FACTORS AFFECTING TRACTOR PURCHASES AND EXPENDITURES

Thesis for the Degree of M.S.

MICHIGAN STATE UNIVERSITY

A.R. Jones

1966

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FACTORS AFFECTING

TRACTOR PURCHASES AND EXPENDITURES

by

A. R. Jones

A THESIS

Submitted to
Michigan State University
in partial fulfillment of the requirements
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ABSTRACT

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By A. R. Jones

Monetary variables form the hard core of factors used in the forecasting of investment spending. These are measures of ability to invest. Recently, attention has been directed towards the improvement of demand forecasts through incorporating a measure of willingness to invest. This new forecasting approach, using intentions data, infers that purchases will only be made when the ability to invest is coupled with willingness to invest. Measurement of willingness to invest usually involves studying purchase intentions. Additionally, there is some evidence indicating that the probability of purchase (strength of intent) influences both purchases and expenditures.

The objectives of this study were (1) to determine if the purchase intentions of farmers are significant indicators of actual tractor purchases and expenditures, (2) to ascertain which of the various physical and financial factors commonly included in farm records have value in predicting tractor purchases, and (3) to identify the combination(s) of factors most useful in the prediction of tractor purchases and expenditures.

Mail questionnaires, completed by farmers enrolled in Michigan State Mail Account project for the years 1960 and 1961, provided the data on strength of intent and the intended expenditures. The

respondents' farm records provided information on tillable acreage farmed, previous and current year's disposable income, change in disposable income, the value of the opening inventory machinery investment, the annual hired labor cost, tractor purchases and the expenditure made.

This research demonstrated that intentions data make a significant contribution to the explanation of buying behavior beyond that possible with financial variables alone. However, since the predictive ability of strength of intent and intended expenditure was not the same in both years, one must be careful not to form an exaggerated opinion of their accuracy and empirical stability. Strength of intent was found more valuable for the prediction of tractor purchases than for the prediction of tractor expenditures. Intended expenditures had greater predictive ability in expenditure equations than strength of intent.

Of the variates recorded in account books and tested, either previous year's disposable income or machinery investment may furnish information on buying behavior which is not provided by strength of intent or intended expenditure. However, for those respondents indicating a "no chance of buying" intent, current and change in disposable income are needed to explain their subsequent buying behavior.

Strength of intent designations such as "very certain", "quite certain", "fair chance" and "slight chance" were found more effective in predicting tractor purchases than the less specific intent categories, i.e., "some chance" and "no chance". This research also indicates that "very certain" and "quite certain" categories can be combined without significantly altering their predictive value.

Intended expenditure was a very effective predictor of the tractor expenditures of those who expected to purchase without a trade-in of their present tractor. It was a relatively ineffective predictor of the expenditures of those who expected to purchase with a trade-in. Annual hired labor cost emerged as a dominant factor influencing intended expenditures.

More data might permit more accurate predictions of tractor purchases and expenditures. Company and/or dealer policy regarding length of time tractor parts are stocked for particular models, tractor operating hours per year, total tractor hours operated and total tax deductions for depreciation of farm machinery probably warrant inclusion in future prediction models of tractor purchases and expenditures.

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A special word of thanks is due my wife, Mary; my former director, Mr. S. S. Graham; and my present director, Dr. G. Purnell; who encouraged my post graduate training and the completion of this thesis.

A. R. Jones

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CHAPTER I

INTRODUCTION

The continual and most pressing managerial problems of farm machinery manufacturers involve planning what to do in the next few months. Management must predict the likely demand for tractors over some future time period. Which factors to consider and how to predict with an acceptable degree of accuracy continues to be a baffling problem for those who have the responsibility of seeing that their firm's resources are used most effectively.

Because of expediency and mental limitations in handling a large number of variables, management must usually resort to the consideration of only a few variables. Even when it is economically feasible to use computers to handle several variables there is still the problem of selecting relevant variables for the farm machinery business. Because of these limitations it is likely that the bulk of the forecasts will continue to be made on the basis of consideration of only a few factors. The factors which will likely enter into a prediction are those which management considers most likely to influence the final results. The factors ignored are those which, they hope, will exert only a small change in the results or else will tend to balance out over the time period covered in their prediction.

Monetary variables form the hard core of the acceptable variables used in forecasts of investment spending. Their use has sometimes led

to reasonably accurate forecasts but at other times end results have been poor. There is interest, therefore, in trying new approaches which offer some hope of correcting some of the weaknesses which may be inherent in any method which relies on financial variables exclusively.

It has been suggested that a person's stated intention to invest or not to invest foretells to some extent the actual investment made. This is a relatively new idea which may be valuable to management for prediction purposes. It must be afforded ample opportunity to demonstrate whether or not it will help increase the accuracy of demand analyses and forecasts and at the same time provide a method which is economically feasible.

This approach to forecasting infers that investments depend on two main factors--the ability to buy and the willingness to buy. An individual may have control of sufficient resources to make an investment but if he is not willing to invest he will not make the investment. Similarly, a person may be willing to buy but be unable to get control of adequate financial resources. The end result is the same--no investment will be made. An investment will be made only when the ability to invest is coupled with the willingness to invest.

To use intentions alone, to predict the demand for tractors, it is necessary to make some broad and basic assumptions. First, it presumes that those who state their intentions have sufficient knowledge on which to act and will be able to carry out their intended action. Secondly, the individual can actually foretell all the changes which will develop during the ensuing time period and has made all the necessary allowances before stating his intentions.

If stated intentions to purchase only partially foretell subsequent

behavior then it would be wise to study this determinant to see if it can be used with presently recognized objective variables to improve the accuracy of demand forecasts.

The Problem

Manufacturers of farm machinery do not know if they can improve their own production and marketing planning by finding out from farmers the number of tractors the latter intend to buy. Nor do they know how reliable farmers' stated intentions are, i.e., how completely farmers fulfill their tractor purchase intentions. This reliability needs to be established before the intention to purchase method is accepted.

It is thought that intentions are held with various degrees or strengths of certainty and that these have a measurable influence on whether or not a purchase is made. It is conceivable that farmers who state, for instance, that they are "quite certain" that they will buy a machine are more likely to purchase than those who state there is only a "slight chance" that they will purchase. Whether strength of intention is more valuable as an indicator of actual purchase than an intention made without any qualification also needs to be ascertained.

The agricultural sector of the economy has been virtually neglected insofar as the testing of the usefulness of intentions and strength of intent approaches because of the high unit cost in checking whether or not farmers carry out their intended investment plans. The availability of mail-in farm account records to check on whether or not intended investments are made, presented an opportunity to test the usefulness of the approach.

Strength of intent plus certain other variables will be examined

to determine their worthiness in explaining and predicting actual tractor purchases. These, then, will form the centre of the investigation reported herein.

Objectives of the Investigation

This study was undertaken to measure (1) subjective opinions, i.e., purchase intentions and strength of intent as indicated by farmers, to see if they are of any significant value as indicators of actual tractor purchases, (2) selected financial and physical variables so as to evaluate each factor's significance in explaining the purchases of tractors, and (3) combinations of accessible variables so as to determine how much of the variance in tractor purchases and expenditures can be explained by each combination.

More specifically, the objectives of this investigation can be stated in the form of questions as follows:

1. Do farmers' stated intentions assist in the prediction of tractor purchases?
2. Is there any explanatory advantage in asking an individual how certain he is of making a tractor purchase as compared to asking him simply, do you intend to buy?
3. Does a knowledge of a respondent's disposable income (previous, current or change-in net cash available) plus the size of tillable acreage farmed give any indication of his subsequent tractor purchases and/or expenditures?
4. Which combination of the accessible variables gave the "best" explanation of tractor purchases and expenditures?

CHAPTER II

REVIEW OF PREVIOUS DEMAND STUDIES INVOLVING INTENSIONS DATA

The purpose of this chapter is to review the literature on intentions studies data and thereby provide the necessary background for a study of the intended and actual tractor buying expenditures of farmers. This review begins with the early work utilizing intentions data in the preparation of forecasts, and follows with the modern research findings involving intentions data in the consumer and business sectors of the economy. It concludes with an examination of the results obtained from recent demand studies involving agricultural machinery.

Early History of Research Utilizing Intentions Data

The earliest efforts in the regular gatherings of intentions data can be traced back to the early 1920's when the federal Department of Agriculture conducted sample surveys to determine what farmers planned to produce in the coming year.[1] Their purpose was to inform producers what other farmers were doing so that they could make any adjustment that appeared warranted. There is no evidence that the Department of Agriculture checked with each respondent to see if production plans were carried out. However, the U.S.D.A. estimation procedure itself

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[1] Franco Modigliono, and J. Cohen, "The Role of Anticipations and Plans in Economic Behavior and Their Use in Economic Analysis and Forecasting", (Bureau of Economic and Business Research, University of Illinois, Bulletin No. 4, 1961) pp. 148-149.

involves an adjustment of aggregate intentions on the basis of their past experience before they publish their "intentions" report.[2]

In the late 1920's the American Railroad's Regional Boards prepared forecasts of anticipated freight car requirements by commodity groups and included in its report actual car loadings. In 1938 Sweden commenced sample surveying to collect information on business plans for capital investment and in a relatively short period had not only demonstrated that the collection of data was feasible but that the information was useful in the preparation of short term forecasts.[3]

Major research efforts, using the new intentions approach did not get underway until after World War II.

Modern Work on Consumer Spending Intentions

Sample surveys recording factors assumed to influence consumer actions are now extensively employed for short-term forecasting purposes. The most important contributions in the consumer research field have been made by G. Katona and co-workers[4] and are aimed at supplementing the traditional analysis (income, spending, saving, investment, prices) with the factors underlying the behavior of consumers. In three reinterview studies in 1948, 1949, and 1952, plans to buy were found to be highly correlated with actual purchases by Lansing and Withey. This correlation was supported by the multivariate studies of Klein and

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[2] L. V. Manderscheid, Personal communication, January, 1966.

[3] Modigliani and Cohen, op. cit., p. 149.

[4] G. Katona and E. Mueller, Consumer Expectations 1953-1956, (Survey Research Center, Institute of Social Research, University of Michigan), pp. 1-44.

Lansing involving 1,036 cases. The factors contributing to the carrying out of buying intentions were purchase expectation, respondents' feeling of economic well-being and price expectation. Price-income interactions, income expectations, appraisal of buying conditions and past income changes were not found to be useful in distinguishing between buyers and non-buyers of automobiles and household goods. They also found little relation between asset holdings and purchase decisions. In dealing with aggregate variables they found their data could be substantially improved by combining these with the actual course of the variables representing initial conditions, even though the effect of these variables should already be reflected in the initial expectations.

In the 1953 Survey of Consumer Finances (conducted for the Board of Governors of the Federal Reserve System by the Survey Research Center of the University of Michigan) 1,036 of the spending units interviewed were spending units which had also been interviewed in the 1952 Survey (the same sample used by Klein and Lansing reported above). Kreinin[5] found that 52 percent of those who early in 1952 expected to buy a used car actually bought one, while only 15 percent of those who did not express any intention to buy actually bought. He found that the socio-economic variables most related to used car purchases are income, liquid assets and life cycle. But in addition to these factors, changes in the individual's economic position, his subjective evaluation of market conditions and the age of the car he owns are important explanatory variables.

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[5] M. Kreinin, "Analysis of Used Car Purchases", Review of Economics and Statistics, Vol. XLI (Feb., 1959), pp. 419-425.

In subsequent studies by the Survey Research Center, Katona and Mueller report that there were logical explanations for the consumers who expressed no intention to buy and for the failure to purchase by those who expressed an intention to buy.[6] Unexpected developments, such as income increases or decreases, suddenly arising needs, high trade-in allowance, an oversupply of cars, good buys and a host of other reasons helped to account for the discrepancy between intended and actual purchases.

James Tobin[7] concluded that buying intentions are not an adequate substitute for objective variables. Buying intentions are to be considered but as complementary to objective variables, not substitutes for them.

Katona[8] has presented the psychological thesis that expressed intentions reflect current attitudes rather than indications of things to come and that these attitudes represent useful information for those who wish to make predictions about consumer demand in conjunction with relevant information on changes in financial variables. He further expresses the view that intentions and other attitudinal variables are most useful in determining the direction rather than the magnitude of forthcoming developments. The predictive value of the data is contingent

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[6] G. Katona and E. Mueller, Consumer Expectations 1953-1956, (Survey Research Center, Institute of Social Research, University of Michigan), p. 67.

[7] James Tobin, "On the Predictive Value of Consumer Intentions and Attitude," Review of Economics and Statistics, Vol. XLI, No. 1 (Feb., 1959), pp. 1-10.

[8] G. Katona and E. Mueller, Consumer Expectations 1953-1956, (Survey Research Center, Institute of Social Research, University of Michigan).

upon the absence of important external developments which are not foreseen by the consumer.

