinvesting only \( OX_3 - OX_2 \) quantity back into the firm to build its capital structure. A firm operated by a family with this set of values, never assumes any great capital structure since little of each year's income is reinvested. Most of each year's income is consumed immediately by the family.\(^2\)

Thus it becomes evident that the firm-household relationships are closer in agriculture than in any other industry. This is due largely to the fact that the farm family supplies the greater proportion of the firm's resources employed in the form of the operator and family labor. Most farms carry on some form of subsistence farming. Much of the wife's activity is spent in subsistence activity. Present-day farmers are tending to place greater emphasis on leisure in view of mechanical devices.

---

\(^1\)The indifference curves are convex to the origin since consumption between two different time periods substitute for each other at a diminishing marginal rate.

\(^2\)It is conceivable that a family may borrow for consumption purposes in which case the present consumption rate would exceed even the present year income.
EMPIRICAL ANALYSIS

Introduction

An attempt has been made to accomplish two objectives in the preceding section: (1) to point out several of the many facets to the problem of determining why entrepreneurs do not operate their firm closer to some optimum level of performance, and (2) to provide the research worker with a beginning set of hypotheses to guide the empirical phase of investigation into this general area. Obviously, to test all the hypotheses implied in the analytical models presented would require a study much broader in scope than was undertaken in this particular case. For instance, models were developed to spell out the probable influence of risk and uncertainty on decisions and actions and the various adjustments which farmers could make in response to the different types of uncertainty. The forces creating uncertainty in the farmers' mind, the nature of uncertainty and testing the effectiveness of various adjustments in response to uncertainty provides a fertile area in itself for research undertakings. The purpose of this study was not to shed light on these aspects of uncertainty but rather to determine the importance of uncertainty in conditioning farmers' decisions and actions. More attention was given to role of capital rationing, knowledge, and certain psychological and social factors in explaining farmers' actions and lack of action. But like most theoretical treatments, an effort was made to develop all of the relevant theory, with the knowledge that the empirical study would be much more limited in scope.
The broad objectives of this study were to shed some light on the factors or conditions responsible for the deviation of the agricultural firm from some feasible and desirable standard of performance and then to seek out the reasons why the operator had not taken steps to improve his firm's position.

Rather than attempt to analyse the complete functioning of the agricultural firm with its many enterprises, it was considered more effective to concentrate attention on that enterprise which represented the major source of income to the firm. Confining the study in this fashion permitted a more intensive analysis of the firm's major phase of operation.

The dairy enterprise was chosen for two important reasons. First, approximately 41 per cent of gross market receipts to Pennsylvania farmers for 1950 was derived from the dairy enterprise.¹ This makes it the most important enterprise. Secondly, a complete labor income statement and cost of production figures were available for the current year on a large group of dairy farms in the State which could be sampled for this study. These reasons seemed to justify the choice of the dairy enterprise for intensive analysis with regard to the general objectives outlined above.

Sampling Procedure

The farms contacted for this study represented a sample of the owner-

¹Calculations from 1952 Agricultural Statistics.
operated, dairy farms located on limestone soils of Huntington, Centre and Clinton counties of Central Pennsylvania (see map on following page). This area, extending over 17 townships, represented approximately 80 percent of the area which was randomly sampled for a cost of milk production and labor income study conducted in 1948 and 1949.2

The reason for using farms in this investigation which had been used in the previous cost and labor income study was that the necessary cost and income data were already available. This meant that all of the one and half hours of interviewing time with the farmer could be devoted to obtaining additional information not provided in the cost and income study.

Only owner-operated farms were contacted for this study because of a general tendency for tenants to rationalize many of their decisions and actions in light of their existing tenure agreement. The 17 township area included 162 owner-operated dairy farms on which cost and income data were available. These farmers were contacted for this study during the summer of 1949. Of this number, two refused to cooperate. Nine of the questionnaires were found to be incomplete, so were discarded. The remaining 151 questionnaires were analyzed for this study.

---

1A dairy farm was designated as one on which six or more cows were maintained and from which fluid milk had been sold for at least nine months of the year being studied.

2Cost and labor income study was conducted in 1948 and 1949 by the Department of Agricultural Economics and Rural Sociology of The Pennsylvania State University. Refer to the Appendix for detailed discussion of the sample drawn for the cost study which was sub-sampled for this study.
Figure 28. Sampling area
A comparison of the 151 owner-operators used in this study with all owners and tenants contacted for the cost and income study revealed no appreciable differences with respect to age, size of herd, production per cow, real estate value per acre and labor incomes (Table 1). The formal education of the group of farmers used in this study was significantly greater than for all farmers contacted.

Table 1. Comparison of farms used in this study with all contacted owners and tenants on various factors.

<table>
<thead>
<tr>
<th>Factors</th>
<th>Farms used in this study (151)</th>
<th>All contacted tenants (179)</th>
<th>All contacted owners (325)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>66.3</td>
<td>39.2</td>
<td>48.3</td>
</tr>
<tr>
<td>Education (per cent of operators with more than eight grades completed)</td>
<td>46.3c</td>
<td>35.3</td>
<td>35.7</td>
</tr>
<tr>
<td>Size of herd (number of cows)</td>
<td>13.3</td>
<td>13.7</td>
<td>13.9</td>
</tr>
<tr>
<td>Pounds milk sold per cow</td>
<td>7,186</td>
<td>6,869</td>
<td>6,986</td>
</tr>
<tr>
<td>Value per acre of land and buildingsb</td>
<td>$75.23</td>
<td>$68.13</td>
<td>$73.95</td>
</tr>
<tr>
<td>Labor incomeb</td>
<td>$2,833</td>
<td>$3,129</td>
<td>$2,883</td>
</tr>
</tbody>
</table>

aContacted owners and tenants represent all those dairymen contacted for the cost and income study in the year previous to this study as explained in Pennsylvania Experiment Station Bul. 549.

bReal estate values and labor income figures are based on 179 owners and 94 tenants for which information was available.

cFormal education for farmers in this study differed significantly from all tenants and owners contacted. Significant at less than .05 level by chi square test.
Role of Knowledge

One of the major hypotheses tested was the influence of the operator's present state of knowledge on farmers' actions and decisions. It was pointed out in a previous section that entrepreneurs must have proper knowledge of both physical input-output responses and expected price-cost relationships if they are to operate their farms in an optimum manner.

Obviously, it is a difficult and endless task to develop a list of questions which would examine the operator's knowledge on all phases of the farm's operation, or even on all phases of operation for a single enterprise. In the interest of examining the farmer's knowledge with respect to the dairy enterprise, a list of representative questions was drawn up with the advice of dairy extension specialists and included as part of the questionnaire. These questions were designed to test the farmer's knowledge regarding such matters as the recommended rate of feeding grain to dairy cows, the factors that should be considered in determining the rate of feeding grain to dairy cows, the relative feeding value (protein basis) of several of the most common dairy feeds, the proper protein level of grain ration to be fed with various qualities of roughages, the relative feeding values derived from an acre each of corn silage, oats, clover hay, and good pasture under certain stated yields, the most important factors to be considered in choosing a herd sire and finally the nature of the response to increased levels of grain feeding to dairy cows. Although this is a short list of questions, it was felt
that it provided a reasonably valid index of the farmer's knowledge regarding the dairy.

Scores to be assigned each answer were determined with the aid of the dairy extension specialists. A range in individual operator scores from 96 down to 10 were recorded with an average score on the test of 66 based on a perfect score of 100. This range in grades suggests that the test resulted in segregating dairymen into different knowledge groups assuming that the test examined the operator over the significant areas of knowledge with respect to the dairy enterprise.

Relationship of knowledge to farming success

As an indication of the apparent relationship of knowledge to the success of the total farm business, and more specifically the dairy enterprise, the scores made by these operators were related to such factors as labor income, overall farm efficiency,\(^1\) returns above feed costs per cow,

\(^1\)The efficiency rating for a farm represents the per cent that its gross dollar output is above or below the average gross output for a group of farms with similar dollar amounts of total inputs. Total output here represents gross farm receipts plus the value of farm perquisites and any inventory increases. Total resource inputs represents the dollar sum of all cash farm operating expenses, plus a six per cent charge on real estate investment, an eight per cent charge on non-real estate investment, decreases in farm inventory, and the value of operator's time and unpaid family labor. A regression of output on inputs was calculated based on 190 owner-operated farms from which the 151 farms were selected. From the regression formula, it was possible to determine the average or expected returns for the level of inputs corresponding to each farm. The percentage difference (either a positive or negative) between
of the individual questions.

A high degree of consensus was found between scores made on each

score than would be plus 0.67 per cent. This "efficiency rating"

\[
\text{Furthermore, negatively correlated to the}
\quad \frac{\text{15,000 minus } 15,000}{15,000} = \text{the average.}
\]

\[
\text{The correlation between the variance of the two variables would}
\quad \text{increase above other variables which in turn would increase on the}
\quad \text{basis of the factor of } \frac{\text{15,000 minus } 15,000}{15,000} = \text{the average.}
\]

*For instance, parameter values, operating with total intake of \(15,000\) have

the farm's actual output and expected output based on the average represents

level by the sum total of variance test.

other mean differences are significant at less than five per cent.

<table>
<thead>
<tr>
<th>Average</th>
<th>1ST</th>
<th>2ND</th>
<th>3RD</th>
<th>4TH</th>
<th>5TH</th>
<th>6TH</th>
</tr>
</thead>
<tbody>
<tr>
<td>$52.3$</td>
<td>$216$</td>
<td>$1.0$</td>
<td>$2.82$</td>
<td>$3.83$</td>
<td>$4.84$</td>
<td>$5.68$</td>
</tr>
<tr>
<td>$15.92$</td>
<td>$15.49$</td>
<td>$25.92$</td>
<td>$2.83$</td>
<td>$3.83$</td>
<td>$4.84$</td>
<td>$5.68$</td>
</tr>
<tr>
<td>$27.6$</td>
<td>$221$</td>
<td>$0.5$</td>
<td>$2.94$</td>
<td>$1.85$</td>
<td>$2.86$</td>
<td>$3.87$</td>
</tr>
<tr>
<td>$5.27$</td>
<td>$6.99$</td>
<td>$0.6$</td>
<td>$3.83$</td>
<td>$2.84$</td>
<td>$3.85$</td>
<td>$4.86$</td>
</tr>
</tbody>
</table>

The correlation between scores and total capital investment (Table 2)....

Table 2. Relationship of knowledge to the success of the total farm

between knowledge scores and total capital investment (Table 2),

percentages and the dairy enterprise, 1ST dairy farmers, central.

business and the dairy enterprise, 1ST dairy farmers, central.
Influence of level of formal schooling on farming success

The knowledge test given to each operator as part of the questionnaire represents, for the most part, a test of the operator's acquired knowledge, rather than specific evidence of his inherent ability of basic level of intelligence. No effort was made in this study, as was done in the Pond and Wilcox study of 1930, to determine some index of basic or inherent ability of each operator. However, the amount of formal schooling (highest grade attained in school) was available for each operator. Note the positive relationship between the level of schooling

Table 3. Relationship of years of schooling to success of the total farm business, 147 Central Pennsylvania dairy farmers. (1948-1949)

<table>
<thead>
<tr>
<th>Level of schooling</th>
<th>Number of cases</th>
<th>Knowledge score</th>
<th>Age</th>
<th>Total capital</th>
<th>Size of herd</th>
<th>Labor income</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade school</td>
<td>79</td>
<td>62.1</td>
<td>48.6</td>
<td>$21,649</td>
<td>12.9</td>
<td>$2,412</td>
</tr>
<tr>
<td>High school</td>
<td>50</td>
<td>67.5</td>
<td>42.1</td>
<td>23,551</td>
<td>12.9</td>
<td>3,231</td>
</tr>
<tr>
<td>More than high school</td>
<td>18</td>
<td>77.2</td>
<td>46.1</td>
<td>29,569</td>
<td>16.2</td>
<td>3,697</td>
</tr>
<tr>
<td>Average</td>
<td>147</td>
<td>66</td>
<td>46</td>
<td>$23,266</td>
<td>13.3</td>
<td>$2,348</td>
</tr>
</tbody>
</table>

1 All mean differences significant at less than five per cent level by analysis of variance test.


2 Refer to the final chapter for a discussion of the limitations of the tabular method of analysis used exclusively for this study and the associated tests of significance.
and the scores made in the knowledge test (Table 3)\textsuperscript{2} even though the area
over which the operators were quizzed represented information which would
have been acquired in most instances apart from their formal schooling.
Larger businesses were being operated by those operators with more formal
schooling. Incomes were also higher for this group.

Since there is a high degree of relationship between the level of
formal schooling and the scores made on the knowledge test an effort was
made in Table 4 to test the importance of knowledge within each of the
formal schooling groups. Within the grade school group of farmers, the

\begin{table}
\centering
\begin{tabular}{|l|l|l|l|l|l|l|}
\hline
Level of schooling & Knowledge score in & Number of & Average & Age of & Size of herd & Milk per cow & Labor income\textsuperscript{a} \\
& groups & cases & score & operator & & & \\
\hline
Grade & over 65 & 33 & 78 & 45 & 14.6 & 8,350 & $3,089 \\
School & 65 or less & 46 & 51 & 51 & 11.7 & 7,544 & 1,928 \\
High & over 65 & 32 & 80 & 40 & 13.5 & 8,117 & 3,440 \\
School & 65 or less & 18 & 45 & 45 & 12.0 & 7,471 & 2,860 \\
More than & over 65 & 15 & 82 & 46 & 16.2 & 7,858 & 3,888 \\
high school & 65 or less & 3 & 56 & 47 & 16.5 & 8,543 & 2,739 \\
\hline
Average & & 147 & 66 & 46 & 13.3 & 7,719 & $2,248 \\
\hline
\end{tabular}
\caption{Relationship of knowledge within formal schooling groups to
several personal and business factors, 147 Central Pennsylvania dairymen. (1948-1949)}
\end{table}

\textsuperscript{a}Analysis of covariance shows mean difference adjusted to the mean
knowledge score groups to be significant at less than one per
cent level.
took a more active part in communities where they were more present.

Knowledge Groups (the lower 50 per cent) were the most active, as compared to the lower 50 per cent of the upper 20 per cent of the operators were pronounced by their answers to certain types of questions.

It was found that the upper-knowledge groups did not answer as many questions as the lower-knowledge groups, to a number of personal characteristics of farm operators. The lower-knowledge groups, on the other hand, were more successful in answering their questions as to the other operators.

The more possession of proper knowledge in their own assurance.

The table shows the relationship of knowledge to certain personal characteristics and farm operators.

Knowledge Groups, and Farm Operators

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Upper Knowledge Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farm Operators</td>
<td>Present than more than grade school</td>
</tr>
</tbody>
</table>
| The general relationship were more a younger group of farmers, the same farmers are between the more than grade school and the younger farmers, and with nearly 70 more total investment, they more operators who made scores of over 65 on the knowledge test and...
Table 5. Relationships of knowledge to certain personal characteristics of operators, 151 Central Pennsylvania dairymen. (1948-1949)

<table>
<thead>
<tr>
<th>Personal characteristics</th>
<th>Number of cases</th>
<th>Percentage of operators in different knowledge score groups</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Upper 3 deciles</td>
<td>Lower 3 deciles</td>
</tr>
<tr>
<td>Progressiveness:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>What year did you adopt hybrid corn?</td>
<td>1941 or earlier</td>
<td>62</td>
<td>39</td>
</tr>
<tr>
<td></td>
<td>Since 1941</td>
<td>80</td>
<td>22</td>
</tr>
<tr>
<td>Do you take part in organizations?</td>
<td>Yes</td>
<td>72</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>79</td>
<td>19</td>
</tr>
<tr>
<td>Do you belong to DHIA?</td>
<td>Yes</td>
<td>32</td>
<td>62</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>115</td>
<td>21</td>
</tr>
<tr>
<td>Interest in farming:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>What do you like to work with best in farming?</td>
<td>Equal interest</td>
<td>78</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>Stock</td>
<td>44</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>Crops</td>
<td>19</td>
<td>32</td>
</tr>
<tr>
<td>Concept:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>What do you consider to be a good rate of milk production per cow?</td>
<td>11,000 or more</td>
<td>28</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>9,500-10,999</td>
<td>22</td>
<td>41</td>
</tr>
<tr>
<td></td>
<td>Less than 9,500</td>
<td>31</td>
<td>42</td>
</tr>
<tr>
<td></td>
<td>Doesn't know</td>
<td>67</td>
<td>10</td>
</tr>
<tr>
<td>Standard:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Down to what level must cow drop before culling?</td>
<td>8,000-10,000 lbs.</td>
<td>16</td>
<td>56</td>
</tr>
<tr>
<td></td>
<td>6,000-7,999 lbs.</td>
<td>31</td>
<td>45</td>
</tr>
<tr>
<td></td>
<td>Under 6,000 lbs.</td>
<td>20</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>Doesn't know</td>
<td>83</td>
<td>17</td>
</tr>
<tr>
<td>Age: Upper three deciles (older)</td>
<td></td>
<td>44</td>
<td>18</td>
</tr>
<tr>
<td>Middle four deciles</td>
<td></td>
<td>63</td>
<td>37</td>
</tr>
<tr>
<td>Lower three deciles (younger)</td>
<td></td>
<td>44</td>
<td>30</td>
</tr>
<tr>
<td>Farmer’s Self-rating:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>As all-round farmer</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Upper 1/5</td>
<td></td>
<td>53</td>
<td>45</td>
</tr>
<tr>
<td>Second 1/5</td>
<td></td>
<td>26</td>
<td>23</td>
</tr>
<tr>
<td>Lower 3/5</td>
<td></td>
<td>68</td>
<td>18</td>
</tr>
<tr>
<td>On milk produced</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>per cow</td>
<td>Upper 1/5</td>
<td>44</td>
<td>48</td>
</tr>
<tr>
<td></td>
<td>Second 1/5</td>
<td>29</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>Lower 3/5</td>
<td>71</td>
<td>22</td>
</tr>
</tbody>
</table>

a All relationships significant at five per cent level or less by the chi square test.

b The number of cases varies quite often from the total of 151 farmers in the study because some operators were not able to answer all the questions. In other instances only the important answer categories are indicated on the table.

c Production given by farmers have been corrected to four per cent butterfat basis.
more frequently to the local Dairy Herd Improvement Association; indicated livestock to be their chief interest in farming; had a better concept of what was considered a "good" rate of milk production per cow; had a much higher standard of satisfactory performance as indicated by a high level of production below which they cull cows from their herd; were the younger group of farmers; and finally tended to rate themselves above their neighboring dairymen with respect to their herd's milk production and as an all-round farmer. High knowledge is thus associated with many other characteristics which are usually considered desirable so that we cannot say that the overall success of these operators can be attributed to correct knowledge alone.

Since correct knowledge becomes the most important basis for decisions and actions, what is the relationship between the level of knowledge and actions by farmers? Do those who possess the proper knowledge actually apply it in their decisions and actions? Table 6 presents evidence to support the hypothesis that correct knowledge usually promotes proper decisions and actions. Or to state the hypothesis in another manner, lack of proper knowledge is largely responsible for incorrect decisions and then either improper actions or lack of action entirely. As pointed out in this table, the high-knowledge group as compared to the low-knowledge group changed the protein level of their dairy grain ration more often during the year in response to changes in quality of their roughages. Of the 69 operators who were feeding hay and/or silage as supplemental feed during part of the summer period, 39 indicated a shortage of pasture during some part of the pasture season.
Table 6. Relationship of knowledge to certain actions of operators, 151 Central Pennsylvania dairymen. (1948-1949)

<table>
<thead>
<tr>
<th>Actions of operators</th>
<th>Number of cases</th>
<th>Percentage of operators in different knowledge score groups</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Upper 3 deciles</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lower 3 deciles</td>
</tr>
<tr>
<td>Do you change protein level of grain ration during the year?a</td>
<td>Yes</td>
<td>102</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>49</td>
</tr>
<tr>
<td>Does quality of your roughage influence protein content of your grain ration?</td>
<td>Yes</td>
<td>108</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>42</td>
</tr>
<tr>
<td>Have you taken any measures during last 4 or 5 years to correct the pasture shortage?a</td>
<td>Yes</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>9</td>
</tr>
<tr>
<td>Has milk production changed any in last 3 to 4 years?</td>
<td>Yes, increased</td>
<td>97</td>
</tr>
<tr>
<td></td>
<td>No change</td>
<td>38</td>
</tr>
<tr>
<td>What change in milk production do you expect in next 3 to 4 years?</td>
<td>Increase</td>
<td>120</td>
</tr>
<tr>
<td></td>
<td>No change</td>
<td>26</td>
</tr>
<tr>
<td>How would you go about getting a 15 per cent increase in volume of milk produced within the next year?</td>
<td>Keep more cows</td>
<td>80</td>
</tr>
<tr>
<td></td>
<td>Feed stronger</td>
<td>51</td>
</tr>
<tr>
<td>Have you thought about any changes to reduce time to do dairy chores?</td>
<td>Yes</td>
<td>58</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>55</td>
</tr>
<tr>
<td>Why have you never joined a DHIA?</td>
<td>Cost too great</td>
<td>26</td>
</tr>
<tr>
<td></td>
<td>Never bothered</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>Was member -</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>dropped out</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Miscellaneous</td>
<td>36</td>
</tr>
</tbody>
</table>

aRelationship significant at 10-20 per cent level by the chi square test. All other relationships are significant at five per cent level or less.
Of this number, 30 had indicated that they had taken measures over the past few years to correct this condition. Forty per cent of these operators were in the upper-knowledge group while 17 per cent were in the low-knowledge group. Of the nine operators who had taken no measures to correct this condition, a much higher percentage of these were in the lower-knowledge group. Out of the group who had taken measures, 50 per cent had indicated the measures to be successful. Seventy-five per cent of this group were in the high-knowledge group.

When asked whether their milk production had changed any during the last three to four years, a higher percentage of those indicating an increase were in the high-knowledge group. Whereas for those indicating no change, most of these were in the lower-knowledge group. Of those operators anticipating an increase in production over the next three to four years, a significantly higher percentage were in the high-knowledge group again, whereas, most of those expecting no change in production were in the low-knowledge group.

To get some idea as to how near to the most profitable feeding level these dairymen felt they were feeding, they were asked how they would propose to get an increase of 15 per cent over their present volume of milk production within the next year. Of those indicating that to do so would mean keeping more cows, which may be interpreted as meaning that they felt they were feeding their herd up to the most profitable level, more of these men were in the high-knowledge group. On the other hand, those indicating they felt they could get a 15 per cent increase in milk produced by feeding their present herd at a higher level, which may be
interpreted as a confession on their part that they are not feeding their herd up to the most profitable level, 41 per cent of this group were in the low-knowledge group compared to only 14 per cent in the high-knowledge group.

Since the use of labor is so important to efficiency in dairying, it is interesting to note that when asked whether they had thought seriously about any changes to reduce the time required to do the dairy chores, of those answering "yes," 41 per cent were in the high-knowledge group with only 23 per cent in the low-knowledge group. A higher percentage of those answering "no" were among the low-knowledge group. This would seem to indicate greater concern and foresight on the part of the high-knowledge group with regard to future efficiencies in the operation of the dairy.

In Table 5 it was shown that more of the high-knowledge group were members of the Dairy Herd Improvement Association than was true for the low-knowledge group. When asked why they did not belong to this Association, 40 had indicated that they had "never bothered" looking into the possibility. Of this number, 50 per cent were in the low-knowledge group compared to only 12 per cent in the high-knowledge group. This would seem to point up a general lack of enthusiasm and interest on the part of the low-knowledge group.

To summarize Tables 5 and 6, one can safely say that the level of dairy knowledge is not only significantly related to other desirable personal characteristics but is related also to the number of apparently correct decisions. These facts would tend to support the notion that improvement in farmers' knowledge would serve to improve the efficiency
and profitableness of farming operations,

Role of Capital

It was pointed out in the theoretical section that capital rationing of either the self-imposed or external form frequently limits the efficiency with which agricultural resources are employed. This limitation may take the form of restricting the scale of operations or influencing the factor combination. It can place restrictions on the use of one or several of the essential production elements, e.g., the level of fertilization; improvement in the quality of the herd sire; proper amount of labor or machinery to insure harvesting of crops on schedule, etc.

Capital funds are lacking in a business only if the operator feels that he could use more funds to advantage to combine with the existing capital, labor, and management. External capital rationing is represented by the inability of the borrower to obtain all the capital funds desired at the going rate of interest. Internal capital rationing on the other hand exists where additional funds are justified in the business at the existing rate of interest, and these funds are available, but the operator hesitates to borrow these additional funds. Empirical evidence concerning the role played by capital rationing of both forms on the farms studied will be presented later. The following section illustrates the relationship of the total invested capital.¹

¹ The term capital as used here has reference only to invested capital, and may be thought of as being almost synonymous with scale of operations since the sample studied was confined to dairy farmers.
(real estate and personal) under the operators' control to certain measures of efficiency within the operation, to certain personal characteristics of the operator and actions taken.

**Relationship of investment level to certain personal and business factors**

The 151 operators were arrayed on total capital invested and sorted into three capital investment groups as shown in Table 7. Personal characteristics, measures of size and success were calculated for each of these groups.\(^1\) No great differences were noted between the average age of the operators in each capital group. However, when compared to the low- and medium-capital groups a higher percentage of those in the high-capital group had more than a grade school education and made higher scores on the dairy knowledge test given them. Likewise, the high-capital group tended to be a more progressive group as measured by their earlier adoption of hybrid corn and taking a more active part in community organizations. They also had a higher concept of what was considered to be a good level of milk production per cow and would cull their herd at a much higher level of production. Forty-three per cent of the high-capital group were members of a Dairy Herd Improvement Association as compared with 20 per cent and five per cent for the medium- and low-capital groups respectively.

The general relationship then of capital investment to certain important personal characteristics reveals quite conclusively that as individuals,

\(^1\)The ratio of real estate to non-real estate investments for each of these investment groups differed only slightly.
Table 7. Relationship of total investment to certain personal and business factors, 151 Central Pennsylvania dairymen, 1948-49.