Juster,[9] using unusually large samples of a product testing organization called the Consumers Union of the United States, found that about 95 percent of the total yearly variation over the period 1949 to 1957 can be explained (statistically) by the two variables--changes in disposable income and the buying plans of the Consumers Union members. After allowing for the effects of changes in disposable income on purchases, some 80 percent of the residual year-to-year variation in aggregate purchases is associated (statistically) with variations in the buying plan of Consumer Union members. From the survey carried out between October 1947 and April 1958, Juster noted that income changes of around 20 percent or less had little effect on durable good purchases or buying intentions. He comments that this result may be due to the sharp business contraction which occurred during the survey and which would influence the plans and purchases during the period. In examining expectation variables, Juster found that expectations about general business condition, income expectations for the one year future period and household attitudes about current buying conditions were strongly related to buying plans and recent purchases.

Recent research (1963) by Eva Mueller[10] indicates that the predictive performance of buying intentions is not consistent from one test to another. She also reports that similar conclusions regarding

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[9] F. Thomas Juster, Consumer Expectations, Plans, and Purchases: A Progress Report, Occasional Paper 5 (National Bureau of Economic Research, Inc., 1959).

[10] E. Mueller, "Ten Years of Consumer Attitude Surveys: Their Forecasting Record," Journal of the American Statistical Association, Vol. 58, No. 384 (Dec., 1963).

predictive value of buying intentions were recently arrived at by Friend and Jones. Consumer buying intentions made a contribution in only a few of their regression equations and these were largely equations not containing their Index of Consumer Attitudes. Mueller found that discretionary spending by consumers is to a large extent determined by their income level and the state of consumer optimism and confidence.

Modern Work on Business Expenditure Intentions

Since World War II there has been a strong effort directed towards finding out the capital expenditure intentions of business in order to appraise the business climate. One of the most important regular sample surveys revolving around the plans for plant and equipment expenditure is conducted by the U. S. Department of Commerce in cooperation with the Securities and Exchange Commission. This survey collects information on investment plans on a quarterly and annual basis for the purpose of preparing an aggregate forecast. A similar survey covering approximately 500 of the most important capital consuming industries is conducted by McGraw-Hill.

George Katona[11] has made some interesting generalizations from the McGraw-Hill surveys, on the capital expenditure plans of companies: (1) The capital spending plans of some industries are more likely to be carried out than those of other industries. (2) Plans for the replacement of old equipment are more likely to be carried out than are

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[11]George Katona, Psychological Surveys in Business Forecasting. Report of a seminar conducted by the Foundation for Research on Human Behavior, Ann Arbor, Michigan, Jan. 22-23 and Feb. 5-6, 1954, pp. 16-18.

plans for the replacement of newer equipment. (3) The capital spending plans of large companies are more likely to be carried out than are those of small companies. (4) There seems to be a consistent tendency for small firms to underestimate their investment outlay; whereas large firms, on the average, do not have this tendency. (5) Plans in the more distant future are very likely to be vague and incomplete, as compared with plans for the immediate future, and therefore have a downward bias. (6) Although differences between planned and actual investments have more or less cancelled out up to the present, there is no guarantee that they will do so in the future. (7) The surveys are not very reliable for predicting regional economic conditions. (8) The fact that the McGraw-Hill survey is a large company survey might well influence the results, particularly during major economic changes. Using data for 1947, 1948 and 1949 from the Commerce-SEC data, Katona also reports that individual capital expenditure plans have been compared with actual expenditures. This analysis showed that only about one-fourth of the firms were within 20 percent of planned expenditures. A third of the firms went over planned expenditures by 100 percent or fell short by 50 percent or more. The largest firms were quite close to planned expenditures, while medium sized firms went over each year by a substantial amount and the smallest firms exceeded their intended expenditures by even more than the medium sized firms.

Robert Eisner[12] reports that forecasts based in investment surveys

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[12]Robert Eisner, Forecasting Investment Spending, Eleventh Annual Conference on Economic Outlook (University of Michigan, Mimeograph) p. 4.

such as those of the Securities and Exchange Commission and the office of Business Economics, as well as the McGraw-Hill Department of Economics, have, in fact, an impressive record of accuracy. The accuracy is due to a considerable extent on the cancelling out of compensating errors among individual firms and industries. This same view is shared by Irwin Friend and Jean Bronfenbrenner[13] in their study of the extent to which individual investment plans are fulfilled.

U. Lewis Bassie[14] warns that the results of surveys on intentions cannot be considered sure because plans do change rapidly with a change in the business climate. He calls attention to the instability noted in the recession of 1958 where the cutbacks in both inventory and fixed capital were drastic.

Modern Studies on the Demand for Farm Machinery

Recently there has been some research on the demand for farm machinery. Fettig[15] using secondary data found that changes in farm income are more closely associated with machinery purchases in contractions than in expansions. He attributes this to the tendency of the farmer to be more careful in making expenditures when there is a general business decline and the difficulty of obtaining the necessary credit. Although it was expected that expenditures on machinery would fall as

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[13]Irwin Friend and Jean Bronfenbrenner, "Business Investment Programs and Their Realization," Survey of Current Business (30th Dec., 1950), pp. 11-22.

[14]U. Lewis Bassie, Uncertainty in Forecasting and Policy Formation, Bureau of Business Research (University of Texas, Austin, 1958-1959 Series), pp. 15-20.

[15]Lyle P. Fettig, "Purchases of New Farm Tractors and Machinery in Relation to Non-Farm Business Cycle", (unpublished Master of Science thesis, Michigan State University, 1958), p. 31.

income fell, the regression coefficients indicated that the expenditures reductions were more than proportionate to the income decreases. In a further examination of the relation between farm income and farmers' expenditures on tractors and machinery purchases he presents evidence that farmers reduce machinery expenditures rapidly (in the current year) as a result of income decreases but they only slowly increase expenditures when income increases, i.e., there is a lag of about one year. While this phenomenon did not occur in every instance of farm income increases and decreases, the relation appeared to have a noticeable regularity.

Reiling[16] in reviewing Cromarty's statistical study on wheel-type tractors for the years 1926 - 1956 inclusive, points out the following interesting results using income as one of the determinants of demand: (1) A 10 percent increase in net farm income for the previous year was accompanied by a 5 percent increase in machinery purchases. (2) The amount of machinery on farms appears to have no effect on the quantity purchased during the year. (3) A 10 percent increase in net farm cash receipts for the previous year resulted in a 2 to 4 percent increase in tractor purchases.

Wright and Vincent[17] conducted the initial research in Michigan in 1959 on intended and actual farm machinery purchases using data obtained from farmers cooperating in the M.S.U. Farm Accounting Project.

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[16] Eldon A. Reiling, "Demand Analysis for Combines, Pickup Balers and Forage Harvestors," (unpublished M. Sc. thesis, Department of Agricultural Economics, Michigan State University, East Lansing, 1962).

[17] K. T. Wright and W. H. Vincent, "Intended and Actual Tractor Purchases by Farmers in Michigan, 1959," Quarterly Bulletin of Michigan Agricultural Experiment Station, Vol. XLIV, (East Lansing: Michigan State University, Nov. 1961).

They obtained intended machinery purchases data from a mail questionnaire and determined whether machinery purchases were as intended, by referring to each ccoperator's own farm records. Their objectives were to determine the number intending to make major machinery investments, the time at which the investment would be made and the strength of the intention to make a machinery investment. On the basis of one year's results they reported that 50 percent of the farmers who indicated some probability of buying ("some chance") actually fulfilled their intentions of buying. Some 14 percent of the "no chance" farmers, who indicated on the questionnaire that they would not be buying a tractor, actually purchased tractors. When it came to the actual amount of the expenditures compared to the intended amount, it was found that cooperators spend considerably more than they had expected to spend. When they tried to relate strength of intent to actual tractor purchases they found that some 65 percent of the "very certain" farm operators actually purchased tractors, 72 percent of the "quite certain", 49 percent of the "fair chance" and 40 percent of the "slight chance" farmers purchased tractors.

The relationship between the level of disposable income (current and previous year) appeared to influence more the purchase decisions of those cooperators who had expressed a "no chance" intention of buying than those who expressed a "some chance" intention of buying. They concluded that more than strength of intent to buy and income levels are needed to predict the percentage of farmers who will buy tractors.

Wright[18], using data from the same source and obtained at the same

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[18] K. T. Wright, Purchases of Major Farm Machinery. Research Report No. 3 (Michigan State University, Agr. Experimental Station, 1963).

time, but studying major agricultural machinery other than tractors, reached a similar conclusion to that reported for tractors. Almost 80 percent of those indicating a "some chance" probability of buying other major machinery actually bought. Detracting somewhat from this 80 percent fulfillment rate of those who intended to buy and did buy was the fact that almost half of the "no chance" group did not fulfill their original intention of not buying, i.e., they bought major machinery other than tractors. Actual per farm expenditures for major farm machinery was double that estimated by those who intended to buy and did buy. The total amount spent by those who did not express an intention to buy was almost one-half that of all those who expressed an intention to buy. Total expenditure exceeded intended expenditure by some 80 percent. Considering only those who expressed an intention to buy, over 90 percent of the "very certain", 84 percent of the "quite certain", 74 percent of the "fair chance" and 74 percent of the "slight chance" actually made major machinery purchases. For these groups higher net income from the previous year was associated with a higher percentage fulfilment of intentions. Income level of the previous year was more closely correlated to actual expenditures than was income level in the current year. Wright concluded that strength of intent and income level do help explain some of the purchases but that these variables were not sufficient to explain a substantial proportion of the deviations between intended and actual purchases or the dollar amounts to be expended.

Conclusions from Literature Review

A review of the literature on business and consumer demand forecasting as it relates to intentions indicates that the following conclusions might be drawn.

1. No infallible way to predict future purchases and expenditures has yet been developed, i.e., there is no formula which will blueprint the expenditures which will be made. Forecasts are still estimates about which no one can be sure. In spite of recent contributions in the uncertainty aspects of decision making, there is still no accepted framework for the analysis of choice under uncertainty. New techniques for analysis are needed.

2. Although it has been hoped that buying intentions would embody all the effects of relevant variables, the evidence shows this hope is far from being realized. Individuals and groups in both the business and consumer sector go over and under their intended expenditure by substantial amounts. Expressed intentions must be used along with other objective variables for predictive purposes, i.e., they can't stand alone. A host of variables have been used with and without expressed intentions to predict the future.

3. The need for information on intentions to buy arises primarily from our inadequate knowledge of many important aspects of economic behavior. Intentions appear to have some explanatory value above that obtainable with the more traditional economic variables.

4. There is a rapidly growing body of information available on the investment intentions of business and the buying intentions of consumers. The information on actual fulfilment of buying intentions is scarce. In the agricultural industry the fulfilment of farmers'

machinery investment intentions has apparently not been studied prior to the initiation of the project on "Intended and Actual Machinery Purchases" by the Department of Agricultural Economics at Michigan State University.

CHAPTER III

METHODOLOGY AND HYPOTHESES

Data for this thesis are primary data derived from mail questionnaires completed by farmers enrolled in Michigan's mail accounting project plus available physical and financial information recorded in their respective accounts books. Survey questionnaires were mailed in December and returned within one month for the years 1960 and 1961. An average of approximately 85% of the farmers returned the questionnaire. The samples for the analyses consisted of all those who had both completed the questionnaires and their account books.

In the questionnaire (see Appendix) the farmers were first asked whether there was "some chance" or "no chance" of their buying a tractor in the next twelve months. If they intended to buy a tractor they were asked to record how certain they were of buying. If they had already made or were making a deal on a tractor they recorded this strength of intent as "very certain". With a considerably better than a 50:50 chance of buying the "quite certain" designation was used. A 50:50 chance and a considerably less than 50:50 chance was to be indicated as "fair chance" and "slight chance", respectively. Then, they were asked to check (a) the quarter of the year in which they intended to buy, (b) whether they expected to buy new or used, (c) whether they expected to trade in a tractor and (d) how much they expected to pay.

Data from each respondent's farm record provided information on

tillable acreage farmed, previous and current year's net cash income available, change in net cash available, the value of the machinery investment and the amount spent for hired labor. The same record was used to determine whether or not the individual had purchased a tractor and the amount he had paid. The data from the account book were then matched against the intentions recorded on the survey questionnaire.

The intentions to buy major farm machinery survey was initiated by and the sample selected by the staff of the Department of Agricultural Economics. The collection of the data, analysis and publication of the research results of the 1959 survey and the collection and four original tabulations for the 1960 and 1961 data are also due to their efforts alone. The original project covered all major farm machinery but this thesis is concerned only with tractors and only with the data that had not been analyzed previously, i.e., for the years 1960 and 1961.

Limitation of Study

The project was designed to explore an area of methodology--to explore devices which might have commercial value. There is thus no claim that if, for instance, 70 percent of the farmers fulfilled their purchase intentions that this rate could be transferred to industry at large.

The farm operators participating in this project are considered typical of those in the upper 30-40 percent income levels of commercial farms and so the sample is biased upward.[1]

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[1] K. Wright, Personal communication, Nov., 1963.

With regard to the application of the data, it is worth noting that farm machinery manufacturers were especially interested in the behavior of farmers of the same type as those enrolled in the mail accounting project. Also, they suggested that the results would be of more use to them in indicating the general buying behavior of commercial farmers than a probability sample cutting across all income levels.[2]

Treatment of Data

Not all returned questionnaires were used. Some operators completed the questionnaire but not the account book. Some account books did not contain sufficient information so that previous year's net cash available (disposable income) and change in net cash available could be calculated.[3] A few cooperators did not indicate the strength of their intent. For any of the above circumstances, the data were excluded from the analysis.