<table>
<thead>
<tr>
<th>Total investmenta (Class interval)</th>
<th>Number of cases</th>
<th>Average capital</th>
<th>Per cent with more than grade school education</th>
<th>Knowledge score</th>
<th>Culling level</th>
<th>Per cent using hybrid corn 1941 or earlierb</th>
<th>Total turnover</th>
<th>Milk per cow</th>
<th>Labor Efficiency rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than $18,000 Range $6,318- $17,970</td>
<td>45</td>
<td>$14,068</td>
<td>36</td>
<td>60</td>
<td>5,827</td>
<td>32</td>
<td>341</td>
<td>7,391</td>
<td>$1539 -6.16</td>
</tr>
<tr>
<td>$18,000 to $26,000 Range $18,000- $25,869</td>
<td>60</td>
<td>21,349</td>
<td>42</td>
<td>65</td>
<td>6,559</td>
<td>40</td>
<td>464</td>
<td>7,579</td>
<td>2514 -1.07</td>
</tr>
<tr>
<td>More than $26,000 Range $26,210- $60,065</td>
<td>16</td>
<td>34,715</td>
<td>61</td>
<td>73</td>
<td>7,401</td>
<td>52</td>
<td>641</td>
<td>8,754</td>
<td>4514 3.54</td>
</tr>
<tr>
<td>Total or average</td>
<td>151</td>
<td>$23,251</td>
<td>66</td>
<td>66</td>
<td>6,811</td>
<td>41</td>
<td>481</td>
<td>7,881</td>
<td>2833 -1.2</td>
</tr>
</tbody>
</table>

aBy analysis of variance, mean differences were significant at the five per cent level or lower. All tests of significance by the analysis of variance test have reference to the mean differences in the body of the table, and not to the sort factor.

bSignificant at less than five per cent level by the chi square test.
the operators of the larger investment units possess what are normally
assumed to be more desirable personal characteristics than do those on
smaller investment units.

Referring again to table 7, it will be noted that the favorable per-
sonal characteristics of the high-capital group reveal themselves in terms
of more efficient and profitable farming operations. The high-investment
operators are operating units almost twice as large (as measured by
productive man work units) as the small-capital group. Milk production
per cow averages much higher. Their labor incomes averaged $14,514 as com-
pared to labor incomes of $2,514 and $1,539 for the medium and low capital
group respectively. Efficiency rating for this high capital group was
+3.54 as compared to a -1.07 for the medium group and a mere -6.16 for the
low capital group.

High capital investment then is usually linked with a combination of
desirable personal characteristics, high rates of production, and a large,
efficient and profitable farming operation. The opposite exists for the
low-investment group with the medium-capital group occupying something of
average position in this respect. The facts point out quite clearly the
importance of ample amounts of capital in cases where the operators' 
managerial skills will permit. This does not imply, however, that un-
limited capital investment is justified, although within the range of the
data, the larger the investment, the higher the incomes.1

---

1Analysis of the 151 operators when sorted into "above" and "below
average" on the ratio of non-real estate investment to real estate invest-
ment did not disclose any significant differences in certain of the personal
characteristics and business factors. The "above average" group in non-real
estate investment were more prone to take certain desired actions.
When the 46 operators in the high-investment group were studied in
greater detail, the 18 dairymen who were operating with more than a
$45,000 investment showed labor incomes averaging $5,017, production per
cow at the 9,077 pound level, and returns above feed costs per cow at the
$256 level. This average labor income of $5,017 compared with an average
labor income of $4,191 and returns above feed costs of $241 for the other
28 operators operating with an investment ranging from $26,000 to $45,000.
However, the efficiency rating on these 18 high-investment farms was +1.2,
somewhat below the +5.0 for the other 28 operators who were employing
less total capital. This would suggest that these 18 operators were
employing their resources closer to the point of equating marginal costs
with marginal returns than were the 28 operators with a somewhat smaller
investment.

In the previous section dealing with the importance of knowledge,
it was shown that those operators who made high scores on the knowledge
test were operating with the higher capital investment. In the present
section where the importance of capital investment to success is treated,
the close relationship of investment to knowledge can be observed again.
Because of this very close inter-relationship between knowledge and capital
investment, an effort was made to measure the influence of one of the
factors on income while holding the other constant. To accomplish this,
the same sorts on capital investment as used in table 7 are further sub-
sorted into three knowledge score classes and then related to labor
incomes, Table 8.
Table 8. Relationship of knowledge within each of three capital investment groups to labor income, 151 Central Pennsylvania dairy farms, 1948-49.

<table>
<thead>
<tr>
<th>Capital groups</th>
<th>Number of cases</th>
<th>Average capital</th>
<th>Knowledge score interval</th>
<th>Number of cases</th>
<th>Average knowledge score</th>
<th>Average capital</th>
<th>Labor incomea</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower 1/3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less than $18,000</td>
<td>45</td>
<td>$14,068</td>
<td>Below 60</td>
<td>23</td>
<td>45.9</td>
<td>$13,643</td>
<td>$1,378</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>60 - 75</td>
<td>12</td>
<td>67.3</td>
<td>$14,243</td>
<td>1,637</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Over 75</td>
<td>10</td>
<td>83.9</td>
<td>$14,836</td>
<td>1,793</td>
</tr>
<tr>
<td>Middle 1/3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$18,000-$26,000</td>
<td>60</td>
<td>$21,349</td>
<td>Below 60</td>
<td>19</td>
<td>42.5</td>
<td>$21,987</td>
<td>2,094</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>60 - 75</td>
<td>19</td>
<td>65.9</td>
<td>$20,776</td>
<td>2,801</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Over 75</td>
<td>22</td>
<td>82.6</td>
<td>$21,293</td>
<td>2,628</td>
</tr>
<tr>
<td>Upper 1/3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>More than $26,000</td>
<td>46</td>
<td>$34,175</td>
<td>Below 60</td>
<td>9</td>
<td>50.8</td>
<td>$32,857</td>
<td>2,957</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>60 - 75</td>
<td>13</td>
<td>68.1</td>
<td>$33,090</td>
<td>4,836</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Over 75</td>
<td>24</td>
<td>84.6</td>
<td>$36,292</td>
<td>4,924</td>
</tr>
<tr>
<td>Total or average</td>
<td>151</td>
<td></td>
<td></td>
<td>151</td>
<td>65.9</td>
<td>$23,251</td>
<td>$2,833</td>
</tr>
</tbody>
</table>

aAnalysis of covariance tests shows capital investment to have a significant effect on labor incomes after adjustment is made for different levels of knowledge.
Two major conclusions can be drawn from this table. (1) For the same level of investment, the higher the knowledge, the higher the labor incomes generally. The greatest response to knowledge occurred within the high capital investment group where an average labor income of $2,957 was noted for the "below 60" knowledge score group as compared to $4,924 for those in the "above 75" knowledge score group. Apparently limited capital places restrictions on the response to premium knowledge. (2) Within the same knowledge score groups, the higher the capital investment, the higher the labor incomes. For example, an average labor income of $1,793 was noted for the "over 75" knowledge score group operating with nearly $15,000 capital as compared to an average labor income of $4,924 for an "over 75" knowledge score group that were operating with $36,000 investment.

Therefore, both knowledge and capital are very important to successful farming operations, the greatest response occurs in instances where there is a combination of high knowledge and high capital investment. Within the limits of this data, the influence of capital on labor incomes appears to be more important than knowledge. For example, the high-knowledge, low-capital group of operators had labor incomes averaging only $1,793 as compared to average labor incomes of $2,957 for the low-knowledge, high-capital group.

Relationship of investment level to actions

In an attempt to determine the extent to which actions are conditioned or influenced by the level of investment, the incidence and nature of specific actions taken to improve the dairy enterprise are related to the
If measures to correct the condition

implanted a particular syndrome condition were asked whether they had taken

additionally and ease of this was found when the operators who had

the quantity of hay and the quantity of measures to be taken

total captured in both jurisdictions that the desire to take measures to improve

Aq dealt with capital group. Again the experience of the role played

interested in inattention to change to better harvesting methods. If were in

terrestrial, most were in the low-capital group. Of the 12 operators who

those who planned to improve their hay quality or applied or more time and

planned to take or further improve their hay quantity. 12 operators repeated

were years to produce better hay were asked what other measures they

When those operators who had taken some measures during the past

compared to those taken by the higher-capital group

operators would not have been represented as large an outlay of capital than may have been.

capital group. Notice that the measures taken by the low investment

Like the capital group, most that the measures taken by the high

of better harvesting methods were mentioned more frequently, whereas, the use

mentioned the low investment capital group. However, the application of more time and better

Hay mixtures were mentioned, almost the same number of those occurred in

of the 13 instances in which an improvement in the composition of hay

taken was mentioned more frequently by the low-average capital group.

the last few years to improve the quality of their hay. Any measures were asked what measures they had taken in

investment levels (Table 9). When those operators who were interested in
Table 9. Relationship of total investment to actions of operators, 151 Central Pennsylvania dairymen, 1948-49.

<table>
<thead>
<tr>
<th>Actions</th>
<th>Cases</th>
<th>Percentage of operators in each of two capital groups (includes real estate and personal property.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(For those operators interested in producing better hay) What measures have you taken in last five years to produce better hay?a</td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>21</td>
<td>38 62</td>
</tr>
<tr>
<td>Improved hay mixtures</td>
<td>73</td>
<td>49 51</td>
</tr>
<tr>
<td>Applied more fertilizer and lime</td>
<td>37</td>
<td>32 68</td>
</tr>
<tr>
<td>Using better harvesting methods</td>
<td>22</td>
<td>64 36</td>
</tr>
<tr>
<td>What changes have you made in last three or four years to reduce the time required to feed your herd?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>91</td>
<td>43 57</td>
</tr>
<tr>
<td>Rearranged interior of barn some</td>
<td>14</td>
<td>36 64</td>
</tr>
<tr>
<td>Altered feeding and watering practices</td>
<td>17</td>
<td>47 53</td>
</tr>
<tr>
<td>Built new barn or leaping shed</td>
<td>10</td>
<td>100 0</td>
</tr>
<tr>
<td>What changes have you made in last three years to reduce time to clean the stables?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>108</td>
<td>42 58</td>
</tr>
<tr>
<td>Rearranged barn interior somewhat</td>
<td>22</td>
<td>41 59</td>
</tr>
<tr>
<td>Built new barn</td>
<td>8</td>
<td>100 0</td>
</tr>
<tr>
<td>Installed new cleaning facilities</td>
<td>11</td>
<td>91 9</td>
</tr>
</tbody>
</table>

*aBy chi square test, relationships significant at 5-10 per cent level. All other relationships significant at less than five per cent level.*
answered "no" were in the low-capital group as compared to two-thirds of the affirmative group being in the high-capital group.

When asked what changes they had made to reduce the time required to feed the herd or in cleaning the stables, most of those indicating that either "no measures had been taken," or that "some minor rearrangements within the barn had been made" were in the low-capital group. With but one exception, only operators in the high-capital group had gone so far as to construct a new barn or to install new cleaning facilities as a means toward reducing feeding and stable-cleaning chore time.

These facts would tend to support the conclusion that the amount of total capital under an operator's control influences quite definitely both the incidences and nature of measures taken to improve the efficiency of his dairy operation.

**Role of capital rationing in limiting actions**

It has been pointed out that the level of total investments influences not only the frequency with which desired actions are taken within the dairy enterprise, but influences as well the nature of the actions taken. The discussion to follow is directed toward a study of the importance of capital rationing as one of the reasons why a particular group of operators took no action in instances when they felt there were measures which could have been taken.¹

¹There is no empirical proof of the profitableness of any of these "desired actions." The mention of these actions by operators as desirable ones gives the impression of assumed profitableness except in those instances where the operator indicated that there was some question in his mind as to the profitableness of the measure.
It is interesting to study the characteristics of those operators who continually keep abreast of the most recent developments in agriculture and carry out most of the approved recommendations. But even more interesting, and without question more important to the advancement of agriculture, is an understanding of why more of our farmers aren't adopting approved recommendations which are being brought to their attention daily through the medium of newspapers, magazines, radio, and through our agricultural extension personnel in the field. It is one thing to be unaware of appropriate actions, but something entirely different to recognize appropriate actions, to be interested in taking these actions, but not actually take these actions for various reasons.

Efforts to get farmers to adopt practices which they find themselves unable to take are futile unless some attempt is first made to remove the obstacles to adoption. To accomplish the latter requires first a study to uncover the nature and relative importance of these obstacles. This was one of the major objectives of this study.

To get some notion as to the frequency with which certain obstacles occur is a relatively simple task. But to measure the overall impact of these obstacles on the efficiency of agricultural operations in much more difficult. Some evidence of the latter with respect to capital rationing will be presented in this section.

The first concern will be with those operators who were not able to take certain desired actions to improve the dairy enterprise. When the 81 operators who felt that "there were other measures that would definitely raise their herd's average milk production" were asked what the major
reason was for not being able to carry through with the desired action, one-third gave lack of necessary capital as the major limiting factor (Table 10). Another one-fourth gave uncertainty as to the profitableness of the measures in light of existing costs and uncertain future milk prices. Since capital rationing is associated with uncertainty, one cannot be certain how many of the latter group of operators may have been covering up the existence of capital rationing by answering that uncertainty was their chief reason for not being able to take the desired action. Thus, it is possible that capital rationing may have been the responsible element in more than half of the cases.

Upon questioning the group of operators who were interested in producing more and higher quality hay for their dairy herd, it was discovered that insufficient funds again accounted for lack of action in over one-fourth of the instances where measures which the operators were interested in taking were not taken earlier (Table 10). Uncertainty was mentioned in less than 10 per cent of the instances. Lack of labor or time on the operator's part was mentioned in 10 per cent of the instances. As expected, a host of other miscellaneous reasons were given such as "the condition of soil, layout of farm, weather problems, negligence, etc."