The data on tractor purchase intentions (from mail questionnaires) plus land and capital information (from the farm records) were key punched on I.B.M. cards and machine sorted and four tabulations machine printed. The machine sorts were (1) tillable acreage, (2) previous year's net cash available, (3) current year's net cash available and (4) change in net cash available. Sorting was done from low to high for each variable and divided into quartiles. Additional hand tabulations were produced from the four basic machine tabulations.

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[2] W. Vincent, Personal communication, Nov., 1963.

[3] Net cash available = total cash receipts minus all cash expenses except those cash expenses made on machinery and improvements. Disposable income is used as a shorthand for the net cash available terminology.

The major portion of this thesis is devoted to the analysis of the effects of the subjective (intentions and strength of intent) and objective variables (tillable acreage and disposable income) on actual tractor purchased. The chi-square test of significance is used to measure the validity of these variables and the so-called contingency coefficient is used to measure the strength of the relationships. The final part of this investigation is concerned with the joint effects of each of the above variables plus three additional variables, i.e., intended expenditures on tractors, value of machinery inventory and the year's hired labor cost on tractor expenditures. To ascertain joint effects, linear multiple regression models are used.

General Hypotheses

1. Tillable acreage and disposable income (previous year's, current year's and change in net cash available) are constraints on the number of tractor purchases and expenditures made.
2. An indicated intention to buy and/or the amount of the intended expenditure are variables which can be used to explain tractor purchases and expenditures.
3. An intention made with some qualification (strength of intent) is more indicative of subsequent tractor purchases than an intention made without qualifications.
4. An individual interprets all the relevant physical and financial variables and expresses these in his intention to buy and in his strength of intent.

More specific and statistically testable hypotheses are formulated and tested in Chapters IV and V of this thesis.

CHAPTER IV

THE INFLUENCE OF INDIVIDUAL FACTORS ON TRACTOR PURCHASES

We are never sure which factors dominate purchase decisions. Undoubtedly many factors are involved in final buying decisions. Some of the important determinants may be those quantified in farm account books. The same and/or additional factors might be captured through "intentions" surveys. How much explanatory information can be squeezed from the data on each accessible variate insofar as tractor purchasers are concerned? The central task in this chapter is to isolate those variates that have explanatory value. The chi-square statistic (X^2) is used to determine whether differences in buying proportions may be attributed to chance or to the variate under consideration. The strength of each bivariate relationship is measured with the contingency coefficient.

Buyers and Non-Buyers of Farm Tractors in 1960 and 1961

One of the first questions that needs to be answered from the data available is whether there is a significant difference in the proportions of buyers from one year to the next. If there is no significant difference, data might be pooled for the purpose of some analyses.

So that we know what to expect the hypothesis is stated in statistically testable form, i.e., H_o--the null hypothesis or "no difference". In case the null hypothesis is rejected there is the

alternative hypothesis of some difference accepted H_A.

The first null hypothesis which we want to test is H_o1: The proportion of the farm operators who buy tractors is the same in both years. The alternative hypothesis is that the respective buying proportions are significantly different.

The survey samples yielded the results given in Table 1.

TABLE 1

ACTUAL FREQUENCIES OF BUYERS AND NON-BUYERS OF FARM TRACTORS IN MICHIGAN STATE UNIVERSITY'S FARM MACHINERY SURVEY IN 1960 AND 1961

	1960	1961	Total
Buyers	157	124	281
Non-Buyers	480	410	890
Sample Total	637	534	1,171
Percentage Buyers	25	23	24

Denoting the actual proportions of buyers in the given two years as P_1 and P_2 we shall want to test the hypothesis.

Null hypothesis: $P_1 = P_2 \ (=P)$

against the alternate hypothesis that the two P's are not the same.

Assuming that P is unknown we shall estimate it as the proportion of buyers observed in the two samples combined, namely as

$$\frac{157 + 124}{637 + 534} = \frac{281}{1171} = 0.24$$

We can now ask for the number of buyers that we could have expected in each of the two samples if the null hypothesis were true and P equalled 281/1171 or (0.24). In a sample of 637 we could have

expected 637 (0.24) = 152.9 buyers, and in a sample of 534 we could have expected 534 (0.24) = 128.1. Writing the expected frequencies, i.e., the expected number of buyers and non-buyers below the corresponding entries in Table 1, we have

Year	1961	1962	Total
Buyers	157 (152.9)	124 (128.1)	281
Non-Buyers	480 (484.1)	410 (405.9)	890
Total	637	534	

where the expected number of non-buyers was obtained by subtracting the expected number of buyers from the totals of each sample.

In order to test the hypothesis formulated above, we now compare the expected frequencies shown in this table with the frequencies actually observed. It stands to reason that the null hypothesis should be accepted if these two frequencies are very much alike. After all, we would then have obtained almost exactly what we should have expected if the null hypothesis were true. If the discrepancies between the two sets of frequencies are large, the observed frequencies do not agree with what we could have expected and we conclude that our expectations and, hence, the null hypothesis must be false.

Our next step will be to test whether the discrepancies between the observed frequencies and the expected frequencies are significant, or whether they may reasonably be attributed to chance. The criterion that is generally used for this purpose is based on the statistic

$$\chi^2 = \sum \frac{(\text{observed frequency} - \text{expected frequency})^2}{\text{expected frequency}}$$

which is called chi-square.

In other words, we must calculate the statistic for each cell of the 2 x 2 (r x k) or contingency table and then add the values obtained.

Using X^2 we can now test the null hypothesis with the following criterion:

Reject the null hypothesis if $X^2 > X^2_{.05}$ where X^2 is to be calculated as outlined above and the number of degrees of freedom equals $(k - 1)(r - 1)$.

Returning to the data calculate X^2 for the observed and expected number of buyers and non-buyers of farm tractors as follows:

$$X^2 = \frac{(157 - 152.9)^2}{152.9} + \frac{(112 - 128.1)^2}{128.1}$$

$$+ \frac{(480 - 484.1)^2}{484.1} + \frac{(410 - 405.9)^2}{405.9}$$

$$= .11 + .13 + .03 + .04$$

$$= 0.31$$

Since this is less than 3.841 the value given for $X^2_{.05}$ with $(2 - 1)(2 - 1) = 1$ degree of freedom, the null hypothesis cannot be rejected. The discrepancy between the proportion of buyers may be attributed to chance and we shall conclude that the actual proportion of buyers remained constant in the two years studied.

Would we be justified in concluding that henceforth about 24 percent of the farmers in this sample could be expected to purchase each year? No, because economic theory and historical evidence indicate that we can expect some socio-economic factors to change and thereby significantly alter buying portions. The task now is to identify the subjective and objective factors which do have value in explaining differences in buying proportions.

For the balance of the analyses the expected frequencies are denoted by a number enclosed by parenthesis. Chi-square (X^2) is used for the purpose of testing the null hypothesis, i.e., that the buying proportion is the same for all groups.

The strength of the relationship between variables will be measured with the contingency coefficient (C)

$$C = \sqrt{\frac{X^2}{X^2 + n}}$$

where n is the grand total of the contingency table and X^2 is the value of chi-square.

Tillable Acreage as a Factor Affecting Tractor Purchases

One of the physical measures available from farm account books is termed tillable acreage. Farmers with the larger tillable acreage are generally assumed to have more tractors, and buy more often than those farming smaller tillable acreages. It might be expected that the former buy proportionately more tractors than the latter.

If the total number of farms in the sample are first sorted from low to high tillable acreage and then divided into four quartiles, a comparison of the proportion of buyers can then be made to determine the effect of tillable acreage on tractor buying proportion.

$H_o 2$: The distribution of the proportions of those who buy tractors is the same for all four tillable acreage groups.

The two samples yielded the results given in Table 2 for the years 1960 and 1961. The porportions of buyers are 38/159 = 0.24, 31/159 = 0.19, 36/159 = 0.23 and 53/159 = 0.33 in 1960 for the four groups involved in this analysis. But in 1961 and for the same four categories these are

TABLE 2

RELATION OF TRACTOR PURCHASES TO TILLABLE ACREAGE--1960, 1961[1]

	1960 Average Tillable Acreage				
	109 ac	160 ac	215 ac	313 ac	Total
Buyers	38 (40)	31 (40)	36 (40)	53 (40)	158
Non-Buyers	121 (119)	128 (119)	123 (119)	107 (120)	479
Total	159	159	159	160	
Proportion Buyers	0.24	0.19	0.23	0.33	(0.25)
SAMPLE: $X^2 = 8.98$*		C = 0.11			

	1961 Average Tillable Acreage				
	109 ac	160 ac	215 ac	313 ac	Total
Buyers	26 (30)	22 (30)	35 (31)	41 (31)	124
Non-Buyers	107 (103)	111 (103)	99 (103)	93 (103)	410
Total	133	133	134	134	534
Proportion Buyers	0.20	0.17	0.26	0.30	(0.23)
SAMPLE: $X^2 = 8.30$*		C = 0.11			

[1]Number of buyers and non-buyers of farm tractors in 1960 and 1961 when sorted by tillable acreage farmed, the number expected under the null hypothesis $P_1 = P_2 = P_3 = P_4 = (=P)$ and value of chi-square (X^2) and contingency coefficient. (C)

* Significant at the 0.05 level.

26/133 = 0.20, 22/133 = 0.17, 35/134 = 0.26 and 41/134 = 0.30. The proportion of buyers which we could have expected if the null hypothesis were true is 0.25 in 1960 and 0.23 in 1961. The discrepancies between the observed and expected frequencies are large. We suspect that the null hypothesis must be false.

Both sample chi-square values are greater than the value required for rejection. The null hypothesis must be rejected. We conclude that there is a significant difference in the proportion of tractor buyers and these are effects brought on by differences in tillable acreages. The larger tillable acreage farmers buy proportionately more and the smaller tillable acreage farmers buy proportionately fewer tractors than could be expected on the basis of chance alone.

The contingency coefficient of 0.11 for both years indicates that the correlation between the number of buyers and tillable acreage is consistent but very weak. This suggests the possibility that in a multiple regression analysis tillable acreage may make little if any significant contribution towards an explanation of buying behavior.

Net Cash Available Previous Year as a Factor Affecting Tractor Purchases

Previous year's disposable income is one of the traditional financial variables used to explain purchases, i.e., purchases tend to follow yearly disposable income. This information is also available from farm account books but its value in explaining the purchase of farm tractors needs to be established. The question that needs to be answered is--does the average level of previous year's net cash available influence tractor buying proportions?

H_o3: The proportion of farmers who buy tractors is the same

TABLE 3

RELATION OF TRACTOR PURCHASES TO PREVIOUS YEAR'S NET CASH AVAILABLE 1960, 1961[1]

	1960 Average Net Cash Available Previous Year (1959)				
	$2908	$6062	$8704	$15,085	Total
Buyers	35 (40)	37 (40)	32 (40)	53 (40)	157
Non-Buyers	124 (119)	122 (119)	127 (119)	107 (120)	480
Total	159	159	159	160	637
Proportion Buyers	0.22	0.23	0.20	0.33	(0.25)
SAMPLE: $X^2 = 8.91$*		C = 0.11			

	1961 Average Net Cash Available Previous Year (1960)				
	$3679	$7145	$10,093	$16,651	Total
Buyers	28 (30)	26 (30)	35 (30)	35 (30)	124
Non-Buyers	105 (103)	107 (103)	99 (104)	99 (104)	410
Total	133	133	134	134	534
Proportion Buyers	0.21	0.20	0.26	0.26	(0.23)
SAMPLE: $X^2 = 1.3$		C = 0.06			

[1]The number of buyers and non-buyers of farm tractors in 1960 and 1961 when sorted by previous year's net cash available, the number expected under the null hypothesis $P_1 = P_2 = P_3 = P_4 = (=P)$ and values of chi-square (X^2) and contingency coefficient (C).

*Significant at the 0.05 level.

regardless of the average levels of the previous year's net cash available.

The sample was first sorted from low to high in terms of the previous year's net cash income available and then divided into four equal groups. The sample yielded the results shown in Table 3.

In the first year, the null hypothesis should be rejected, because the sample chi-square yields a value greater than the required value. The proportion of tractor buyers in the highest average previous year's net cash available group is greater than the proportions of buyers in the lowest group. However, in the second year the null hypothesis should be accepted, as the chi-square value is substantially less than the required rejection value.

The results are not consistent from year to year. Also, the strength of the relationship as measured with the contingency coefficient shows the correlation to be weak in both years. Therefore, it is assumed that relatively few of the discrepancies between observed and expected frequencies can be attributed to the level of previous year's net cash available or alternatively that this variable operates intermittently to influence tractor purchasing behavior.

Net Cash Available Current Year as a Factor Affecting Tractor Purchases

Current year's net cash available (disposable) income is another of the traditional financial variables used to explain variability in purchases or investments. There may be a worthwhile relationship between current income and tractor purchases. If a relationship exists then it needs to be ascertained.

$H_o 4$: The distribution of the proportion of the farmers who buy tractors is the same for each group when classified on the basis of average net cash available in the current year.

Examination of Table 4 will show that the proportions of buyers are significantly different at the 0.25 level of probability in 1960, but were very significant in 1961. Those farmers in the highest average current disposable income group in both years are responsible for most of the discrepancies between observed and expected frequencies. They bought proportionately more tractors than those in the lower current year's disposable income groups. The strength of the relationship is rather weak in 1960 and somewhat stronger in 1961.

In comparing the relative sizes of the chi-square values it is apparent that net cash available in the current year was more productive in explaining desired effects on buying proportions than tillable acreage or previous year's net cash available in 1961. In 1960 previous year's net cash available was more productive in explaining discrepancies between observed and expected frequencies than the other two variables considered so far. The analyses so far suggests that different variables are operative in different years.

On the basis of these findings we can conclude that current year's disposable income is a factor affecting tractor purchases but it may or may not be a very strong explanatory variable in a specific year as the proportions of buyers are very significantly different in one year but not in the other.

TABLE 4

RELATION OF TRACTOR PURCHASES TO CURRENT YEAR'S NET CASH AVAILABLE 1960, 1961[1]

	1960 Average Net Cash Available Current Year				
	$3025	$6667	$9364	$16,265	Total
Buyers	34 (39)	35 (39)	40 (39)	48 (39)	157
Non-Buyers	125 (120)	124 (120	119 (120)	112 (121)	480
Total	159	159	159	160	637
Proportion Buyers	0.21	0.22	0.25	0.30	(0.25)
SAMPLE: $X^2 = 4.17$		C = 0.10			

	1961 Average Net Cash Available Current Year				
	$4072	$7445	$10,368	$18,501	Total
Buyers	29 (31)	18 (31)	31 (31)	46 (31)	124
Non-Buyers	104 (102)	115 (102)	103 (103)	88 (103)	410
Total	133	133	134	134	534
Proportion Buyers	0.22	0.13	0.23	0.34	(0.23)
SAMPLE: $X^2 = 16.63$**		C = 0.17			

[1]The number of buyers and non-buyers of farm tractors in 1960 and 1961 when sorted by net cash available current year, together with the number expected under the null hypothesis $P_1 = P_2 = P_3 = P_4 = (=P)$ and values of chi-square (X^2) and contingency coefficient (C).

**Significant at the 0.01 level.

Change in Net Cash Available as a Factor Affecting Tractor Purchases

Economic theory suggests that when farm incomes increase the demand curve for tractors would shift rightward. An increase in net cash available may increase the number of tractor purchases while a decrease might be expected to reduce tractor purchases. Not all increases or decreases, however, could be expected to alter the number of tractor buyers, i.e., it may depend on the magnitude of the change. A positive income change of $1,000 for a farmer who has a relatively small income might induce a tractor purchase while the same increase for a farmer who is already receiving a relatively high income may not lead to a tractor purchase. It might also be expected that a similar decrease in income would prevent the farmer who is normally in a very low income bracket from making a purchase. The same decrease would not be expected to keep a normally high income farmer from making a purchase, i.e., a much larger decrease in income would be needed to prevent his purchase.

$H_o 5$: The proportions of buyers is the same for all four change in disposable income groups.

For the balance of the analyses the lowest level of the factor being examined will be designated as Group 1. Groups 2, 3 and 4 represent increasing average levels of the same factor.

In order to test the hypothesis, we compare the expected frequencies shown in Table 5 with the frequencies actually observed. In 1960 the frequencies are much alike. We have obtained almost exactly what we should have expected if the null hypothesis were true. There is one exception. Group 2 experienced very little income change but

TABLE 5

RELATION OF TRACTOR PURCHASES TO CHANGE IN NET CASH AVAILABLE--1960,1961[1]

	1960 Average Change in Net Cash Available				
	-$4115	-$360	$1312	$5347	Total
Buyers	39 (39)	31 (39)	44 (39)	43 (39)	157
Non-Buyers	120 (120)	128 (120)	115 (120)	117 (121)	480
Total	159	159	159	160	637
Proportion Buyers	0.25	0.19	0.28	0.27	(0.25)
SAMPLE: $X^2 = 3.45$		C = 0.07			

	1961 Average Change in Net Cash Available				
	-$4266	-$286	$1294	$5362	Total
Buyers	26 (31)	26 (31)	27 (31)	45 (31)	124
Non-Buyers	107 (102)	107 (102)	107 (103)	89 (103)	410
Total	133	133	134	134	534
Proportion Buyers	0.20	0.20	0.20	0.34	(0.23)
SAMPLE: $X^2 = 10.96$*		C = 0.14			

[1]The number of buyers and non-buyers of farm tractors in 1960 and 1961 when sorted by change in net cash available together with the number expected under the null hypothesis $P_1 = P_2 = P_3 = P_4 = (P)$ and values of chi-square (X^2) and contingency coefficient (C).

*Significant at the 0.05 level.

had fewer buyers than might be expected. The differences are not statistically significant, however. In 1961 the discrepancies between the two frequencies are considerably larger. The observed frequencies do not agree with what we could have expected and we should conclude the null hypothesis is false.

It should be noted that an average positive change of $5,347 (Group 4) in 1960 did not significantly increase the buying proportion over the other three levels but approximately the same increase in income ($5,322) with second year sample resulted in a higher buying proportion. This observation indicates the possibility that this income variable operates intermittently or is showing some of the effects of another variable which is as yet not identified. It could also indicate random variation which is to be expected from sample to sample. The effect of change in income is not consistent from one year to the next. The strength of the relationship is very weak in 1960 and there is not a particularly strong relationship between variables in 1961.

The conclusion from this analysis is that when change in income is a significant explanatory factor its effects appear to be confined to the group who experience the largest average positive change in net cash available. The relative sizes of the chi-square values indicates that current year's net cash available (see the previous analysis) was slightly more productive in desired effects on buying proportions than change in net cash available.

Intentions as a Psychological Factor Affecting Tractor Purchases

The demand for farm tractors is probably a function of willingness to buy. It should be possible to measure willingness to buy by knowing and recording each individual's intentions. Farmers who express some intent to buy are more likely to buy tractors than those farmers who indicate that they do not intend to buy tractors.

H_o5: The proportions of those who buy tractors is the same for both those who indicated intentions to buy as for those with no intention to buy tractors.

The data were sorted into two groups. The first group in each year contains all those who expressed a "some chance of buying" intent while the second group contains all those who expressed a "no chance of buying" intent. The results are tabulated in Table 6.

With reference to 1960, 52 percent of the intenders realized their intentions to buy tractors, whereas only 16 percent of the non-intenders bought tractors. The null hypothesis must be rejected, for the chi-square value of the sample is approximately 20 times as large as the required value. The differences in the proportions of buyers are statistically very significant. In 1961, 63 percent of those who indicated an intention to buy realized their intentions to buy tractors, whereas only 12 percent of those who did not intend to buy, bought tractors. Again, the null hypothesis must be rejected as there is a highly significant difference in the proportions of tractor buyers in these two groups. The sample chi-square value is 34 times as large as the required value. The correlation between the variables is much stronger in both years than any of the other variables investigated

TABLE 6

RELATION OF TRACTOR PURCHASES TO A "SOME CHANCE" OR A "NO CHANCE" INTENT 1960, 1961[1]

	1960 Strength of Intent		
	SCB[a]	NCB[b]	Total
Buyers	80 (39)	77 (121)	157
Non-Buyers	74 (115)	406 (362)	480
Total	154	483	637
Proportion Buyers	0.52	0.16	(0.25)
SAMPLE: $X^2 = 79.1^{**}$		C = 0.33	

	1961 Strength of Intent		
	SCB[a]	NCB[b]	Total
Buyers	72 (26)	52 (96)	124
Non-Buyers	43 (89)	367 (323)	410
Total	115	419	534
Proportion Buyers	0.63	0.12	(0.23)
SAMPLE: $X^2 = 131.2^{**}$		C = 0.44	

[1]The number of buyers and non-buyers of farm tractors in 1960 and 1961 who gave either a "some change of buying" or a "no chance of buying" intent together with the number expected under the null hypothesis $P_1 = P_2 = (P)$ and values of chi-square (X^2) and contingency coefficient (C).

[a]Some chance of buying [b]No chance of buying

**Significant at the 0.01 level.

previously. Intentions are accepted as an important explanatory variable influencing tractor purchasing behavior.

This analysis indicates that intentions alone cannot be relied on to explain subsequent buying behavior. Intentions alone cannot explain why only one out of every two operators, who indicated "some chance of buying", bought in 1960 and yet in the next year only three out of five in the same category bought. Additionally, the "no chance of buying" classification does not explain why 16 percent of this group bought in the first year and 12 percent in the second. Note also the relative impact of a change in percentage buying on the number of tractors sold. The "no chance" group averaged about 75 percent of the total respondents. A change in the percentage of buyers in this group has considerably more impact on total purchases than does the same percentage change in the "some chance" group. It is essential that the additional factors influencing the purchases of both groups be identified and quantified.

A thorough examination of Table 6 will reveal that: (1) The total number of intentions to buy is reasonably close to the total number of buyers (154 versus 157 in 1960 and 115 versus 124 in 1961) and thus the former might give a reasonably reliable indication of the number of tractors which might be sold in the ensuing year, (2) Neither of the classifications sift in advance the buyers from the non-buyers, and (3) Buying proportions are unstable and therefore the predictive performance of each group cannot be expected to be consistent from one year to the next.

If the probability of purchase could be predetermined for the "some chance" and for the "no chance" groups, then the model for determining the number of buyers would take the following form:

$$E(B_s) = n_1p_1 + n_2p_2$$

where:

$E(B_s)$ = expected number of buyers

n_1 = number of "some chance" intentions

p_1 = their probability of being right, i.e., buying

n_2 = number of "no chance" intentions

p_2 = their probability of being wrong, i.e., buying

and where:

the probability of buying is obtained for each group through a regression of probabilities on time or through linear extrapolation or through free hand curve fitting.

Inference from the sample to the population can then be made through the following relationship:

$$E(B_p) = \frac{N_p}{n_s}(n_1p_1 + n_2p_2)$$

where:

$E(B_p)$ = expected number buying in population

N_p = population size and n_s = sample size and other variables are as listed above. If the buying proportions were fairly stable there would be no problem in estimating the number of buyers. Because these change from year to year other factors are involved and these must be identified, quantified, and the significant ones included in a forecasting model.

Factors Expected to Influence the Purchases of the "No Chance" Group

The "no chance of buying" group comprises approximately 75 percent of all the farmers in each sample. Despite their indicated intentions not to buy, this group purchased more than 40 percent of all the tractors. The percentage of this group who purchased has previously been established as 16 and 12 for the years 1960 and 1961, respectively. These percentages indicate that there were a substantial number who did not carry through their original intention not to buy. Because of the relative impact of changes in buying proportions in this group, it is very important that we identify the chief determinants of their buying behavior.

Theoretically, many factors affect the number of tractors purchased by this group. A "no chance" intent might be indicated by those who do not expect to purchase because their present tractor meets their power requirements. Respondents could be expected to buy if their tractor subsequently failed to live up to their expectations and they couldn't afford to wait until overhaul was completed. Postponement might involve taking a risk which may have a greater potential cost than the cost of acquiring another tractor. Individuals in this situation might be expected to buy, and by so doing negate their original intention. Others might find themselves underpowered in the ensuing year and to get the timeliness required, some might be expected to buy while others would likely work longer hours. Prestige buying, higher than usual trade-in allowances, higher than normal discounts for outright purchases, neighborhood auction sales, persuasive and effective advertising and salesmanship might be expected to alter intentions.

Additionally some farmers may have given little thought to tractor purchases at the time of questionnaire completion. Subsequent study of their tractor situation may have led some of them to buy tractors. Presumably an improved equity situation or brighter crop and livestock profit prospects might alter original intentions.

This section is limited to those variables on which data were available from their account books, i.e., previous, current and change-in net cash available and tillable acreage. These variables are examined in turn.

The Effect of Net Cash Available in the Previous Year, Given a "No Chance" Intent, on Tractor Purchases.

Previous year's net cash available is normally thought to be a constraint on the number of tractor purchases by any group of farmers. Even if one income group indicates the same intention as another group we might expect that the group with the highest previous year's net cash available would purchase proportionately more tractors. Whether this is the case or not can be determined by selecting those who indicate a "no chance of buying" intent and examining the effect of increasing average levels of income on tractor purchases. Each year's sample was selected on the basis of the level of previous year's net cash available from the original tabulations of the "some chance" and "no chance" groups. There are, therefore, unequal numbers in each income group in Table 7. However, equal numbers per group is not a requirement of the type of statistical analysis conducted herein.

$H_o 6$: If a "no chance" intent is given, the distribution of the proportions of those who buy tractors is the same for all levels of previous year's net cash available. The results are presented in Table 7.