Since the production of ample, high quality pasture is a requisite to a well-balanced roughage program, a great deal of research and extension activity has recently been directed toward the improvement of pastures. The economy of production arising from feeding ample quantities of good roughage has been constantly brought to the dairyman's attention in the last five to ten years. Yet, much is still to be accomplished in pasture
Table 10. Summary of reasons given by operators for not being able to take certain desired actions within the dairy enterprise, 151 Central Pennsylvania dairymen, 1948-1949.

<table>
<thead>
<tr>
<th>Desired actions</th>
<th>Lack of capital</th>
<th>Uncertainty of profitability of light of present costs</th>
<th>Lack of labor</th>
<th>Miscellaneous</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>To increase dairy herd's average production</td>
<td>29 36</td>
<td>20 25</td>
<td>5 6</td>
<td>27 31</td>
<td>81</td>
</tr>
<tr>
<td>To produce more and higher quality hay</td>
<td>25 28</td>
<td>6 7</td>
<td>9 10</td>
<td>49 55</td>
<td>89</td>
</tr>
<tr>
<td>To produce more and higher quality pasture</td>
<td>3 12</td>
<td>1 4</td>
<td>6 25</td>
<td>14 59</td>
<td>24</td>
</tr>
<tr>
<td>To reduce the time required to do the feeding, milking, and cleaning stables</td>
<td>50 40</td>
<td>24 20</td>
<td>19 15</td>
<td>32 25</td>
<td>125</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>107 34</strong></td>
<td><strong>51 16</strong></td>
<td><strong>39 12</strong></td>
<td><strong>122 38</strong></td>
<td><strong>319</strong></td>
</tr>
</tbody>
</table>

*Most of the reasons classified above as miscellaneous are sound reasons. For example, the conditions of the soil, size and layout of the farm or weather conditions was mentioned in 126 instances. Lack of knowledge as to how to effect the action was mentioned five times. Satisfied with present arrangements or conditions accounted for no action in 10 instances. Negligence was confessed to in 22 instances. It is possible that negligence may have accounted for no action in a number of other instances when lack of capital or some other reason was given.*
improvement on most of our dairy farms.

In an attempt to find out why more had not been done to improve pastures, those operators, who admitted to supplementary feeding of hay and/or silage during part or all of the regular pasture season because of a pasture shortage, were quizzed as to why they had not taken measures to remedy the situation. Lack of capital or uncertainty was mentioned in only 16 per cent of the cases. Apparently, the shortage of funds or uncertainty as to the profitableness of the measure was not considered to limit action in this particular area. Yet if one were to examine the underlying cause of the six operators who mentioned lack of labor and the seven who mentioned soil conditions, it is possible that a lack of funds may have been the real reason for not taking action to correct either of these. Labor could be hired and land can be limed and fertilized up to the proper level or may even justify renovation in many instances to permit the establishment of good pastures. Perhaps the lack of labor or soil conditions are only surface indications of an underlying need for additional funds. This could be true in so far that labor was available and the desired measures were considered profitable in the operator's mind. This could be true also for a number of other cases discussed above. So, it is difficult to measure the extent to which limited funds may have prevented appropriate measures to improve pastures in these instances.

The need for additional funds becomes even more apparent when one questions operators regarding lack of actions in reducing labor requirements. To accomplish this often means substantial changes within the plant. These changes may take the form of modifying the physical structure itself,
or in replacing or adding to the existing plant equipment. This is particularly true when one attempts to reduce the labor requirements in the dairy enterprise. Most of the dairy barns in Central Pennsylvania, and for that part most of the Atlantic Coastal States, are modified horse and general livestock barns. Therefore, the shift to an efficient dairy barn requires substantial alterations.

The need for additional funds to accomplish these changes was felt severely by operators of this study. Out of 117 instances where operators desired to make certain changes (in addition to those already taken) in order to reduce the time required to do the feeding and milking of their herd and cleaning of the stables, 50 of the operators (42 per cent) indicated a shortage of necessary capital as the reason for not being able to proceed with the desired change (Table 10). Uncertainty as to the profitableness of the change was mentioned by another 21 per cent. Lack of labor was mentioned by 16 per cent. Again this may be only a surface reflection of need for funds. Of the 32 operators (25 per cent) who are classified as giving miscellaneous reasons, eight admitted to being "just negligent" in making the change. Another eight operators indicated an interest in making some other changes first before being ready to make the desired change referred to in the questioning.

When the reasons for not taking all of the desired actions discussed above were combined, it was found that lack of capital was mentioned in one-third (34 per cent) of the instances. Uncertainty accounts for another 16 per cent. Thus, the need for additional funds and uncertainty account for lack of desired actions in one-half the instances. In so far,
as lack of labor may represent a lack of capital or uncertainty, capital rationing may be responsible for lack of actions in nearly two-thirds of the instances. Soil conditions, layout and size of farm and weather conditions accounted for lack of action in 14 per cent of the instances. Negligence was mentioned in only six per cent of the cases.

The above discussion dealt only with those operators who had indicated a desire to take certain measures which they thought would improve the efficiency and profitableness of their dairy enterprise. The 107 instances where lack of capital was mentioned represents the replies of 58 operators (38 per cent of the total sample) who had indicated the need for additional capital as limiting certain of their actions. A comparison of these 58 operators with the remaining 93 operators who had not indicated a lack of capital reveals some interesting facts (Table 11).

The group needing additional funds are younger, know less about the dairy operation, are operating with a smaller herd, and with nearly $5,000 smaller investment (Table 11). The most revealing differences come to light when the two groups are compared income and efficiency-wise. The capital-rationed group had an average labor income of $2,056 compared to $3,317 for the group not indicating a lack of capital funds. When the efficiency with which the resource inputs are employed is studied for each group, an efficiency rating of -5.4 is found for the capital-rationed group compared to a +1.4 rating for the other group. The capital-rationed group also had higher costs of milk production. When compared on the basis of returns above feed costs per cow, again the non-capital-rationed group fared much better, $229 as compared to $194. As an indication of
Table 11. Some comparisons of the capital-rationed group with those not indicating need for additional funds in the dairy enterprise on certain personal and business factors, 151 Central Pennsylvania dairymen, 1948-1949.

<table>
<thead>
<tr>
<th>Capital rationing position</th>
<th>Number of cases</th>
<th>Age of operator</th>
<th>Knowledge scorea</th>
<th>Total PMWUsa</th>
<th>Size of herds</th>
<th>Total investment</th>
<th>Labor income</th>
<th>Efficiency rating</th>
<th>Returns above feed costs per cow</th>
<th>Per cent well satisfied with operation of farmb</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do not lack capital</td>
<td>93</td>
<td>48.3</td>
<td>68</td>
<td>501</td>
<td>13.8</td>
<td>$24,957</td>
<td>$3,317</td>
<td>1.4</td>
<td>229</td>
<td>53</td>
</tr>
<tr>
<td>Lacks capital</td>
<td>58</td>
<td>43.1</td>
<td>63</td>
<td>450</td>
<td>12.3</td>
<td>20,515</td>
<td>2,056</td>
<td>-5.4</td>
<td>194</td>
<td>32</td>
</tr>
<tr>
<td>Total or average</td>
<td>151</td>
<td>46.3</td>
<td>66</td>
<td>481</td>
<td>13.3</td>
<td>$23,251</td>
<td>$2,833</td>
<td>-1.2</td>
<td>216</td>
<td>45</td>
</tr>
</tbody>
</table>

aBy the T test, mean differences are significant at 10 per cent level. All other mean differences are significant at less than five per cent level by T test.

bSignificant at less than .05 level by chi square test.
I have an understanding that the operator's part of the borrower is not getting the Good Faith, t.e.,

the interest rate is where the operator prefers to borrow the needed funds.

nature in which case the needed credit is not available, or on an

then capitalization can take one of two forms: one of an experimental

the surplus earnings of the firm will provide, in the business above what the surplus earnings of the farm will provide, assuming that there are determined to be a justified need for additional capital.

In other words, the need of the operator to borrow the needed funds. In other words,

the added capital is available, there are excess in economic on the

the additional capital requirement, of credit the not available. Or, if corrected under the farm is unable to produce surplus earnings to meet

the farm. Yet, the lack of need of funds within a business can be

doe. If the evidence seems to point out that the availability that capitalization

the degree of satisfaction with the manner in which the farm was being

an aware of this fact,

who appear to be very satisfied as compared to 33 per cent of the 93 operators of the capitalization group felt otherwise.
manner. The operator may prefer not to borrow because of previous debt. Yet any previous debt should not influence the decision concerning a newly acquired debt if there were certainty as to the repayment ability of the business. Or the operator may say that he "just doesn't care to go into debt." Here again, debt is to be feared only if there is uncertainty in the operator's mind as to the farm's ability to repay. It would appear then that uncertainty is at the root of most capital rationing.

Analysis of the 58 operators who were lacking capital funds suggests that most of the capital rationing was of an internal or self-imposed nature. When questioned as to whether they felt they could borrow the necessary funds, 51 of the 58 operators felt quite certain that they could borrow the needed funds. Thus credit apparently was available in 88 per cent of the cases. Two of the operators did not know what their chances were of borrowing the needed funds, while four were quite certain that they could not borrow the needed funds. There was insufficient evidence available on one operator to classify his response.

1Because of the subjective nature of the questioning in this study, it was felt best not to query the operator on such a personal matter as his debt position. Also, a previous study conducted throughout Pennsylvania in 1947 pointed out that most commercial farmers were in a reasonably, comfortable debt position. Thus the influence of existing debt on actions was assumed to be of minor importance except in a few special cases.2

2L. F. Miller and F. A. Hughes. Credit sources, practices and opinions of Pennsylvania farmers. Pennsylvania Agricultural Experiment Station Bul. 514. June 1949, p. 3. Forty-eight per cent of a representative sample of 399 commercial farmers in 1947 had no debt. Only 25 per cent had any real estate indebtedness, averaging $3,700 or 31 per cent of the value of their real estate. Forty-five per cent were using some kind of short-term credit, averaging slightly less than $1,000. On the average, only six cents was owed on each dollar of investment.
What then was the attitude toward borrowing the needed funds? Of the 51 operators who were quite certain the necessary credit was available for the asking, 45 indicated a preference not to borrow while the other six operators intended to go ahead and borrow the needed funds. Thus, the evidence points conclusively to the existence of a self-imposed (internal) capital rationing and not to a lack of available credit.

The decision not to borrow funds is conditioned largely by the operator's attitude toward assuming debt. This attitude arises from the feeling that assuming a debt means assuming the risk of being made insolvent in the short run if conditions become too unfavorable. The latter would be more likely only in cases of very small equity in the total business. Yet, the accumulation of the limited capital in many farm situations has been a slow and arduous one. The mere thought of risking the loss of their already accumulated and relatively debt-free capital creates a feeling of fear toward additional debt. Perhaps the feeling of being debt-free more than offsets the possibility of increased income. One need not look too far to see the rationale in this type of thinking, particularly if the history of the late twenties and depression period is recalled. Perhaps a program is needed which would educate farmers to respect credit as just another factor of production, a commodity that need not be feared, but one, which if used with good judgment, can do much to improve the efficiency with which the existing capital, labor, and management are already being employed.

The development of such a program would necessarily have to be based on some understanding as to why some operators preferred not to borrow
the needed funds even though they felt these funds to be available.\(^1\) Of the 45 operators who indicated a preference not to borrow, one-fourth (27 per cent) pointed out that they were already in debt far enough and preferred not to borrow any more until the existing debt had been retired or reduced to a comfortable level. Another one-fourth (27 per cent) of them indicated uncertainty as to the profitableness of the investment in light of existing costs and uncertain price prospects. Thus one-half of the group gave pretty sound reasons for not borrowing. The revealing evidence was that over one-third (38 per cent) replied by saying that "they just do not care to borrow." They gave no reason other than this. Apparently, the profitability of the investment weighed very lightly in their decision. This latter group would prove the most difficult group to work with in any credit program.\(^2\)

**Farmers' implied use of new capital funds**

The preceding section has shown that level of investment is particularly important in determining incomes, and that lack of capital restricted specific actions in making improvements within the dairy enterprise. The question arises as to how these operators would use additional capital if it were made available on a free or non-payment basis. Simply

---

\(^1\)A comparison of the 45 operators who preferred not to borrow with those who intended to go ahead with the borrowing or felt they could not borrow the needed funds did not show any significant difference in certain personal or business factors.

\(^2\)Analysis of these three groups did not show any significant differences regarding certain personal and business factors.
because lack of capital was given as limiting certain actions within the dairy enterprise does not imply that additional capital would be used for these purposes in light of competing uses for capital in other parts of the business or in the household. To shed light on the priority of uses of additional injections of capital the operators were asked the question, "how would you use $1,000 if you were to win it on some radio show with no stipulations as to how it was to be used?" Since the objective was to get the operator to consider all competing uses, this question was purposely asked before querying the operators in detail on reasons for not making certain improvements in the dairy enterprise. Because of the thought and attention given the question by the operators, it was felt to be a reasonably valid measure of the relative priority given to alternative uses of any newly, injected capital.

A summary of the replies shows the following priority in preferred use of the prize money. Sixty-five of the 144 operators who indicated a definite priority of use chose to use it within the farm business. Nearly two-thirds of this number were planning to use it to repair or construct new buildings, build up land or purchase more land. Only two operators of this group would plan to use this money to purchase more land. Nine had indicated a combination of building up land and repair of buildings as their preferred use. That leaves 28 who would use it exclusively for repair of buildings, two for building up land and 24 for
the purchasing of more machinery and livestock.

These replies would suggest that farmers are apparently more concerned about the improvement of their real estate than in the acquisition of either more real estate or operating capital (farm machinery, equipment, livestock, etc.). The high costs of building materials preceding the time of this interview and the inability on the part of the operator to arrive at a decision as to proper improvements to the real estate are probably responsible for the accumulated need for real estate improvements on most of these farms.

The replies further revealed 29 operators who felt their debt position such that first priority was given to applying it on their current indebtedness. The remaining 50 operators preferred to use the prize money for non-farm purposes. Thirty-one of this number, who apparently felt no great financial pressure, were planning to save it; another 13 would use it in the household while six would plan to use it to go on a vacation.

When each operator was asked how his wife would probably want to use the prize money, 104 seemed to feel that his wife would in all probability want to use it the same as he had indicated previously.² Twenty-two operators felt that the wife would want to use it on improve-

²It would have been interesting to have compared the replies of the wives in this question with those of the husband. Such a comparison would bring to light any severe conflicts between the household and the farm for newly injected capital. However, it was impractical to get the wive's replies on just this one question.
ments in the home. Only two felt that the wife would want to split the
use between the household and the farm. In seven instances, the preferred
use was either save, invest in property, use for travel or buy a house
or car. In ten instances, the wife had been deceased or the operator was
not married. No information was available in five instances.

In those 31 cases where the operator indicated that the probable use
by the wife would differ from that of the husband, the operator was asked
how they would use it if they were to make the decision together. In 14
cases the money would have been shared 50-50, each using their half as
desired. In nine instances it would have been used to pay off debts or
for farm purposes. Investment, savings or use in household was preferred
in the remaining eight instances.

In either case, whether the wife was to make the decision or if it
was a combined decision, the money would have been used in the household
in 22 instances as compared with only 13 instances if the husband made
the decision alone. Savings would have occurred in only a few instances
if either wife or wife and husband together made the decision as compared
with 31 instances if husband alone made the decisions. Apparently the
husbands placed greater emphasis on a reserve or savings fund. Otherwise
the most probable use would not differ greatly regardless of who made the
decision.

Another question which naturally arises is whether there is any
tendency for those operators who indicated a need for additional capital
within the dairy enterprise to more often choose to use this newly,
injected capital for farm purposes than would be true for operators
feeling less of a need for capital within the farm business. A comparison of the 58 operators who indicated lack of capital as retarding improvements within the dairy enterprise with the other 93 operators points out quite clearly that this tendency does exist (Table 12). Fifty-seven per cent of the "lack of capital" group would plan to use the prize money for farm purposes as compared to 43 per cent of those not indicating any need for capital for dairy improvement purposes. Likewise more of the "capital lacking" group (26 per cent) would use it for paying off debts as compared to only 15 per cent of the other group. The reverse of this is true when considering non-farm use of the capital. Here, only 17 per cent of the "capital lacking" group propose to use it for non-farm purposes, while 42 per cent of the other 93 operators would plan to use this $1,000 for non-farm purposes.

An analysis of the personal characteristics and business factors for each of the groups according to preferred use of the prize money shows that those proposing farm use of the fund tend to be older, are operating smaller units, with a smaller total investment, and are reaping lower labor incomes, with less efficiency in use of resource inputs (Table 13). It would appear that these farming units are in serious need of additional capital and that the operators recognize this need. The group preferring to use it for purposes of debt retirement on the other hand are a considerably younger group, (average age of 40) with somewhat larger units and larger investment than the above discussed group. Their labor incomes are just a little higher with somewhat greater efficiency in resource use. These are younger operators who are "on the
Table 12. Relationship of capital rationing to implied use of $1,000 prize fund, 151 Central Pennsylvania dairymen, 1948-1949.

<table>
<thead>
<tr>
<th>Implied use of $1,000 prize funda</th>
<th>Operators indicating need for additional funds (58)</th>
<th>Operators not indicating need for additional funds (93)</th>
<th>All operators (141)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cases</td>
<td>Per cent</td>
<td>Cases</td>
</tr>
<tr>
<td>Farm use:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>To repair and construct buildings</td>
<td>23</td>
<td>40</td>
<td>14</td>
</tr>
<tr>
<td>To purchase or repair machinery and equipment</td>
<td>3</td>
<td>5</td>
<td>15</td>
</tr>
<tr>
<td>Build up land</td>
<td>5b</td>
<td>9</td>
<td>6c</td>
</tr>
<tr>
<td>To purchase livestock</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Buy more land</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>33</td>
<td>57</td>
<td>41</td>
</tr>
<tr>
<td>Pay off existing debt</td>
<td>15</td>
<td>26</td>
<td>14</td>
</tr>
<tr>
<td>Non-farm use:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Save</td>
<td>4</td>
<td>7</td>
<td>27</td>
</tr>
<tr>
<td>Use in household</td>
<td>5</td>
<td>9</td>
<td>8</td>
</tr>
<tr>
<td>Take a vacation</td>
<td>1</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Total</td>
<td>10</td>
<td>17</td>
<td>40</td>
</tr>
</tbody>
</table>

a Implied use of prize money for farm use, paying off debt, and non-farm use was significantly different for those 58 operators who needed additional capital as compared to the other 93 operators. (Chi square test)

b Three of these five operators occur above as part of the 23 who would use some of the fund on buildings. These three operators would use the fund for both purposes.

c These six operators occur above as part of the 14 who would use some of the fund to repair buildings. These six operators would use it for both purposes.

d Nine of the 37 cases who would use the $1,000 to repair buildings occur again as part of the 11 cases who would use it to build up land. These nine operators preferred to use the $1,000 for both purposes. With these exceptions, the implied use represents the only preferred use of the fund.
Table 13. Relationship of "how the operator would use the $1,000 prize money" to certain personal characteristics and measures of size of business and success, 151 Central Pennsylvania dairymen, 1948-1949.

<table>
<thead>
<tr>
<th>Proposed use of $1,000 prize money</th>
<th>Number of operators</th>
<th>Age of operator</th>
<th>Total capital</th>
<th>Total MNU'S</th>
<th>Labor income</th>
<th>Efficiency rating</th>
<th>Per cent indicating lack of capital</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farm use:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Repair or construct new buildings, buy more land or build up present land</td>
<td>41</td>
<td>47</td>
<td>$21,893</td>
<td>468</td>
<td>$2,545</td>
<td>-3.9</td>
<td>61</td>
</tr>
<tr>
<td>Purchase more machinery and livestock</td>
<td>24</td>
<td>48</td>
<td>20,200</td>
<td>413</td>
<td>2,457</td>
<td>-2.0</td>
<td>21</td>
</tr>
<tr>
<td>Total</td>
<td>65</td>
<td>48</td>
<td>21,281</td>
<td>448</td>
<td>2,512</td>
<td>-3.2</td>
<td>46</td>
</tr>
<tr>
<td>Pay off existing debt</td>
<td>29</td>
<td>40</td>
<td>21,800</td>
<td>472</td>
<td>2,593</td>
<td>-6</td>
<td>52</td>
</tr>
<tr>
<td>Non-farm use:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Save it</td>
<td>31</td>
<td>49</td>
<td>28,100</td>
<td>535</td>
<td>4,030</td>
<td>6.2</td>
<td>13</td>
</tr>
<tr>
<td>Use in household</td>
<td>13</td>
<td>44</td>
<td>22,900</td>
<td>516</td>
<td>3,128</td>
<td>.6</td>
<td>38</td>
</tr>
<tr>
<td>Take a vacation</td>
<td>6</td>
<td>46</td>
<td>27,600</td>
<td>476</td>
<td>2,156</td>
<td>-3.6</td>
<td>17</td>
</tr>
<tr>
<td>Total</td>
<td>50</td>
<td>47</td>
<td>26,700</td>
<td>523</td>
<td>3,571</td>
<td>3.6</td>
<td>20</td>
</tr>
<tr>
<td>Total or average</td>
<td>144b</td>
<td>46</td>
<td>$23,268</td>
<td>479</td>
<td>$2,896</td>
<td>-.52</td>
<td>38</td>
</tr>
</tbody>
</table>

aBy analysis of variance test differences between "farm use," "pay off debt," and "non-farm use" groups is significant at 10 per cent level. Efficiency rating differences are not significant. Differences in other factors are significant at less than five per cent level.

bNo information was obtained from five operators. Two operators gave a combination of farm and non-farm use. These are not recorded above.
way up" in farming, still considerably in debt, but operating units that show a little more promise of earning their way.

The 50 operators who plan to use it for non-farm purposes are as old as the first group discussed, they are operating very large units, with a considerably larger investment than either of the other two groups. Their incomes averaging $3,571 are considerably above the $2,500 level for the other two groups. The efficiency with which they are using their resources reflects somewhat more efficient and profitable units. In light of the income position of this latter group, it seems quite rational that they should choose to use this prize fund for non-farm use.

It is particularly interesting to study the "save it" group. These 31 operators, are the oldest, are operating the largest units with over $28,000 investment, are earning over $4,000 labor income with a 6.2 efficiency rating. These operators probably represent the so-called "well-to-do" successful farmers of the community, who are quite satisfied with their farming operations and feel no great need for additional capital in the business. So, they prefer to save the prize money.

Contrast these "save it" operators with the "take a vacation" group. These six operators are operating with nearly the same investment but are earning the lowest incomes of any of the groups. Yet they would use the prize money for a vacation.

Note that 46 per cent of the group preferring farm use for this fund had indicated need for additional capital within the dairy enterprise. Had these operators been questioned regarding other parts of the farm business, perhaps many of them would have indicated need for additional
funds there also. Fifty-two per cent of the "pay off existing debt" group had indicated need for funds for dairy improvements. Contrast this with only 20 per cent of the "non-farm use" group who indicated lack of capital as retarding certain dairy improvements. Why should this latter group need funds in the dairy and yet propose to use the prize funds outside the business? Does it necessarily represent inconsistency on the part of these operators? The answer is probably not. They are simply placing a higher priority on the use of this newly injected capital outside the business than for the indicated need within the dairy enterprise.

Role of Psychological and Sociological Factors

Three major conclusions can be drawn from the preceding sections: (1) Knowledge has been demonstrated to be very important in correct decision-making. Imperfections in knowledge reflects itself in reduced efficiencies. (2) Assuming that the correct decisions have been made, the necessary capital funds must be available to effect certain of the proposed measures to improve the profitableness of the operation. The data disclosed that in those cases where there was insufficient capital, the efficiency of operations was affected significantly. (3) In most cases where the need for additional funds was indicated, the credit was considered to be available in the majority of cases, yet the operators preferred not to borrow the needed funds. Therefore, the capital rationing was mostly of the self-imposed type.

Therefore, empirical evidence presented thus far would suggest very strongly that limited knowledge hampers the casting of correct decisions
while shortage of capital places severe restrictions on the degree to which the proper decisions or plans can be implemented; both influencing the efficiency with which the dairy enterprise may be operated. These influences have been pointed out in number of different ways. Yet, would the removal of these two important limitations automatically result in the firm approaching an optimum position. To accomplish the latter, the operator must first be motivated to operate his firm in the optimum manner. To the extent that proper motivation is lacking, the removal of capital and knowledge limitations may not produce the expected improvement in the firm’s operation. The next logical question is: What factors may conditions the operators desire to strive for higher levels of performance within his operations?

Our friends in sociology and psychology would tell us that first the operator must derive from somewhere, some "fuel" for motivation. What is the nature of this motivation? What form does the source of motivation take in farming? What seems to propel the farmer toward more profitable levels of performance within the limits of his resources, setting aside any capital and knowledge limitations? The following discussion is directed toward this particular question.

Influence of farmers' concept of "good" production

One of the forces thought to condition a person's motivation is his concept of what he considers to be a good level of performance in his particular operations. The hypothesis being that if a person's concept of "good" performance is high, he may be motivated to strive toward this goal.
In attempting to test this hypothesis, each operator in the study was asked "What do you consider to be a good rate of milk production per cow as a herd average?"\(^1\) It was felt that the level of production\(^2\) indicated would in effect, be his "concept of good production." It must be recognized however, that his reply may only reflect his knowledge of what is generally regarded in the community as a "good" level of production on a herd basis. Even though his reply reflects the community concept rather than his own, his awareness of the community concept should be a motivating force in itself, since there is usually a desire to conform to community standards.

Analysis of the 83 operators who were able to give what they considered to be a "good" level of production per cow on a herd basis disclosed answers ranging from 15,000 pounds down to 6,000 pounds with an average of 10,268 pounds. To learn the relationship that this concept may have to certain personal and business factors, these operators were sorted into three groups as shown in Table 14, and averages on the factors were computed for each group.

The data would suggest that the dairymen's concept of a "good" rate of production apparently motivates him toward higher production for his

\(^1\)All annual levels of production per cow were converted to a four per cent fat corrected basis.

\(^2\)It was explained that the inquiry was directed toward no particular herd but was being asked in the interest of obtaining what the farmer considered in general to represent a "good" level of production as a herd average. Had the farmer been asked what he considered a "good" level of production for his herd, his answer would have been conditioned a great deal by the present quality of his herd and may not represent the long range "standard of good production" toward which he is striving to reach.
Table 14. Relationship of farmers concept of "good" level of performance to certain personal and business factors, 151 Central Pennsylvania dairymen, 1948-1949.