TABLE 7

RELATION OF TRACTOR PURCHASES TO PREVIOUS YEAR'S NET CASH AVAILABLE AND A "NO CHANCE" INTENT--1960, 1961[1]

	1960 Average Previous Year's Net Cash Available				
	$3,063	$6,063	$8,754	$14,809	Total
Buyers	16 (20)	20 (20)	17 (20)	24 (17)	77
Non-Buyers	112 (108)	104 (104)	108 (105)	82 (89)	406
Total	128	124	125	106	483
Proportion Buyers	0.13	0.16	0.14	0.23	(0.16)
SAMPLE: $X^2 = 5.07$		C = 0.10			

	1961 Average Previous Year's Net Cash Available				
	$3,846	$7,123	$10,072	$16,243	Total
Buyers	7 (12)	11 (13)	19 (13)	15 (12)	52
Non-Buyers	95 (90)	96 (94)	88 (94)	88 (91)	367
Total	102	107	107	103	419
Proportion Buyers	0.07	0.10	0.18	0.15	(0.12)
SAMPLE: $X^2 = 6.70$		C = 0.12			

[1]Number of buyers and non-buyers of farm tractors in 1960 and 1961 who gave a "no chance of buying" intent, sorted by previous year's net cash available, number expected under the null hypothesis $P_1 = P_2 = P_3 = P_4 = (P)$, values of chi-square ($X^2$) and contingency coefficient (C).

The observed and expected frequencies are different but the differences are not large enough to be statistically significant. Using chi-square at the 5 percent level of probability as criterion, we accept the null hypothesis in both years, i.e., no difference in buying proportions.

In summary, previous year's net cash available is not considered an explanatory variable because buying proportions were not significantly altered in the two years studied.

The Effect of Net Cash Available in the Current Year and a "No Chance" Intent on Tractor Purchases

Current year's net cash available might be considered as a possible constraint on the number of tractors which can be purchased. A group, which has a high average current year's disposable income, might be expected to purchase proportionately more tractors than any group with a relatively lower income even though they both indicated the same "no chance of buying" intent.

$H_o 7$: The proportion who negate their "no chance" intention is the same for all current year's disposable income levels. The analysis results are given in Table 8.

Using a 5 percent level of significance, the buying proportions are not significantly different in 1960. There are highly significant differences in buying proportions in the following year. The strength of the relationship is not strong in either year. Apparently, current year's net cash available operates intermittently.

The conclusion from this analysis is that current year's net cash available varies in its effectiveness in controlling tractor purchases from year to year, i.e., it operates intermittently. Therefore,

TABLE 8

RELATION OF TRACTOR PURCHASES TO CURRENT YEAR'S NET CASH AVAILABLE AND A "NO CHANCE" INTENT--1960, 1961[1]

	1960 Average Current Net Cash Available				
	$3,104	$6,745	$9,493	$15,639	Total
Buyers	13 (19)	22 (20)	18 (19)	24 (18)	77
Non-Buyers	110 (104)	104 (106)	105 (104)	87 (93)	406
Total	123	126	123	111	483
Proportion Buyers	0.11	0.17	0.15	0.22	(0.16)
SAMPLE: $X^2 = 4.90$		C = 0.10			

	1961 Average Current Net Cash Available				
	$3,414	$7,413	$10,622	$18,057	Total
Buyers	9 (13)	8 (14)	15 (13)	20 (12)	52
Non-Buyers	98 (94)	102 (96)	90 (92)	77 (85)	367
Total	107	110	105	97	419
Proportion Buyers	0.08	0.07	0.14	0.21	(0.12)
SAMPLE: $X^2 = 10.76$*		C = 0.16			

[1]Number of buyers and non-buyers of farm tractors in 1960 and 1961 who gave a "no chance of buying" intent, sorted by current year's net cash available, number expected under the null hypothesis $P_1 = P_2 = P_3 = P_4 = (P)$, values of chi-square ($X^2$) and contingency coefficients (C).

*Significant at the 0.05 level.

whether or not this variable controls tractor purchases depends on the individual and the year examined. In one year it helped explain the tractor purchases of the "no chance" group and in the other year it did not.

The Effect of a Change-in Net Cash Available, Given a "No Chance" Intent, on Tractor Purchases

A positive change-in net cash available may decrease and a negative change may increase the constraint on tractor purchases by those indicating a "no chance" intent. Whether this is true or not can be determined by selecting those who have this intention and examining the effects of various income changes on buying proportions. The income change is termed change-in net cash available and is calculated by subtracting previous year's net cash available from current year's net cash available. Four average income change levels are involved in this analysis.

$H_o 8$: If a "no chance" intent is given, the proportions of purchases is the same for all change-in disposable income groups. The findings are presented in Table 9.

In 1960, the four change-in income groups produced buying proportions in the expected direction but not of the magnitude required for significance. The calculated chi-square value is small compared to the required value at the 5 percent level. Therefore, it can reasonably be assumed that differences in buying proportions are due to chance. The null hypothesis is accepted.

The results are quite different in 1961. Compare any one of the three lower change-in income groups with the fourth group. Note the much higher buying proportion of the fourth group. The highly

TABLE 9

RELATION OF TRACTOR PURCHASES TO CHANGE-IN NET CASH AVAILABLE AND A "NO CHANCE" INTENT--1960, 1961[1]

	1960 Average Change in Net Cash Available				
	-$4,004	-$229	$1,294	$5,349	Total
Buyers	16 (18)	15 (19)	23 (19)	23 (20)	77
Non-Buyers	100 (98)	107 (103)	98 (102)	101 (104)	406
Total	116	122	121	124	483
Proportion Buyers	0.14	0.12	0.19	0.19	(0.16)
SAMPLE: $X^2 = 2.79$		C = 0.07			

	1961 Average Change in Net Cash Available				
	-$4,280	-$289	$1,276	$5,082	Total
Buyers	13 (14)	7 (13)	11 (14)	21 (12)	52
Non-Buyers	97 (96)	94 (88)	98 (95)	78 (87)	367
Total	110	101	109	99	419
Proportion Buyers	0.12	0.07	0.10	0.21	(0.12)
SAMPLE: $X^2 = 11.66$**		C = 0.16			

[1]Number of buyers and non-buyers of farm tractors in 1960 and 1961 who gave a "no chance of buying" intent, sorted by change-in net cash available, number expected under the null hypothesis $P_1 = P_2 = P_3 = P_4 = (P)$, values of chi-square ($X^2$) and contingency coefficient (C).

**Significant at the 0.01 level.

significant chi-square value owes its size almost entirely to the difference in observed and expected frequencies in Group 4 compared to differences in these frequencies in the other three groups. The differences in buying proportions are not the result of chance variation but to changes in net cash available.

The contingency coefficient for 1961 is more than twice that of 1960 and this might indicate the stronger influence of change-in net cash available on tractor purchases in the second year compared to the first year. But, the contingency coefficients indicate that the relationship of change-in net cash available to tractor purchases is not particularly strong. The conclusion that may be drawn from this analysis is that change-in net cash available does not help to further explain the tractor purchasing behavior of the three lower change-in income groups but does help explain the higher buying proportion of the group receiving the largest gain in income. The previous analysis indicated that current year's net cash available operates intermittently to influence tractor purchasing behavior of those indicating a "no chance" intent. This analysis goes a step further. It demonstrates that when current year's net cash available operates, it is only the group receiving the largest gain in income that increases (about double in 1961 sample) its buying proportion above what might be expected on the basis of chance alone.

The Effect of Tillable Acreage, Given a "No Chance" Intent on Tractor Purchases

Larger acreage farmers typically have more tractors and higher incomes than those on smaller acreages. It is to be expected, then, that there is a higher probability of replacement of tractors by the

former compared to the latter. It may be hypothesized that those on the larger tillable acreages will buy proportionately more tractors than those on the smaller tillable acreages even though both groups indicate a "no chance" of buying intent.

To test the above hypothesis we use the null hypothesis.

$H_o 9$: There is no association between the tillable acreage farmed and the proportion of buyers, if "no chance of buying" intent is given. The results are given in Table 10.

In 1960, there is no significant difference in the buying proportion of the four groups. The null hypothesis is accepted. The strength of the relationship is weak. In contrast to these results, the proportions are very significantly different in the second year. However, since the tillable acreages in comparable groups in the two years are almost the same, we might conclude that it is not the relative size of tillable acreage that control buying proportions but some other variables. If tillable acreage influences buying proportions, then, it does so, indirectly, through its influence on other variates. The influence of these other variates on buying proportion, are reflected in the tillable acreage classification used. Two of the influencing factors were current year's net cash available and change-in net cash available. These factors have been identified in the two preceding analyses.

In summarizing the effects of the objective variables analyzed on the "no chance of buying" group, it appears that current year's net cash available and change-in net cash available can influence tractor buying decisions. However, both these factors operate intermittently. Previous year's net cash available is not recognized as an explanatory variable for this group. Tillable acreage probably affects tractor purchases

TABLE 10

RELATION OF TRACTOR PURCHASES TO TILLABLE ACREAGE AND A "NO CHANCE" INTENT--1960, 1961[1].

	1960 Average Tillable Acreage				
	108ac	160ac	215ac	331ac	Total
Buyers	20 (20)	16 (21)	18 (19)	23 (17)	77
Non-Buyers	104 (104)	113 (108)	103 (102)	86 (92)	406
Total	124	129	121	109	483
Proportion Buyers	0.16	0.12	0.15	0.21	(0.16)
SAMPLE: $X^2 = 3.44$		C = 0.08			

	1961 Average Tillable Acreage				
	111ac	171ac	221ac	331ac	Total
Buyers	9 (12)	9 (14)	15 (12)	19 (12)	52
Non-Buyers	94 (91)	106 (101)	88 (91)	79 (87)	367
Total	103	115	103	98	419
Proportion Buyers	0.09	0.08	0.15	0.19	(0.12)
SAMPLE: $X^2 = 9.87$*		C = 0.14			

[1]Number of buyers and non-buyers of farm tractors in 1960 and 1961 who gave a "no chance of buying" intent, sorted by tillable acreage, number expected under the hypothesis $P_1 = P_2 = P_3 = P_4 = (P)$, values of chi-square ($X^2$) and contingency coefficient (C).

*Significant at the 0.05 level.

indirectly through its influence on other variates. This latter conclusion is on the basis of logic rather than the statistical analysis used.

The Effect of a "Some Chance" Intent and Variable Physical and Financial Factors on Tractor Purchases

Can more usable information be obtained if we ask a respondent his strength of intent to buy a tractor than if we ask him, is there "some chance" you will buy? If it is sufficient to indicate only an intention to buy, then which physical and financial factors best explain resultant behavior? The answer to the first question is temporarily postponed. An answer to the second question is sought now.

Answers to the second question might be obtained by selecting those who indicated that they had "some chance of buying" intent and examining the effects of each variable, in turn, on tractor purchases. Each year's sample was sorted into four groups on the basis of the variable involved from low to high.

The null hypothesis which we shall want to test is that when a "some chance" intent is given, then, the distribution of the proportions of tractor buyers is the same for (1) all four current year's net cash available group (H_o10), (2) all four previous year's net cash available groups (H_o11a), (3) all change in net cash available groups (H_o11b) and, (4) all four tillable acreage groups (H_o12).

Only current year's net cash available groups produced observed and expected frequencies which were sufficiently different to give a suggestion of any relationship. The results are given in Table 11. The other three variables yielded expected frequencies which were almost identical with observed frequencies. Therefore, for these three

TABLE 11

RELATION OF TRACTOR PURCHASES TO CURRENT YEAR'S NET CASH AVAILABLE AND A "SOME CHANCE" INTENT--1960, 1961[1]

	1960 Average Net Cash Available Current Year				
	$3,025	$6,667	$9,364	$16,265	Total
Buyers	21 (19)	13 (17)	22 (19)	24 (25)	80
Non-Buyers	15 (17)	20 (16)	14 (17)	25 (24)	74
Total	36	33	36	49	154
Proportion Buyers	0.58	0.39	0.61	0.49	(0.52)
SAMPLE: $X^2 = 4.21$		C = 0.16			

	1961 Average Net Cash Available Current Year				
	$4,072	$7,445	$10,368	$18,501	Total
Buyers	20 (16)	10 (14)	16 (18)	26 (23)	72
Non-Buyers	6 (10)	13 (9)	13 (11)	11 (14)	43
Total	26	23	29	37	115
Proportion Buyers	0.77	0.43	0.55	0.70	(0.63)
SAMPLE: $X^2 = 7.28$		C = 0.24			

[1]Number of buyers and non-buyers of farm tractors in 1960 and 1961 who gave a "some chance" intent, sorted by current year's net cash available, number expected under the null hypothesis $P_1 = P_2 = P_3 = P_4 = (P)$, values of chi-square ($X^2$) and contingency coefficient (C).

variables, the null hypothesis is accepted. The tabular analyses are included in Appendix 1, Tables 1, 2 and 3.

Apparently, if a "some chance" intent is given, then additional information on buying behavior cannot be secured from the added knowledge of previous year's net cash available or change-in net cash available or tillable acreage. An intention to buy ("some chance") either incorporates the influence of these variables, or the influences of these variables are not sufficiently strong to significantly alter buying proportions.

Consider now only the effect of current year's net cash available on buying proportions, given a "some chance" intent to buy. Table 11 buying proportions suggest a nonlinear rather than a linear relationship. Note that the lowest income group bought at least as high a proportion of the tractors as the upper middle and highest income groups while the lower middle group bought the smallest proportion in both years.