<table>
<thead>
<tr>
<th>What operator considers &quot;good&quot; level of production per cow</th>
<th>Cases</th>
<th>Concept level of production</th>
<th>Actual production per cow$^a$</th>
<th>Culling level for their herd$^a$</th>
<th>Size of herd$^a$</th>
<th>Value per cow$^a$</th>
<th>Returns above feed costs per cow$^a$</th>
<th>Knowledge score$^a$</th>
<th>Total capital$^a$</th>
</tr>
</thead>
<tbody>
<tr>
<td>11,000 lbs. or more</td>
<td>28</td>
<td>12,340</td>
<td>9,039</td>
<td>7,616</td>
<td>14.5</td>
<td>$303</td>
<td>$252</td>
<td>75.2</td>
<td>$28,217</td>
</tr>
<tr>
<td>9,500 to 10,999 lbs.</td>
<td>23</td>
<td>10,028</td>
<td>7,886</td>
<td>6,790</td>
<td>13.9</td>
<td>291</td>
<td>229</td>
<td>75.4</td>
<td>24,052</td>
</tr>
<tr>
<td>Below 9,500 lbs.</td>
<td>32</td>
<td>8,627</td>
<td>7,747</td>
<td>6,188</td>
<td>14.6</td>
<td>295</td>
<td>214</td>
<td>73.4</td>
<td>26,162</td>
</tr>
<tr>
<td>Doesn't know</td>
<td>68</td>
<td>--</td>
<td>7,465</td>
<td>5,925</td>
<td>11.9</td>
<td>262</td>
<td>197</td>
<td>55.3</td>
<td>19,566</td>
</tr>
<tr>
<td>Total or average</td>
<td>151</td>
<td>10,268</td>
<td>7,881</td>
<td>6,784$^b$</td>
<td>13.3</td>
<td>$281</td>
<td>$216</td>
<td>65.9</td>
<td>$23,251</td>
</tr>
</tbody>
</table>

$^a$Mean differences significant at five per cent level or less by analysis of variance test.

$^b$Based on replies of 72 operators. No information was available on the others concerning their culling level. The figure 5,925 pounds culling level for the "doesn't know" group is based on only two operators. Average culling levels above are based on 22, 20, and 26 cases respectively reading from top to bottom.
herd. For example, those operators who considered 11,000 pounds or better to be a good rate of production had herds averaging slightly over 9,000 pounds per cow as a herd average. Actual herd average production was considerably lower for those dairymen having a lower concept in mind.

Those dairymen with the high concept also would tend to cull their herds at a considerably higher level than would be true for those with a lower concept. Likewise their dairies yielded higher returns above feed costs per cow. Those operators with a lower concept had progressively lower producing herds which were yielding somewhat lower returns above feed costs.

One important conclusion can be drawn from the data in Table 14. It was only in those instances where the operator's concept of a "good" level of production was unusually high (11,000 pounds or over) that the operator's concept might be assumed to represent a motivating force toward higher levels of production for his herd (slightly over 9,000 pounds per cow) with the accompanying higher returns ($252 returns above feed costs per cow). Contrast this with the performance of those 68 operators who were unable to answer the question, which would suggest that they had no idea of what was considered a "good" level of production or were not even aware of the community concept. Their performance of 7,465 pounds of milk per cow and $197 returns above feed costs per cow does not compare too favorably.
Influence of farmers' standard

It was recognized in the preceding section that a farmer's concept of "good" production may not have been the "standard" that he had in mind for his own herd. In order to obtain a more positive indication of a farmer's "standard" which related directly to his own herd, each operator was asked the question: "Down to what level of milk production (on an annual production basis) must a cow drop before you cull her out of your herd?" Analysis of the answers showed a range from 11,500 pounds down to 3,000 pounds with an average of 6,743 pounds. These culling levels were considered to represent evidence of action being taken by each dairyman toward the achievement of his "standard of good production." The higher the culling level, the higher the level of production toward which he is attempting to reach as a herd average.¹

Those 72 operators who indicated a culling level for their herd were sorted into three culling level groups and then related to certain personal and business factors as a test of the influence of the operator's standard (Table 15). The table discloses two major points of interest.

1) Those operators with a high standard as reflected by their high culling level actually had much higher producing herds (averaging 9,107 pounds per cow), and were operating larger and more profitable dairies (15.3 cow dairies averaging $260 returns above feed costs per cow) with a more

¹It was recognized that the culling level of any one dairyman may be conditioned by his capital position, the stage of development of his herd, his patience in the development of the herd, and the degree of compromise in the dairyman's mind between size and quality of herd.
Table 15. Relationship of farmers culling level for his herd to certain personal and business factors, 151 Central Pennsylvania dairymen, 1948-1949.

<table>
<thead>
<tr>
<th>Operator's culling level</th>
<th>Cases</th>
<th>Average culling level</th>
<th>Actual milk per cow</th>
<th>Size of herd</th>
<th>Returns above feed costs per cow</th>
<th>Labor income</th>
<th>Knowledge score</th>
<th>Concept level of production</th>
</tr>
</thead>
<tbody>
<tr>
<td>7,500 lbs. or more</td>
<td>26</td>
<td>8,493</td>
<td>9,107</td>
<td>15.3</td>
<td>$260</td>
<td>$3,783</td>
<td>79.0</td>
<td>10,978</td>
</tr>
<tr>
<td>6,000 to 7,499 lbs.</td>
<td>22</td>
<td>6,680</td>
<td>7,701</td>
<td>14.9</td>
<td>220</td>
<td>3,471</td>
<td>73.2</td>
<td>10,035</td>
</tr>
<tr>
<td>Below 6,000 lbs.</td>
<td>21</td>
<td>4,956</td>
<td>7,544</td>
<td>12.7</td>
<td>204</td>
<td>2,254</td>
<td>70.2</td>
<td>9,634</td>
</tr>
<tr>
<td>Doesn't know</td>
<td>79</td>
<td></td>
<td>7,630</td>
<td>12.3</td>
<td>204</td>
<td>2,518</td>
<td>58.3</td>
<td>10,349</td>
</tr>
<tr>
<td>Total or average</td>
<td>151</td>
<td>6,783</td>
<td>7,881</td>
<td>13.3</td>
<td>$216</td>
<td>$2,833</td>
<td>65.9</td>
<td>10,268</td>
</tr>
</tbody>
</table>

\(^a\)All mean differences significant at less than five per cent level by analysis of variance test.

\(^b\)Based on 83 operators' concept of good production. No information was available on the others. Differences were not significant by analysis of variance test.
profitable overall farm business (average labor income of $3,783) than did those operators having lower culling levels or giving no culling level at all. (2) As was true in the case of the concept of good production, only an unusually high culling level seemed to influence to any great degree the production performance and profitableness of the dairy operations. Little difference was found on the business factors between the "medium" and "low" culling level groups and for that matter, between those and the "doesn't know" culling level group.

The data presented in Tables 14 and 15 would suggest that the performance levels in farming, particularly the dairy enterprise, are conditioned quite favorably by high "concepts" or "standards" of performance by the operators. Stated in another fashion, high standards apparently contribute to successful farming operations while low standards adversely influence performance levels.¹

Influence of operator's self rating

Another hypothesis tested in this study was the influence that a farmers' rating of his own performance relative to his neighbors has upon his achievement level. For instance, if a person feels that his performance is much higher than it actually is, as compared to his colleagues, this may discourage him from exerting himself toward higher levels of achievement. It was thought that many dairymen may consider their herds'

¹Although the casual relationship between "standards" and the degree of motivation was not established, the data suggests that high "standards" might serve as one means of motivating dairymen to take those measures which would improve their herd's performance.
production performance to be average or above, (a level at which they may be satisfied) when actually their herd's performance in considerably below average. This tendency to over-rate one's own performance was thought to be one of the explanations for "average" or "below average" dairymen not taking measures to improve their position.

To get evidence concerning the tendency to over-rate one's self it was necessary to get each operator to rank himself on a 10 point scale as to where he thought his herd's production per cow ranked in comparison to his neighbors. A distribution of these rankings are presented in Table 16. Note the tendency for the rankings to cluster near the average (number 5 on the scale) or above average, even though it was made clear to the interviewee that not all dairymen could be average. Only 13 ranked themselves below the fifth decile. Our attention will first be directed toward the relationship of the farmer-rated positions to certain personal and business factors. Do those operators who rank themselves high on herd production differ from those who rank themselves lower? Do their dairies perform any differently? 1

A study of Table 16 reveals that those who feel that their herd's average production would rank them at or near the top in comparison to their neighbor's are only slightly younger than those ranking themselves lower, but they have made generally higher scores on the dairy knowledge test, are operating larger dairies, and larger overall businesses with

1It is possible that bias on the part of the farmer could enter into his answer. The farmer may realize that he would rank near the bottom but prefer not to admit this to the enumerator.
<table>
<thead>
<tr>
<th>Farmer's idea of where his herd's production would rank him compared to neighboring dairymen</th>
<th>Cases</th>
<th>Age of operator</th>
<th>Knowledge score</th>
<th>Size of herd</th>
<th>Actual milk per cow</th>
<th>Value per cow</th>
<th>Returns above feed costs per cow</th>
<th>Labor income</th>
<th>Per cent operators satisfied with present operation of farm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper two deciles</td>
<td>44</td>
<td>44.3</td>
<td>71.6</td>
<td>15.2</td>
<td>8,557</td>
<td>319</td>
<td>$242</td>
<td>$3,836</td>
<td>57</td>
</tr>
<tr>
<td>Second two deciles</td>
<td>29</td>
<td>44.4</td>
<td>69.2</td>
<td>13.1</td>
<td>8,441</td>
<td>293</td>
<td>229</td>
<td>3,019</td>
<td>54</td>
</tr>
<tr>
<td>Fifth decile</td>
<td>60</td>
<td>47.5</td>
<td>58.5</td>
<td>11.9</td>
<td>7,453</td>
<td>258</td>
<td>207</td>
<td>2,118</td>
<td>36</td>
</tr>
<tr>
<td>Lower five deciles</td>
<td>13</td>
<td>47.1</td>
<td>71.7</td>
<td>14.3</td>
<td>6,662</td>
<td>235</td>
<td>157</td>
<td>2,635</td>
<td>23</td>
</tr>
<tr>
<td>Total or average</td>
<td>146</td>
<td>45.9</td>
<td>65.8</td>
<td>13.3</td>
<td>7,913</td>
<td>281</td>
<td>$217</td>
<td>$2,861</td>
<td>45</td>
</tr>
</tbody>
</table>

*Mean differences are significant at less than five per cent level by analysis of variance test except for age of operator.*
In the Swedish section, various concepts were discussed, including the idea of cooperating in a formal way. The text mentions that the cooperation was based on the agreement of the companies involved.

The text also mentions a tendency to over-rate or under-rate certain aspects, which are related to the performance of the cooperatives. The cooperatives are discussed in terms of their performance, with a particular emphasis on the performance of the Swedish cooperatives.

It is mentioned that the cooperatives have a tendency to over-rate or under-rate certain aspects, which are related to the performance of the cooperatives. The cooperatives are discussed in terms of their performance, with a particular emphasis on the performance of the Swedish cooperatives.

The cooperatives are mentioned in terms of their performance, with a particular emphasis on the performance of the Swedish cooperatives. The cooperatives are discussed in terms of their performance, with a particular emphasis on the performance of the Swedish cooperatives.

The cooperatives are mentioned in terms of their performance, with a particular emphasis on the performance of the Swedish cooperatives. The cooperatives are discussed in terms of their performance, with a particular emphasis on the performance of the Swedish cooperatives.

The cooperatives are mentioned in terms of their performance, with a particular emphasis on the performance of the Swedish cooperatives. The cooperatives are discussed in terms of their performance, with a particular emphasis on the performance of the Swedish cooperatives.

The cooperatives are mentioned in terms of their performance, with a particular emphasis on the performance of the Swedish cooperatives. The cooperatives are discussed in terms of their performance, with a particular emphasis on the performance of the Swedish cooperatives.

The cooperatives are mentioned in terms of their performance, with a particular emphasis on the performance of the Swedish cooperatives. The cooperatives are discussed in terms of their performance, with a particular emphasis on the performance of the Swedish cooperatives.

The cooperatives are mentioned in terms of their performance, with a particular emphasis on the performance of the Swedish cooperatives. The cooperatives are discussed in terms of their performance, with a particular emphasis on the performance of the Swedish cooperatives.

The cooperatives are mentioned in terms of their performance, with a particular emphasis on the performance of the Swedish cooperatives. The cooperatives are discussed in terms of their performance, with a particular emphasis on the performance of the Swedish cooperatives.

The cooperatives are mentioned in terms of their performance, with a particular emphasis on the performance of the Swedish cooperatives. The cooperatives are discussed in terms of their performance, with a particular emphasis on the performance of the Swedish cooperatives.

The cooperatives are mentioned in terms of their performance, with a particular emphasis on the performance of the Swedish cooperatives. The cooperatives are discussed in terms of their performance, with a particular emphasis on the performance of the Swedish cooperatives.

The cooperatives are mentioned in terms of their performance, with a particular emphasis on the performance of the Swedish cooperatives. The cooperatives are discussed in terms of their performance, with a particular emphasis on the performance of the Swedish cooperatives.

The cooperatives are mentioned in terms of their performance, with a particular emphasis on the performance of the Swedish cooperatives. The cooperatives are discussed in terms of their performance, with a particular emphasis on the performance of the Swedish cooperatives.

The cooperatives are mentioned in terms of their performance, with a particular emphasis on the performance of the Swedish cooperatives. The cooperatives are discussed in terms of their performance, with a particular emphasis on the performance of the Swedish cooperatives.

The cooperatives are mentioned in terms of their performance, with a particular emphasis on the performance of the Swedish cooperatives. The cooperatives are discussed in terms of their performance, with a particular emphasis on the performance of the Swedish cooperatives.

The cooperatives are mentioned in terms of their performance, with a particular emphasis on the performance of the Swedish cooperatives. The cooperatives are discussed in terms of their performance, with a particular emphasis on the performance of the Swedish cooperatives.

The cooperatives are mentioned in terms of their performance, with a particular emphasis on the performance of the Swedish cooperatives. The cooperatives are discussed in terms of their performance, with a particular emphasis on the performance of the Swedish cooperatives.

The cooperatives are mentioned in terms of their performance, with a particular emphasis on the performance of the Swedish cooperatives. The cooperatives are discussed in terms of their performance, with a particular emphasis on the performance of the Swedish cooperatives.

The cooperatives are mentioned in terms of their performance, with a particular emphasis on the performance of the Swedish cooperatives. The cooperatives are discussed in terms of their performance, with a particular emphasis on the performance of the Swedish cooperatives.

The cooperatives are mentioned in terms of their performance, with a particular emphasis on the performance of the Swedish cooperatives. The cooperatives are discussed in terms of their performance, with a particular emphasis on the performance of the Swedish cooperatives.

The cooperatives are mentioned in terms of their performance, with a particular emphasis on the performance of the Swedish cooperatives. The cooperatives are discussed in terms of their performance, with a particular emphasis on the performance of the Swedish cooperatives.

The cooperatives are mentioned in terms of their performance, with a particular emphasis on the performance of the Swedish cooperatives. The cooperatives are discussed in terms of their performance, with a particular emphasis on the performance of the Swedish cooperatives.

The cooperatives are mentioned in terms of their performance, with a particular emphasis on the performance of the Swedish cooperatives. The cooperatives are discussed in terms of their performance, with a particular emphasis on the performance of the Swedish cooperatives.

The cooperatives are mentioned in terms of their performance, with a particular emphasis on the performance of the Swedish cooperatives. The cooperatives are discussed in terms of their performance, with a particular emphasis on the performance of the Swedish cooperatives.

The cooperatives are mentioned in terms of their performance, with a particular emphasis on the performance of the Swedish cooperatives. The cooperatives are discussed in terms of their performance, with a particular emphasis on the performance of the Swedish cooperatives.

The cooperatives are mentioned in terms of their performance, with a particular emphasis on the performance of the Swedish cooperatives. The cooperatives are discussed in terms of their performance, with a particular emphasis on the performance of the Swedish cooperatives.

The cooperatives are mentioned in terms of their performance, with a particular emphasis on the performance of the Swedish cooperatives. The cooperatives are discussed in terms of their performance, with a particular emphasis on the performance of the Swedish cooperatives.

The cooperatives are mentioned in terms of their performance, with a particular emphasis on the performance of the Swedish cooperatives. The cooperatives are discussed in terms of their performance, with a particular emphasis on the performance of the Swedish cooperatives.

The cooperatives are mentioned in terms of their performance, with a particular emphasis on the performance of the Swedish cooperatives. The cooperatives are discussed in terms of their performance, with a particular emphasis on the performance of the Swedish cooperatives.
their herds' production relative to neighboring dairies and if so, by how much and by what type of dairyman?

Incidence and influence of over and under-rating

The accuracy with which these dairymen rank themselves is presented in Table 17. As contrasted with Table 16 where the sorting was based on the farmers' own rated position, in Table 17, the dairymen are sorted into deciles according to their actual milk sold per cow and comparisons are made with their own idea of where they ranked to disclose the incidence and degree of over and under-rating or correct rating. Note the rather heavy concentrations in the upper six deciles when arrayed on the basis of actual milk sold per cow. This is explainable in that the production per cow of the operators included in this study averaged from 200 to 300 pounds higher than for all operators on which information was available (Table 1).

Three major observations can be made based on the comparisons in Table 17. (1) There is a tendency for those dairymen whose actual herd average ranks them in the upper 20 per cent within their area to rate

of herd was available on 484 operators out of the 504 eligible operators. The actual array was then based on milk sold per cow. This method was thought to more nearly represent the inclusion of those dairymen which the operator had in mind in ranking themselves and thus seemed to be a fair and objective basis for comparison purposes. When the comparisons were based on an array of the 484 farms on a total area basis rather than arraying within each of four separate areas a slightly higher incidence of over-rating and less under-rating resulted. When the comparisons were based on an array of only the operators in this study (151), a much higher incidence of over-rating with a lower incidence of under-rating resulted. For these reasons, the array of the 484 operators within each of the four smaller areas was used.
<table>
<thead>
<tr>
<th>Actual deciles ranking when arrayed on milk sold per cow</th>
<th>Number of operators</th>
<th>Operators giving their ranking</th>
<th>Average decile ranking</th>
<th>Cases of correct ranking</th>
<th>Cases of over-ranking</th>
<th>Average deciles of over-ranking</th>
<th>Cases of under-ranking</th>
<th>Average deciles of under-ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper two deciles</td>
<td>38</td>
<td>38</td>
<td>2.9</td>
<td>15</td>
<td>2</td>
<td>1.0</td>
<td>21</td>
<td>2.8</td>
</tr>
<tr>
<td>Third and fourth deciles</td>
<td>38</td>
<td>37</td>
<td>3.6</td>
<td>5</td>
<td>14</td>
<td>1.8</td>
<td>18</td>
<td>1.5</td>
</tr>
<tr>
<td>Fifth and sixth deciles</td>
<td>39</td>
<td>38</td>
<td>4.1</td>
<td>5</td>
<td>30</td>
<td>1.9</td>
<td>3</td>
<td>2.0</td>
</tr>
<tr>
<td>Seventh and eighth deciles</td>
<td>22</td>
<td>21</td>
<td>4.6</td>
<td>1</td>
<td>20</td>
<td>3.0</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>Bottom two deciles</td>
<td>14</td>
<td>12</td>
<td>4.4</td>
<td>0</td>
<td>12</td>
<td>4.8</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>Total or average</td>
<td>151</td>
<td>146</td>
<td>3.75</td>
<td>26</td>
<td>78</td>
<td>2.63</td>
<td>42</td>
<td>2.17</td>
</tr>
</tbody>
</table>

*Information on the amount of milk sold and size of herd was available on 48 of the 50 farms originally contacted whereas milk produced per cow was available only on those 273 farms from which complete records were obtained for the cost of the milk production study. Farmers were, therefore, arrayed on milk sold per cow since it permitted the inclusion of a much higher percentage of all dairymen in the area.*
themselves properly or to under-rate themselves. For instance, of the 38 dairymen whose herds actually rank in the upper two deciles, 15 had ranked themselves properly while 21 under-rated themselves by an average of 2.8 deciles. Only two operators of this group over-rated themselves. (2) Those operators whose actual herd average ranks them toward the bottom of the array as compared to their neighbors tend to over-rate themselves. For example, of the 33 operators who ranked in the lower 40 per cent, 32 of them over-rated themselves by an average of 3.7 deciles while only one operator ranked himself properly. (3) Overall, there appears to be a tendency to more often over-rate one's self than to under-rate. Notice that of the 146 operators who ranked themselves, 78 over-rated themselves, 42 under-rated themselves while only 26 rated themselves properly.

What do these observations mean in terms of explaining farmers' actions? What, if any, differences exist between the ones who tend to over-rate themselves as compared to those who under-rate themselves or rate themselves properly? A comparison of these groups on certain personal and business factors reveals no appreciable differences in age of operators, or size of their herds (Table 18). The group ranking themselves properly made the best score on the dairy knowledge test, and were apparently more progressive. However, the 14 operators who severely under-rated themselves by three to four deciles had by far the highest producing herds, averaging 9,598 pounds per cow with $281 returns above feed cost per cow. Those ranking themselves properly had herds performing nearly comparable to these 14 operators who severely under-
Table 18. Relationship of how close the farmer's own ranking on herd production compares to the actual ranking of his herd's production within his community to certain personal and business factors, 151 Central Pennsylvania dairymen, 1948-1949.

<table>
<thead>
<tr>
<th>Comparison of farmer's own rating as compared to actual ranking for his herd's production</th>
<th>Cases</th>
<th>Average deciles of farmer rating&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Age of operator</th>
<th>Knowledge score</th>
<th>Per cent using hybrid corn 1941 or earlier&lt;sup&gt;b&lt;/sup&gt;</th>
<th>Size of herd&lt;sup&gt;c&lt;/sup&gt;</th>
<th>Actual production per cow</th>
<th>Returns above feed costs per cow</th>
</tr>
</thead>
<tbody>
<tr>
<td>Under-rates himself by 3 to 4 deciles</td>
<td>14</td>
<td>5.14</td>
<td>43.7</td>
<td>63.8</td>
<td>57</td>
<td>12.4</td>
<td>9,598</td>
<td>281</td>
</tr>
<tr>
<td>Under-rates himself by 1 to 2 deciles</td>
<td>28</td>
<td>4.65</td>
<td>45.7</td>
<td>63.8</td>
<td>46</td>
<td>12.7</td>
<td>8,190</td>
<td>230</td>
</tr>
<tr>
<td>Rates himself properly</td>
<td>26</td>
<td>4.04</td>
<td>44.1</td>
<td>72.2</td>
<td>48</td>
<td>14.2</td>
<td>9,066</td>
<td>265</td>
</tr>
<tr>
<td>Over-rates himself by 1 to 2 deciles</td>
<td>45</td>
<td>4.02</td>
<td>48.0</td>
<td>67.8</td>
<td>33</td>
<td>13.3</td>
<td>7,335</td>
<td>189</td>
</tr>
<tr>
<td>Over-rates himself by 3 or more deciles</td>
<td>33</td>
<td>2.91</td>
<td>45.5</td>
<td>60.7</td>
<td>39</td>
<td>13.5</td>
<td>6,842</td>
<td>181</td>
</tr>
<tr>
<td>Total or average</td>
<td>146</td>
<td>45.9</td>
<td>65.8</td>
<td>42</td>
<td>13.3</td>
<td>7,193</td>
<td>217</td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup>A rating of one (1) indicates that he felt that his herd's production would rank at the top while a rating of 10 indicated that he felt it would rank at the bottom.

<sup>b</sup>Difference significant at less than five per cent level by chi square test.

<sup>c</sup>Mean differences not significant on this factor. All other mean differences are significant at less than five per cent according to analysis of variance test.
rated themselves. On the other hand, those operators over-rating themselves, particularly the severely over-rated group had herds averaging only 6,842 pounds and yielding only $181 above feed costs per cow.

Perhaps, the fact that operators of "poor" herds almost consistently over-rate themselves may be a partial explanation as to why they have low-producing herds. The mere fact that some think their herd's performance is much higher than it actually is (as compared with their neighbors) may discourage taking any measures to improve their position. On the other hand, the fact that some dairymen tend to under-rate themselves may serve as a motivating force to encourage them to take those measures which would improve their herd's performance—the result being a top-notch herd.

In this connection it is significant that in over-rating themselves, the severely over-rated group ranked themselves significantly higher on the production scale (average decile ranking of 2.91) than any of the other groups. The severely, under-rated group, on the other hand, ranked themselves near the average (average decile ranking of 5.14).

One would expect to find a greater tendency on the part of the under-rated group to have taken more measures to improve their herd's production than was true for the over-rated group. Yet, the data does not support this notion. Neither is there any evidence that the under-rated group has any greater intentions of taking appropriate measures in the future. The fact that the actual production per cow of the under-rated group is considerably higher would suggest that the efficiency and determination in carrying out these measures was high on the part of the under-rated group.
In other words, the "degree" of motivation may still have been less in the case of the over-rated operators.
IMPLICATIONS OF THE STUDY

The empirical evidence presented in this study has implications not only for teachers and extension personnel but to research workers as well. The data demonstrates quite clearly the unreality in assuming that operators always have the proper knowledge with which to make correct decisions. Extension personnel should bear in mind the knowledge limitations of many of their farmer contacts. Even with adequate knowledge, there still may exist some doubt in the operator's mind as to the profitability of the measure. This doubt may arise from imperfect knowledge concerning the technical response that might be expected, or expectations as to costs involved and possible future product prices.

The results of the knowledge test employed in this study which quizzed the farmer over the technical phases of dairy production would suggest that a high proportion of our farmers are lacking much of the basic knowledge required for proper decision-making. (Scores ranged from 96 down to 10 with an average of 66 based on a perfect score of 100). The gap between the present state of knowledge of many farmers and that required to actually adopt improved practices may be greater than frequently appreciated. The final result is only a mediocre level of performance where the available resources might suggest much higher levels of accomplishment. The importance of overcoming knowledge deficiencies is suggested by the fact that those operators who made high scores on the knowledge test had higher-producing herds, which yielded higher returns above feed costs per cow and averaged higher labor incomes as well.
The recommendations referred to may represent only one practice or they may take the form of recommendations requiring some substantial modifications in the overall farm organization and operation. The latter would probably require knowledge on many new practices to effect the changes. A good example of this is the shift to a "grassland" system of farming. This represents a major shift in emphasis from "grain farming" to more grass. The knowledge test indicated that many farmers fail to appreciate the relative TDN output from good pastures as compared to other crops. Likewise they lack knowledge of how to produce ample quantities of good forage. And finally, and most important, they fail to appreciate the low cost of TDN from forage sources and thus neglect to substitute them at high levels for grain which represents a more expensive source of TDN.