On the basis of logic, one would expect that higher average levels of current year's disposable income (Groups 2 and 3) could purchase as high a proportion of tractors as the group receiving lower average levels (Group 1). Clearly, this is not the case as they purchased lower proportions. The results observed are probably due to random variation. When tested with chi-square, the observed and expected frequencies are not significantly different in either year. The 1961 chi-square value would be considered significant at the 10% level. The strength of the relationship is very weak in the first year and only slightly stronger in the second year. Considering both years and the criteria used, it is apparent that current year's net cash available does not significantly alter the buying proportions of those farmers

who indicate a "some chance" buying intention.

The conclusions from the analyses of the "some chance" group are: (1) The objective variables examined shed no additional light on the reasons for buying proportions observed on the "some chance" group over the two year study, (2) Current year's net cash available is the only variate to throw even the faintest additional light on reasons for changes in buying proportions and these are neither in the expected direction nor of the magnitude required for statistical significance.

Strength of Intent as a Factor Affecting Tractor Purchases

In preceding sections, the analyses have been directed towards the determination of the value of classifying respondents into two categories, "some chance" and "no chance", and the added value of certain objective factors in explaining differences in buying proportions. This analysis now extends the "some chance" analysis to the actual strength of intent that the respondents indicated on their questionnaires. The reason for requesting a strength of intent designation was to find out if a further subdivision of the "some chance" group would provide more reliable predictive information on buying behavior than that obtained under the latter classification.

Respondents, who indicated that they would buy, were requested to classify the strength of their intention to purchase a tractor into one of the following categories:

1. Very certain--have already made or am making arrangements.
2. Quite certain--considerable better than a 50:50 chance.
3. Fair chance--about 50:50 chance.
4. Slight chance--less than a 50:50 chance.

There was reason to expect that those farmers who have well formulated plans to buy would indicate that they intended to buy by expressing either a "very certain" or a "quite certain" intention on the questionnaire. Those operators who thought that they might buy a tractor but who had not made a decision were expected to register a "fair chance" intent. A "slight chance" intent was expected from those who would buy only if necessary, or if more favorable conditions developed during the year.

If strength of intent is a primary variable explaining buying proportions, then this needs to be ascertained. This information would be useful in model building as it would permit the assignment of probabilities of buying to each strength of intent group.

H_o13: The distribution of the proportions of those who buy tractors is the same for all "strength of intent" groups. The results are given in Table 12.

One of the rules followed by many statisticians is to use the chi-square criterion only when none of the expected frequencies per cell is less than five.[1] To follow this rule requires that "very certain" and "quite certain" categories be combined.

Farmers did actually differentiate between very certain and quite certain categories for almost twice as many designated Q.C. rather than V.C. intentions. Subsequent purchases by these groups indicated that there is essentially no difference in their buying behavior. For forecasting purposes, it appears, that equal probabilities of buying could be assigned to each category without gross violence to the facts.

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[1]John E. Freund, Modern Elementary Statistics (Prentice-Hall Inc., Second Edition, 1960), p. 281.

TABLE 12

RELATION OF TRACTOR PURCHASES TO STRENGTH OF INTENT--1960, 1961[1]

	1960 Strength of Intent			
	VC&QC[a]	FC[b]	SlC[c]	Total
Buyers	27 (18)	33 (34)	20 (28)	80
Non-Buyers	7 (16)	33 (32)	34 (26)	74
Total	34	66	54	154
Proportion Buyers	0.79	0.50	0.37	(0.52)
SAMPLE: $X^2 = 14.30$**		C = 0.29		

	1961 Strength of Intent			
	VC&QC[a]	FC[b]	SlC[c]	Total
Buyers	31 (21)	24 (22)	17 (29)	72
Non-Buyers	3 (13)	11 (14)	29 (17)	43
Total	34	35	46	115
Proportion Buyers	0.91	0.68	0.37	(0.63)
SAMPLE: $X^2 = 22.24$**		C = 0.40		

[1]Number of buyers and non-buyers of farm tractors in 1960 and 1961 sorted by strength of intent, number expected under the null hypothesis $P_1 = P_2 = P_3 = (P)$, values of chi-square (X^2) and contingency coefficient (C).

**Significant at the 1% level.

[a]Very certain plus quite certain, [b]Fair chance, [c]Slight chance

Note that in Table 12, discrepancies between the observed and expected frequencies are much larger than could be expected on the basis of chance alone. There is a highly significant difference in the buying proportions of the three groups. Therefore, the null hypothesis is rejected. The strength of the relationship is considered strong in both years. We can conclude that the higher the strength of intent the higher the probability that a purchase will be made.

There is a disturbing feature brought out of this analysis which has serious implications for forecasting purposes. Buying proportions are not stable from year to year in the same strength of intent category. Note that there is a change in buying proportion between years of 0.12 in the "very certain plus quite certain" category and a 0.18 change in the "fair chance" category. Inflexible buying proportions would be preferred for prediction purposes. Therefore, in using strength of intent one must beware of forming an exaggerated notion of the accuracy and empirical stability of this theoretical concept. Neither intentions to buy or strength of intent, alone, foretell purchases with a high degree of accuracy.

The strength of intent category known as "slight chance" appears to be quite stable from year to year. Tractor purchases were made by 37 percent of the members of this group in both years. Wright and Vincent found that 40 percent of this group bought tractors in the first year of the investigation. Unless there is a reasonably high degree of stability in each strength of intent group much experience would need to be gained before the necessary correction factors could be applied successfully.

The results indicate that the present subdivision reveals more

about subsequent buying behavior than the sample classification "some chance versus no chance" permitted.

The following model emerges for the strength of intent groups analyzed in this section:

$$E(B_s) = \Sigma n_i p_i$$

where:

$E(B_s)$ = expected number of buyers

n_i = the number of respondents in each strength of intent category and where i extends from 1 to 3 and where 1 is the number of "very certain" plus "quite certain" intentions, 2 is the number of "fair chance" intentions and 3 is the number of "slight chance" intentions

p_i = the probability of buying established for each strength of intent category and where p's are predetermined by a regression of p's on time through a least squares technique or by linear extrapolation or through drawing a freehand curve of past proportions to determine future probabilities and where i extends from 1 to 4.

The Effects of a Given Strength of Intent and Variable Financial Factors on Tractor Purchases

In the preceding section, it has been demonstrated that buying proportions are not stable from year to year for each strength of intent group. These results suggest that additional factors were not considered in original intentions and yet subsequently these factors altered buying proportions. Which of the available financial factors are most efficient in explaining the discrepancies between observed and expected frequencies when the strengh of intent is fixed. The answers might be forthcoming if each strength of intent is held constant and financial factors permitted

to vary. This procedure might permit the identification of financial factors which the respondents had not considered when they indicated a specific strength of intent.

The hypothesis is that given a strength of intent, the higher the level of a financial factor, the higher the proportion of buyers that will result. The testable hypotheses are stated in the form of the null hypothesis as follows: When the strengh of intent is given, the distribution of the proportion of buyers is the same for all levels of the financial factor under consideration. (H_o14, 15 and 16)

In this analysis, it is not possible to hold the "very certain" plus "quite certain" category constant and vary each financial factor in turn and use chi-square to determine whether discrepancies are due to chance or to the variable under investigation. Some cells would have frequencies less than five and the "statistician's rule" calls for a minimum of five. The "fair chance" and "slight chance" intents are almost free, or free in at least one year from this statistical limitation and so only these two will be analyzed. To meet cell frequency requirements it was also necessary to use three groups rather than the quartile classification used previously.

Considering the "fair chance" group first, the effect of varying first, previous year's net cash available, then current year's net cash available, and finally change-in cash available on buying proportion can be seen in Tables 13, 14 and 15.

The Effect of Varying Previous Year's Net Cash Available and a "Fair Chance" Intent on Tractor Purchases

The results obtained from holding strength of intent constant at "fair chance" and varying previous year's net cash available can be

TABLE 13

RELATION OF TRACTOR PURCHASES TO PREVIOUS YEAR'S NET CASH AVAILABLE AND A "FAIR CHANCE" INTENT--1960, 1961[1]

	1960 Average Previous Year's Net Cash Available (1959)			
	$3,911	$8,096	$16,008	Total
Buyers	10 (11)	9 (11)	14 (11)	33
Non-Buyers	12 (11)	13 (11)	8 (11)	33
Total	22	22	22	66
Proportion Buyers	0.45	0.41	0.63	(0.50)
SAMPLE: $X^2 = 2.54$		$C = 0.19$		

	1961 Average Previous Year's Net Cash Available (1960)			
	$3,992	$8,369	$19,904	Total
Buyers	9 (8)	8 (8)	7 (8)	24
Non-Buyers	3 (4)	4 (4)	4 (4)	11
Total	12	12	11	35
Proportion Buyers	0.75	0.67	0.64	(0.69)
SAMPLE: $X^2 < 1$		$C = 0.17$		

[1]Number of buyers and non-buyers of farm tractors in 1960 and 1961 who indicated a "fair chance" intent, sorted by previous year's net cash available, number expected under the null hypothesis $P_1 = P_2 = P_3 = (P)$, values of chi-square (X^2) and contingency coefficient (C).

seen by an examination of the buying proportions in Table 13. Note that observed and expected frequencies are well within the range expected on the basis of chance alone. Only in 1960 and for the highest average income group is there any tendency for buying proportion to differ, but the difference is not statistically significant. On the basis of this evidence, there is no alternative but to accept the null hypothesis (H_o13), i.e., no difference in buying proportion can be attributed to the influence of the level of the previous year's net cash available.

Respondents have apparently considered this factor in stating strength of intent to buy as "fair chance". If this is true, then as the analysis shows, there would be as much usable information about subsequent buying behavior contained in their strength of intent as there would be forthcoming from a knowledge of both their strength of intent and previous year's disposable income. This interpretation seems logical. Respondents would have a fairly good idea as to the size of past year's income and by indicating a "fair chance" intent they are apparently suggesting that some additional factors will have to be considered before a tractor buying decision is made.

The Effect of Varying Current Year's Net Cash Available and a "Fair Chance" Intent on Tractor Purchases

Perhaps current year's net cash available is a factor controlling some of the tractor purchases of those who indicate a "fair chance" intent. Table 14 shows the effect of this variable on buying proportion.

Note that in 1960 observed frequencies are exactly the same as expected frequencies. Therefore, the chi-square value is zero. The null hypothesis is accepted, i.e., no difference in buying proportion which is traceable to the level of the current year's disposable income.

TABLE 14

RELATION OF TRACTOR PURCHASES TO CURRENT YEAR'S NET CASH AVAILABLE AND A "FAIR CHANCE" INTENT--1960, 1961[1]

	1960 Average Net Cash Available Current Year			
	$4,429	$8,423	$15,487	Total
Buyers	11 (11)	11 (11)	11 (11)	33
Non-Buyers	11 (11)	11 (11)	11 (11)	33
Total	22	22	22	66
Proportion Buyers	0.50	0.50	0.50	(0.50)
SAMPLE: $X^2 = 0$		C = 0		

	1961 Average Net Cash Available Current Year			
	$5,652	$10,886	$22,658	Total
Buyers	7 (8)	10 (8)	7 (8)	24
Non-Buyers	5 (4)	2 (4)	4 (4)	11
Total	12	12	11	35
Proportion Buyers	0.58	0.83	0.64	(0.69)
SAMPLE: $X^2 = 1.81$		C = 0.22		

[1]Number of buyers and none-buyers of farm tractors in 1960 and 1961 who indicated a "fair chance" intent, sorted by current year's net cash available, number expected under the null hypothesis $P_1 = P_2 = P_3 = (P)$, values of chi-square (X^2) and contingency coefficient (C).

Examination of the 1961 buying proportions reveals that these are well within the range expected on the basis of chance alone. Note that the buying proportion of the middle group is larger than the top group which had twice as large an average disposable income. This is certainly not the logical expected direction. Economic theory suggests that aggregate purchases should generally follow income. Here we are concerned with tractor purchases and these need not change with income.

The rather strong evidence revealed in the 1960 analysis and in full recognition of the statistical limitations of the 1961 data there appears to be no alternative but to accept the null hypothesis, ($H_o 15$). Therefore, current year's net cash available should be eliminated as a key variable explaining the tractor buying proportions of the "fair chance" group.

The Effect of a Change-in Net Cash Available and a "Fair Chance" Intent on Tractor Purchases

Economic theory suggests that, other things being equal, an increase in disposable income shifts the demand curve to the right. Under this assumption, farmers would buy more tractors, even at a higher price. However, other things may not be equal. A change in disposable income may change their indifference maps so that they do not increase their tractor purchases. For example, a farmer may be driving both an older model tractor and an older model car. Suppose now that his disposable income changes sufficiently that he can buy either the tractor or the car. His preference may shift in favor of the car. This shift in preference may shift the demand curve for a tractor back to the original position with the result that a tractor purchase is not made.

Economic theory indicates that a decrease in disposable income

would shift the demand curve to the left, other things being equal. Other things may not be equal. Farmers may reason that this year's reduction in disposable income is only temporary and that their income is still high enough or expected to be high enough to permit a tractor purchase. They may also reason that it is wiser to invest in a tractor now in order to increase future income. These men would, therefore, not postpone tractor purchases. Any of the above reasons may account for the results obtained in this analysis.

The buying proportions that resulted under three average change-in net cash available levels are given in Table 15. Note in the 1960 tabular analysis that Group 1 (lowest income) had an average negative change in income that might be considered rather substantial. Group 3 had a change in income of about the same magnitude but in the opposite direction. However, both groups bought about the same proportion of tractors. These results would suggest that change in net cash available has not had any influence on tractor buying proportions. Contrast these results with the buying proportion of the middle group. Their income didn't change and they ended up buying about half the tractors expected. The chi-square value suggests that the null hypothesis should be rejected. The rejection would be based on the buying performance of this middle group. If this group experienced a very low buying proportion then the buying proportion of Group 1 should be even lower if change in income is a significant factor. This is not the case. Therefore, the change in net cash available has not been instrumental in reducing or increasing buying proportions. How might this be explained? Examination of the original data reveals that a number of the farmers who were in Group 1 were previously in income brackets somewhat higher than

TABLE 15

RELATION OF TRACTOR PURCHASES TO CHANGE-IN NET CASH AVAILABLE AND A "FAIR CHANCE" INTENT--1960, 1961[1]

	1960 Average Change in Net Cash Available			
	-$4,485	$10	$4,723	Total
Buyers	13 (11)	6 (11)	14 (11)	33
Non-Buyers	9 (11)	16 (11)	8 (11)	33
Total	22	22	22	66
Proportion Buyers	0.59	0.27	0.64	(0.50)
SAMPLE: $X^2 = 6.90$*		C = 0.30		

	1961 Average Change in Net Cash Available			
	-$2,319	$1,304	$8,091	Total
Buyers	8 (8)	8 (8)	8 (8)	24
Non-buyers	4 (4)	4 (4)	3 (4)	11
Total	12	12	11	35
Proportion Buyers	0.67	0.67	0.73	(0.69)
SAMPLE: $X^2 < 1$		C = 0.17		

[1]Number of buyers and non-buyers of farm tractors in 1960 and 1961 who indicated a "fair chance" intent, sorted by change-in previous year's net cash available, number expected under the null hypothesis $P_1 = P_2 = P_3 = (P)$, values of chi-square (X^2) and contingency coefficient (C).

*Significant at the 5% level.

the middle income group. Those who are normally in a fairly good income position but find later in the year that their disposable income has been reduced may have purchased because of inadequate foresight. Even if they had foreseen that their income would be reduced, they may not have considered the potential reduction large enough to prevent the purchase of such a key machine as a tractor. Whatever the reasons, it is obvious that differences in buying proportions are not in the expected direction in 1960, and in 1961 the buying proportion is the same for all three groups. Therefore, the evidence is in favor of acceptance of the null hypothesis H_o16.

The Effect of Previous Year's Net Cash Available on the Proportion of Tractor Purchases, Given a "Slight Chance" Intent

The reasons for buying performance variability in the "slight chance" group which may be traceable to the influence of financial variables is of interest in this analysis. Some of the income variables are expected to influence tractor purchases. For example, one might expect that farmers with a relatively high average previous year's net cash available group, would purchase proportionately more tractors than those with a low disposable income even if both groups indicated the same strength of intent at the time of questionnaire completion.

The null hypothesis which we want to test is:

H_o17: The distribution of the proportion of buyers is the same for the three average previous year's net cash available levels, when their strength of intent is the same, i.e., "slight chance".

The results of this analysis are given in Table 16. In 1960 the observed frequencies are nearly the same as the expected frequencies

TABLE 16

RELATION OF TRACTOR PURCHASES TO PREVIOUS YEAR'S NET CASH AVAILABLE AND A "SLIGHT CHANCE" INTENT--1960, 1961[1]

	1960 Average Previous Year's Net Cash Available			
	$3,892	$8,008	$16,511	Total
Buyers	8 (7)	6 (7)	6 (7)	20
Non-Buyers	10 (11)	12 (11)	12 (11)	34
Total	18	18	18	54
Proportion Buyers	0.44	0.33	0.33	(0.37)
SAMPLE: $X^2 < 1$				

	1961 Average Previous Year's Net Cash Available			
	$3,047	$8,778	$16,609	Total
Buyers	5 (6)	3 (6)	9 (6)	17
Non-Buyers	10 (10)	12 (10)	7 (10)	29
Total	15	15	16	46
Proportion Buyers	0.35	0.20	0.56	(0.37)
SAMPLE: $X^2 = 5.27$		C = 0.32		

[1]Number of buyers and non-buyers of farm tractors in 1960 and 1961 who indicated a "slight chance" intent, sorted by previous year's net cash available, number expected under the null hypothesis $P_1 = P_2 = P_3 = (P)$, values of chi-square (X^2) and contingency coefficient (C).

under the null hypothesis. With chi-square as the criterion at the 5 percent probability level, the null hypothesis is accepted. Examination of the 1961 results reveals that differences in buying proportions are not in the expected direction. The middle group bought a smaller proportion of tractors than those with a lower average previous year's disposable income. The relationship appears to be nonlinear and weak.

In 1961, the highest average previous year's disposable income group had a buying proportion of the order expected but in 1960 with a different sample there is a lower relative buying proportion even though they had approximately the same disposable income. Note the inconsistencies between groups and between years.

The inconsistencies and the non-significant chi-square values indicate that the null hypothesis should be accepted in both year. Apparently, previous years net cash available has already been considered in the indicated intention, i.e., "slight chance". This finding agrees with what was found for the "fair chance" group.

The Effect of Current Year's Net Cash Available on the Proportion of Tractor Purchases, Given a "Slight Chance" Intent

Perhaps the level of the current year's net cash available controls to some extent the purchases of the "slight chance" group.

$H_o 18$: The distribution of the proportion of buyers is the same for all current year's net cash available levels when their strength of intent is held constant at "fair chance". Table 17 gives the results obtained when the strength of intent is held constant at "slight chance" and three levels of current year's net cash available are used.

TABLE 17

RELATION OF TRACTOR PURCHASES TO CURRENT YEAR'S NET CASH AVAILABLE AND A "SLIGHT CHANCE" INTENT--1960, 1961[1]

	1960 Average Net Cash Available Current Year			
	$4,515	$9,212	$18,207	Total
Buyers	8 (7)	5 (7)	7 (7)	20
Non-Buyers	10 (11)	13 (11)	11 (11)	34
Total	18	18	18	54
Proportion Buyers	0.44	0.28	0.39	(0.37)
SAMPLE: $X^2 = 1.42$		C = 0.16		

	1961 Average Net Cash Available Current Year			
	$4,477	$9,397	$17,286	Total
Buyers	7 (5)	1 (5)	8 (6)	16
Non-Buyers	8 (10)	14 (10)	8 (11)	30
Total	15	15	16	46
Proportion Buyers	0.47	0.07	0.50	(0.35)
SAMPLE: $X^2 = 7.88$*		C = 0.39		

[1]Number of buyers and non-buyers of farm tractors in 1960 and 1961 who indicated a "slight chance" intent sorted by current year's net cash available, number expected under the null hypothesis $P_1 = P_2 = P_3 = (P)$, value of chi-square (X^2) and contingency coefficient (C).

*Significant at the 5% level.

Note that in 1960 observed frequencies are almost the same as expected frequencies but in 1961 they are different. In both samples, average income levels are essentially the same. The most obvious difference between observed and expected frequencies occurs in 1961 and for the middle group. Only 1 in 15 bought tractors whereas 5 in 15 would be expected. Is it possible that the middle income group attach a lower probability of purchasing to an indicated "slight chance" intent than do those in either a lower or higher current income bracket? Further study would be required to test this hypothesis.

Further examination of Table 17 will show that the buying proportions of Groups 1 and 3 are almost identical in either year. Observations on these two groups would tend to rule out net cash available in the current year as a primary variable influencing the tractor purchases of the "slight chance" group. A rejection of the null hypothesis would be possible only in the second year and would be based on differences in the two frequencies of the middle group.

Considering the almost identical buying proportions of Groups 1 and 3 and the observation that observed frequencies are so close to expected frequencies for the second group in 1960, would weigh the evidence in favor of an acceptance of the null hypothesis. There is, therefore, no statistical or logical evidence that the level of net cash available in the current year exerts a significant influence on the tractor purchases of the "slight chance" group.

The Effect of Varying Change-in Net Cash Available on the Proportions of Purchases, Given a "Slight Chance" Intent

One might suspect that some change in tractor buying proportion would follow from changes in net cash received by those farmers indicating

at the time of questionnaire completion a "slight chance" intent.

$H_o 19$: The distribution of the proportion of buyers is the same for all change-in net cash available groups.

In both years, expected frequencies differ only slightly from observed frequencies. In Group 1, there is a rather substantial negative average change, but no significant reduction in buying proportion developed. Group 2 had as high a proportion buying as Group 3 even though this latter group had an average positive income change that was several times as large as that received by the former. Thus, in Group 3, if change-in net cash available was a controlling variable, buying proportions should be higher than those of Group 2. Examination of Table 18 shows that this is not the case. Since the three change-in net cash available levels produced no significantly different effects on buying proportion in either of the two years analyzed, the null hypothesis should be accepted. Thus, we are left with a relationship which is suspected but cannot be proved with the few observations on each group. More observations in each group might make a difference. Also, perhaps, this variable operates intermittently but did not express itself in the two years studied. Again, there may be more than a one year time lag before this variable expresses itself in tractor buying decisions. Further research would be required to test this latter hypothesis.

The conclusion for the entire section is that there is no significant alteration of the tractor buying proportion by and within the range of the income variables examined, when the strength of intent is held constant.

TABLE 18

RELATION OF TRACTOR PURCHASES TO CHANGE-IN PREVIOUS YEAR'S NET CASH AVAILABLE AND A "SLIGHT CHANCE" INTENT--1960, 1961[1]

	1960 Average Change in Income Level			
	-$3,658	$1,153	$4,165	Total
Buyers	5 (7)	8 (7)	7 (7)	20
Non-Buyers	13 (11)	10 (11)	11 (11)	34
Total	18	18	18	54
Proportion Buyers	0.28	0.44	0.39	(0.37)
SAMPLE: $X^2 = 1.22$		C = 0.14		

	1961 Average Change in Income Level			
	-$3,991	$643	$5,737	Total
Buyers	4 (6)	7 (6)	6 (6)	17
Non-Buyers	11 (10)	8 (10)	10 (10)	29
Total	15	15	16	46
Proportion Buyers	0.27	0.46	0.37	(0.37)
SAMPLE: $X^2 = 1.28$		C = 0.16		

[1]Number of buyers and non-buyers of farm tractors in 1960 and 1961 who indicated a "slight chance" intent, sorted by change-in previous year's net cash available, number expected under the null hypothesis $P_1 = P_2 = P_3 = (P)$, values of chi-square (X^2) and contingency coefficient (C).

CHAPTER V

MULTIPLE REGRESSION ANALYSES OF FACTORS THOUGHT TO INFLUENCE TRACTOR PURCHASES

In the preceding chapter, strength of intent emerged as the dominant factor controlling tractor purchases. With strength of intent held constant, it was not possible to demonstrate any further significant influence of the other factors when they were considered individually. This statement must be qualified because two of the income factors exerted a significant influence on the buying proportions of the "no chance" group in the second year. However, the factors may reinforce each other and if they are examined together they may provide more information on tractor purchases. It is the task in this chapter to ascertain the relative importance of several factors when considered together on tractor purchases. The assessment of the relative contributions of the various factors to information on expenditures will be made in Chapter 6. Multiple regression is the preferred statistical method for handling several observations on each respondent and is used in this chapter and also in the next.

Using attainable data, the following were taken as factors that may be associated with tractor purchases: (1) tillable acreage, (2) previous year's net cash available, (3) current year's net cash available, (4) change in net cash available, (5) machinery inventory value, (6) annual hired labor cost, (7) an intention to buy with a trade-in,

and (8) an intention to buy without a trade-in.[1]

It was assumed that the explanatory factors were related to tractor purchase in a linear fashion. The model used was as follows:

$$Y = a + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6 + b_7X_7 + b_8X_8 + e$$

where a is a constant, e is the random residual and b_1 to b_8 inclusive are the regression coefficients and where:

Y = 1 if the farmer is a buyer

0 otherwise

X_1 = tillable acreage (ac)

X_2 = previous year's net cash available ($)

X_3 = current year's net cash available ($)

X_4 = change in the net cash available ($)

X_5 = machinery inventory value, January 1 ($)

X_6 = annual hired labor cost in current year ($)

X_7 = 1 if the farmer indicates an intention to buy with trade

0 otherwise

X_8 = 1 if farmer indicates an intention to buy without trade

0 otherwise

Statistical Analysis and Results

A computer was used to solve the multiple regression equations, i.e., to determine the empirical relation between tractor purchase and the explanatory factors. An unrestricted least squares regression program was used. Two criteria were used in assessing the significance of

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[1]Variates 1 to 6 inclusive were obtained from account book and 7 and 8 from the mail questionnaire and the latter two variables reflect a "some chance of buying" intent.

each variate: (1) the value of t and (2) the partial correlation coefficient. To measure the relationship of the factors to tractor purchases, the adjusted coefficient of multiple correlation ($\bar{R}$). The adjusted coefficient of determination ($\bar{R}^2$) when multiplied by 100 indicates the percentage of the total variance in tractor purchases which is explained by all the independent factors. The aforementioned measures together with the estimated regression equation and the standard errors of the regression coefficients are presented in Tables 19 and 20 for the years 1960 and 1961.