As important as knowledge is, this study makes it clear that lack of knowledge by no means accounts for all of the failures to adopt improved practices. A farmer may have full appreciation of the profitableness of the measures, of the costs involved and possess the "know-how" to carry through with the practice as recommended. Then why does he fail to take the appropriate action? The answer quite frequently, as evidenced by this study is a lack of necessary funds. Thirty-eight per cent of the operators in this study indicated need for additional funds to effect certain measures that they were interested in taking. We further ask ourselves—if these operators fully appreciate the profitableness of the measure, do they plan to secure the necessary credit? Eighty-eight per cent of the operators who needed additional funds felt certain
that they could obtain the needed credit. Out of these 51 operators who felt the credit to be available, 15 indicated they did not intend to borrow. This complicates the problem even more since making credit available is not the answer to this capital rationing problem in most cases. The existence of indebtedness and uncertainty explained reasons for not borrowing in half the cases. The revealing evidence is that over one-third of them just "do not like to borrow money."

Herein lies an important limitation to the effectiveness of our educational efforts with farm people. Despite efforts to carry out a strong extension program, the degree to which farmers would carry out the recommended practices may be conditioned, not so much by the availability of knowledge and credit but more so, by the attitude toward borrowing. It is difficult to persuade many farmers to borrow needed funds even though the earning rate on the borrowed funds may be high. They apparently take great pride in being relatively debt free. Yet, to compete in an economy which requires a large amount of capital, those taking this conservative attitude are seriously influencing not only the efficiency with which their own resources are employed but the productivity of all resources in agriculture as well.

The importance of this attitude toward borrowing is most serious in those cases when adoption of the practice requires a substantial amount of capital. Yet, the adoption of many improved practices do not require large outlays of capital. For example, it was found that a great many measures were taken by those operators with a low capital investment. But these measures were of the type which required very limited capital
were operated
in the
and knowledge
and the
expected improve-
movement in the
in the necessary
onty the
was to be achieved or
must be interpreted
and the
in the most
operative
and the
we were removed.
and capital
been
we were removed, could we
assume the
in the
are accessible
and capital
the importance
of
the
and the
improvement of
need to improve the
of
some
some camera beyond
consequence
of
the
the
they
the
on the part of
many cameras to
follow the funds
degree of
an erector
answers to these are
as over;
their
an erector
the
proposed to reduce the
and camera
what camera
where it comes
de to take, we are
and camera
in
the
as the time made of
an erector
in
A
when
the
subject
to be
to unerector
the
are responsible
for the
that
would be
to some
what
some erector
of
the
study, perhaps
more of our research
research
research
the
of
the
are to
assumed out of the
the
the camera
of capital
for our research
worker
and the
improvement
The
were
most
with a
larger
such as
they
to
or
of
equal
the
or
amount of
capital
measures, which
a substantial
increase
and

- 152 -
This study suggests that the dairyman's concept of "good" production or his "standard of good production" as reflected by his culling level apparently serves as a source of motivation to improve his herd's production. It was shown that those operators with high "concepts" and "standards" were operating dairies with herds averaging well above their neighbors who had lower "concepts" and "standards." Another source of motivation is derived from how the farmer thinks his herd's performance compares with his neighbors. It was found that those operators who tend to under-rate their herd's performance are actually operating herds with unusually high production and returns above feed costs. Whereas, those who felt their herd's performance would rank them much higher than they actually are, when compared on an actual data basis, are operating dairies with lower producing herds yielding only fair returns above feed costs. The fact that some farmers think their herd's performance is much better than it actually is (as compared to their neighbors) may discourage them from taking the appropriate measures to improve their production. These data suggest that farmers' concepts and self-ratings may be quite influential in affecting their performance and hence imply that they constitute a general problem area of considerable importance to both research and extension workers.

Basically this study has been concerned with the importance of such factors as knowledge, capital, and such human attributes as operator's concepts and self-ratings which frequently have been neglected in farm management research and education. As such, it has succeeded in pointing out that these and other factors associated with the complex human factor
in agriculture may be of strategic importance in explaining farmers' actions in the use of their resources. On the other hand, it has not moved very far towards a fundamental explanation of farmers' actions and decisions or in quantifying their relative importance. The experience gained in this analysis strongly suggests that real progress in this direction will require the concentrated and coordinated attention of psychologists, sociologists, and economists to specific problem areas such as economic and psychological uncertainty, motivation, and goals.
LIMITATIONS OF TABULAR ANALYSIS AND SUGGESTED ALTERNATIVE ANALYSES

The economic models presented earlier serve as theoretical solutions to the problem. As such, they provide the hypotheses for testing. They also identify the variables concerned and the functional relationships between these variables. The object of any study or experiment is to identify these theoretical variables and relationships with actual data or relationships in order to test the model or hypotheses. The model should spell out in advance the bases on which the hypotheses will be accepted or rejected. One of the most important steps in this advance planning is the choice of the appropriate statistical tools. The statistical tools available should be considered in the development of the model. It is possible that models may be developed involving variables which cannot be satisfactorily identified or measured in the "real" world or may suggest relationships between variables which may never exist. It is also possible that appropriate statistical procedures have not yet been perfected to efficiently test the hypotheses developed and for which the necessary data had been collected. Therefore, it is very important for the research worker to determine in advance if the appropriate research procedures and statistical tools are available. If they are not, then it is fruitless to proceed with the proposed study. The discussion to follow appraises the research procedure and statistical tools employed in this study.

The analysis employed in this study was of a tabular nature. It is referred to as cross-classification in much of the literature. Basically,
the method is one of sorting observed units into categories or sort classes based on one of the variables which is usually assumed to be of an independent nature. Averages, usually assumed to be of a dependent nature, are then computed for each of these sort classes on a number of other variables. The relationship is examined by comparing the differences in the averages of the second variable (dependent variable) for different values of the first variable (independent variable). This assumes that the relationship of the dependent variable to the independent variable is not influenced by other "independent" variables. In other words, it is assumed that there are no appreciable interactions among the "independent" variables. If there is a sufficient number of sort classes, a comparison of the calculated averages for the dependent variable between each sort class would suggest whether any relationship between the variables existed and whether this relationship is of a linear or curvilinear nature.

Several very important advantages have been advanced in favor of tabular analysis:

1. Simplicity of calculations.

2. It is a flexible type of analysis. It does not assume the form of the relationships between the dependent and independent variates before the analysis is started but rather permits the research worker to explore his data for any possible relationships.

3. Permits tests of significance although the tests may not be particularly efficient.

However, the method of cross-classification has two major shortcomings. First, the number of cases required for reliable results is quite large. This is true even for a two-variate analysis. It becomes easy
to visualize the large number of observations required for multivariate analysis. For this reason, treatment of a large number of variables by this method of analysis has very limited application.

Secondly, the method provides no measure of how important the relationship shown is as a cause of variation in the variable being studied or how closely the variable may be estimated (predicted) from assigned values of any independent variable.

Thirdly, there is an important danger that false conclusions might be reached because of the assumption that there are no interactions with the variables not being considered.

When data are analyzed by the cross-classification method, the differences among the group averages can be tested for significance by analysis of variance. This procedure relates only to the significance of the observed differences and not to the functional nature of the relations which underlie those differences. Averages by themselves give no indication of the closeness of correlation. Analysis of variance also ignores ordering of the data. It is also assumed in analysis of variance that the effects of the independent factors are additive. However, analysis of variance can be used in cases where the effects are not additive if the proper models including interactions are assumed.

Another method of analysis which could have been used in this study is regression analysis. Regression analysis has the following advantages over tabular analysis:

1. Permits precision in measuring the change in the dependent variable associated with changes in the independent variable
(2) Permits more precise tests of significance
(3) May permit an analysis of causal effects
(4) Requires a smaller number of observations to examine relationships.

Regression analysis will usually prove to be a somewhat more costly analysis than tabular analysis, particularly if a large number of observations are being considered. However, the added information and precision of regression analysis will usually offset its higher costs. Since the regression analysis is usually more precise, there may be cases where the analysis of variance will not indicate any relationship between two variates, when actually a significant relationship exists. A possible example is given in Figure 29. If the data are sorted on the independent variable into only two sub-classes the difference between the mean value of the dependent variable for each of these sub-classes ("A" and "B") may not prove significant. By fitting the proper regression line to the data and testing the regression coefficient, the relationship may be demonstrated to be of curvilinear nature. In instances where the data are clustered very close to a linear regression line and the regression coefficient is small, an analysis of variance test may not detect this high degree of correlation between the two variables (Figure 30).

Therefore, neglecting to employ more precise and efficient statistical techniques, when adaptable to the data, may result in a severe loss of information. Not only may it represent an inefficient use of the data, but even more important, the wrong conclusions may sometimes be drawn from the analysis.
Dependent variable \( y \)

Independent variable \( x \)

Figure 29. Curvilinear relationship between two variables

Dependent variable \( y \)

Independent variable \( x \)

Figure 30. Regression of \( y \) on \( x \) with nearly perfect correlation
However, many unsatisfactory results have been obtained in the past from the use of multiple and partial regression analysis because inappropriate models were used. For example, models were used assuming that the independent variables were not related when it was well known that important joint relationships existed. The use of the tabular method does not avoid this difficulty. More research is needed to provide useful models, in terms of both economics and statistics. In addition, means for obtaining more accurate and appropriate data for testing these models are needed.

When one is concerned primarily with detecting difference in classification or sub-classes of the independent variables, analysis of variance is usually sufficient. However, if one desires a precise measure of the relationship between the variates, some form of regression analysis is usually more appropriate.

Since the isolation of the factors which were related to performance levels in farming was of primary concern in this investigation, tabular analyses with analyses of variance seemed sufficient for purposes of analysis. The functional relationships and the relative importance of these isolated factors (variables) constitute an additional study which is greatly needed. If such a study were conducted, some form of regression analysis would probably be the more appropriate statistical technique to employ. It also seems logical to assume that some form of simultaneous equation approach would be applicable in this general area, particularly in light of the joint relationships between many of the variables concerned.
It is obvious then that this phenomena can be analyzed by one or a combination of three statistical procedures, namely: a simplified tabular analysis, some form of "least squares" regression analysis or by the simultaneous equation approach. There are some aspects of this general area to which the tabular analysis is as efficient as the more complex procedures. However, as pointed out in this section, there are instances where the tabular approach is not only inefficient but may lead to erroneous conclusions. The real problem lies in determining the appropriate statistical procedure to employ in each case. Perhaps, more attention should be devoted to methodological studies of the appropriate statistical procedures and tools before attempting to study the phenomena itself.
ACKNOWLEDGMENTS

The author wishes to express his deep appreciation to the several persons who gave valuable criticism and assistance during the course of this study. The advice, encouragement and assistance of Dr. L. F. Miller of The Pennsylvania State University has been especially valuable throughout all stages of the study. Appreciation is also extended to Dr. Earl O. Head for his valuable assistance and criticism in the development of the theoretical framework for the problem and in the organization and writing of the dissertation.

Dr. M. E. John, Head of the Department of Agricultural Economics and Rural Sociology of The Pennsylvania State University, furnished some very valuable suggestions in the designing of the questionnaire and in the analysis of the psychological and sociological phase of the study.
APPENDIX
Note on Sampling Procedure

This appendix is designed to provide additional information on the manner in which the sample for this study was drawn since it was a sub-sample of a larger sample for a previous study.

The population sampled for the previous study was defined as all dairymen located on the limestone soils of a 21 township geographical area surrounding the town of State College in Central Pennsylvania. A dairy farm was defined as one in which an average of six or more dairy cows were being maintained and from which fluid milk had been sold for at least nine months of the year previous to that study. This population was randomly sampled for the purpose of a cost of production and labor income study in 1948 and 1949.

A tentative listing of all dairymen (including owners and tenants) in the delineated area disclosed a total of 719 such farms. One third of this number (239 farmers) were randomly sampled for the "cost account" method of gathering the necessary data. Since the remaining 480 operators were considered more than necessary, three fourths of these were randomly sampled for the "survey" approach.

Upon contacting these 599 farmers, (239 for account purposes and 360 for surveying purposes) some were found ineligible according to the definition of a "dairyman" as developed. Others were not planning to stay on the farm for the necessary length of time. A final count showed only 504 eligible dairymen out of the 599 contacted. These 504 operators were asked to cooperate on the study. From this number
273 usable cost of production schedules and labor income statements were obtained. The remainder represented refusals to cooperate upon being contacted or dropped out of the account group before the end of the accounting year. The data was considered incomplete or unreliable in a considerable number of other cases.

For the reasons spelled out in the earlier sampling discussion, it was decided for this study to sample those operators in the previous study on which cost and income data was already available. Since tenants are considered to be less stable and may tend to rationalize many of their decisions and actions in light of their tenure arrangements, it was decided to stratify the sampling population for this study to those owners in a more restricted geographical area (to a 17 township area rather than the 21 township area as delineated for the previous study). All of the 162 owner-operated dairies in this restricted area, on which cost and income data was available from the previous study, were contacted for this study in 1949. Two of this number refused to cooperate. Nine of the 160 questionnaires obtained were discarded because of incompleteness. The remaining 151 questionnaires were analyzed for purposes of this study.

Therefore, the population to which inferences can be made from this study is represented by all owner-operated dairies in the restricted 17 township area extending over Centre County and parts of Clinton and Huntington Counties in Central Pennsylvania.