Before the results, a comment on the tables is required. There were three disposable income variables entered in the regression. But the three are perfectly interrelated. Therefore, one of the variables should have been deleted. There was an error in entering one of the variables at the computer center and the perfect interrelation was not revealed. After examination of the results, it was not deemed essential that the regression be rerun.

Examination of the 1960 results will reveal that only two factors; an intention to purchase with trade and an intention to purchase without trade can be regarded as statistically significant at the 5 percent probability level. Both have the coefficient sign as expected. These two variates also rank first and second under the second criterion. There is little doubt that these two variates are the most effective predictors of farm tractor purchase. The other six factors indicate negligible partial correlation coefficients and could be left out of the prediction model. The only variates which have relatively large t values are (1) change-in net cash available and (2) annual hired labor cost. Neither has the coefficient sign expected and thus are not controlling

TABLE 19

MULTIPLE LINEAR REGRESSION ANALYSIS OF TRACTOR PURCHASES WITH EIGHT FACTORS FOR THE YEAR 1960

(a) Multiple Coefficients

Multiple Linear Regression	Standard Error of Estimate	Adjusted Coefficient of Correlation ($\bar{R}$)	Adjusted Coefficient of Determination ($\bar{R}^2$)
YX12345678	0.41	0.33	0.11

(b) Computed Statistics on 637 observations

Explanatory Factors		t Value	Significance Level	Partial Correlation Coefficients
constant		3.57	0.00	
tillable acreage	(X_1)	1.06	0.29	0.04
previous year net cash	(X_2)	0.69	0.50	0.03
current year net cash	(X_3)	0.96	0.34	0.04
change-in net cash	(X_4)	1.36	0.17	0.05
machinery inventory value	(X_5)	0.29	0.76	0.01
hired labor cost	(X_6)	1.50	0.13	0.06
intention with trade	(X_7)	6.43	0.00	0.25
intention without trade	(X_8)	5.97	0.00	0.23

(c) Multiple Linear Regression Equations and Standard Errors of Regression Coefficients

$$\hat{Y} = \underset{}{0.15080} + \underset{(0.045599)}{0.00023X_1} + \underset{(0.000271)}{0.000003X_2} + \underset{(0.000005)}{0.000004X_3} - \underset{(0.000005)}{0.000007X_4} + \underset{(0.000006)}{0.000001X_5} - \underset{(0.000004)}{0.000016X_6} + \underset{(0.000011)}{0.000138X_7} + \underset{(0.000021)}{0.000179X_8}$$

$$\underset{(0.000032)}{}$$

where $\hat{Y}$ is the estimated probability of purchase.

TABLE 20

MULTIPLE LINEAR REGRESSION ANALYSIS OF TRACTOR PURCHASES WITH EIGHT FACTORS FOR THE YEAR 1961

(a) Multiple Coefficients

Multiple Linear Regression	Standard Error of Estimate	Adjusted Coefficient of Correlation ($\bar{R}$)	Adjusted Coefficient of Determination ($\bar{R}^2$)
YX12345678	0.38	0.42	0.18

(b) Computed Statistics on 530 observations*

Explanatory Factors		t Value	Significance Level	Partial Correlation Coefficients
constant		2.15	0.03	
tillable acreage	(X_1)	0.13	0.87	0.01
previous year net cash	(X_2)	-0.92	0.36	0.04
current year net cash	(X_3)	1.03	0.30	0.05
change-in net cash	(X_4)	-0.73	0.47	0.03
machinery inventory value	(X_5)	2.51	0.01	0.11
hired labor cost	(X_6)	-1.02	0.31	0.04
intended purchase with trade	(X_7)	8.06	0.00	0.33
intended purchase w/o trade	(X_8)	6.93	0.00	0.29

(c) Multiple Linear Regression Equations and Standard Errors of Regression Coefficients

$$\hat{Y} = \underset{}{0.098076} + \underset{(0.045599)}{0.000035X_1} - \underset{(0.000271)}{0.000004X_2} + \underset{(0.000005)}{0.000005X_3} - \underset{(0.000005)}{0.000004X_4} + \underset{(0.000006)}{}$$

$$\underset{(0.000004)}{0.000011X_5} + \underset{(0.000011)}{0.000011X_6} + \underset{(0.000024)}{0.000191X_7} + \underset{(0.000032)}{0.000219X_8}$$

*4 cards not accounted for at Michigan State University.

tractor purchases at least in this specific year. The coefficient of determination indicates that only 11 percent of the variance in the dependent variable can be explained by the independent variables examined.

In the second year the coefficient of determination indicates that 18 percent of the variance was explained using all eight factors. Three factors: (1) an intention to purchase with trade, (2) an intention to purchase without trade, and (3) machinery inventory value could be considered as explanatory variables. In common with the results obtained in 1960 note that the factors change-in net cash available (disposable income) and annual hired labor cost do not have the coefficient sign expected. In addition previous year's net cash available (disposable income) has not the expected sign for the coefficient. Additionally the coefficients of tillable acreage, previous year's disposable income, current year's disposable income, change-in disposable income and annual hired labor cost are small in comparison with their sampling errors. These variables were, therefore, the weak or marginal variables.

In considering both years, it is now apparent that strength of intent, i.e., a "some chance" intent to purchase with or without trade and a "no chance" intent remains the dominant explanatory factor. This agrees with the analysis of Chapter 4. A new factor, i.e., machinery inventory, emerged as a significant explanatory factor in this multiple regression but only in one year. This may indicate that the factor operates intermittently to control tractor purchases. Whether it does or not cannot be ascertained on the basis of the two year results presented here.

CHAPTER VI

MULTIPLE LINEAR REGRESSION ANALYSIS OF FACTORS THOUGHT TO BE IMPORTANT IN EXPLAINING TRACTOR EXPENDITURES

The objective of this chapter is to estimate the influence of several variates on the expenditure for tractors. Factors were examined jointly in the hope that a knowledge of several independent variables would together provide a more accurate description of the dependent variable than would a knowledge of any one of them singly.

Linear regression was used because no alternative superior technique was known.

Eight variables were postulated to influence expenditures on tractors: (1) tillable acreage, (2) total labor cost, (3) machinery inventory value, (4) disposable income in the current year (current year's net cash available), (5) strength of intent, (6) disposable income of the previous year, (7) change-in disposable income, and (8) the intended amount of expenditure.

The least squares with no restrictions regression analysis technique was used to determine which variables were important.

The model used was:

$$Y = a + b_1X_1 + b_2X_2 \ldots + b_7X_7 + e$$

where: a is a constant, b_1 to b_7 are the regression coefficients and e is the random residual

and where:

Y = Actual expenditures on tractors made with a trade-in plus those made without a trade-in ($).

X_1 = tillable acres (ac)

X_2 = hired labor cost current year ($)

X_3 = machinery inventory value at the beginning of the year ($)

X_4 = the intended expenditure ($)

X_5 = disposable income for the previous year ($)

X_6 = change in disposable income (current - previous) ($)

X_7 = strength of intent

where:

0.85 was entered if either a "very certain" or "quite certain" intent was indicated on the questionnaire

0.60 if a "fair chance" intent was indicated

0.37 if a "slight chance" intent was indicated

0.14 if a "no chance" intent was indicated

Variates have been developed in previous chapters and therefore it appears unwise to redevelop these here. It would appear sufficient to indicate the source of the factors used in the regressions.

Data on variates X_1, X_2, X_3, X_5 and X_6 were obtained from the account books of respondents and X_4 from the mail questionnaire. X_7 was calculated by a simple averaging of the two year buying proportions for each strength of intent (Chapter IV).

Statistical Analysis and Results

A computer was used to solve the multiple regression equations, i.e., to determine the empirical relations between tractor expenditures

and the explanatory factors. An unrestricted least squares regression program was used. Several criteria were used in assessing the significance of each variate, (1) the value of "t" derived by dividing the regression coefficient by its standard error, (2) the partial correlation coefficient (a tool which makes the correlation coefficients comparable and enables a ranking according to importance), (3) "R^2 deletes" (a tool which indicates the additional variance explained if the specific factor is included in the regression), (4) the "$\bar{R}^2$" adjusted coefficient of multiple correlation (a statistic which measures the relationship of all factors to tractor expenditures and (5) "$\bar{R}^2$" the adjusted coefficient of determination (a statistic which when multiplied by 100 indicates the percentage variation in tractor expenditures which is attributable to all the explanatory factors considered in the regression.

Several regressions were run but only one is reported in detail for both years. The "a" section of Table 21 shows that 17.7 percent of the variance in tractor expenditures could be explained with all seven factors and with the removal of three weak variables, 17.5 percent in 1960. Table 22 ("a" section) shows that for 1961, 30.3 percent of the variance in tractor expenditures could be explained with seven factors and 30.6 percent with only four factors. Thus, as much variance can be explained with four factors as with seven. The statistically significant or explanatory factors in each year are not completely the same ("b" section of tables). In both years intended expenditure and strength of intent are significant explanatory factors. Previous year's disposable income is significant in 1960, but in 1961 machinery inventory value replaces it as a significant factor. For comparative purposes and because either of these variables may be significant in

TABLE 21

MULTIPLE LINEAR REGRESSIONS WITH SEVEN AND FOUR FACTORS IN 1960

(a) Multiple Coefficients

Multiple Linear Regression	Standard Error of Estimate	Adjusted Coefficient of Correlation ($\bar{R}$)	Adjusted Coefficient of Determination ($\bar{R}^2$)
(1) YX1234567	918.663	0.420	0.177
(2) YX3457	919.439	0.418	0.175

(b) Computed Statistics for Four Factors

Factors		"t" Values	Sig. Level	Partial Correlation Coefficients	R^2 Deletes
Intended Expenditure	(X_4)	5.506	0.00	0.214	0.1409
Strength of Intent	(X_7)	2.208	0.03	0.087	0.1739
Previous Year Net Cash	(X_5)	2.202	0.03	0.087	0.1739
Machinery Inventory Value	(X_3)	0.671	0.51	0.027	0.1796

(c) Multiple Linear Regression Equations and Standard Errors of Regression Coefficients

(1) $\hat{Y} = -35.633 + 0.604X_1 - 0.017X_2 + 0.005X_3 + 0.332X_4 + 0.020X_5 -$
$\quad\quad (107.982)\quad (0.491)\quad (0.024)\quad (0.009)\quad (0.060)\quad (0.009)$

$0.018X_6 + 546.820X_7$
$(0.010)\quad (262.068)$

(2) $\hat{Y} = -37.054 + 0.005X_3 + 0.330X_4 + 0.019X_5 + 576.188X_7$
$\quad\quad (93.319)\quad (0.008)\quad (0.060)\quad (0.009)\quad (260.979)$

subsequent years, both are included in the second regression equation ("c" sections).

In the first regression equation in each table the coefficients of tillable acreage, hired labor cost and change in disposable income are small in comparison with their sampling errors and these therefore are considered weak or marginal variables in this study. The second regression equation in each table contain the variables which were significant in one or both years and these are considered the dominant explanatory variables influencing tractor expenditures.

The regression coefficients reveal how much Y changes as each X_1 changes by one unit, assuming all other X's are constant at their means. In equation 2, for example, if average intended expenditure increases by one dollar, per farm tractor expenditure can be expected to increase by 33 cents based on 1960 results and 44.4 cents based on 1961 results. An average increase in strength of intent of 0.1 would increase per farm tractor expenditures by about $58 in 1960 and $129 in 1961.

The relative importance of intended expenditure and strength of intent was expected. But, previous year's disposable income was significant in only one year rather than both. That machinery inventory value should prove a significant explanatory factor was not expected. This study reveals, however, that farmer respondents with high opening inventories values in machinery spend more than those with lower investments in machinery.

Tillable acreage per respondent proved nonsignificant in this study. This was somewhat unexpected because we normally think that the higher acreage farmers spend more on tractors. There are at least two reasons why tillable acreage was not important. One is that these

TABLE 22

MULTIPLE REGRESSIONS WITH SEVEN AND FOUR FACTORS IN 1961

(a) Multiple Coefficients

Multiple Linear Regression	Standard Error of Estimate	Adjusted Coefficient of Correlation ($\bar{R}$)	Adjusted Coefficient of Determination ($\bar{R}^2$)
(1) YX1234567	939.776	0.551	0.303
(2) YX3457	937.640	0.554	0.306

(b) Computed Statistics for Four Factors

Factors		"t" Value	Sig. Level	Partial Correlation Coefficients	R^2 Deletes
Intended Expenditure	(X_4)	6.397	0.00	0.269	0.258
Strength of Intent	(X_7)	4.402	0.00	0.189	0.286
Previous Year Net Cash	(X_5)	0.209	0.82	0.009	0.311
Machinery Inventory Value	(X_3)	2.943	0.00	0.127	0.300

(c) Multiple Linear Regression Equations and Standard Errors of Regression Coefficients

(1) $\hat{Y} = -266.674 + 0.331X_1 - 0.006X_2 + 0.025X_3 + 0.448X_4 +$
$\quad\quad (125.636) \quad (0.637) \quad (0.027) \quad (0.010) \quad (0.070)$

$0.002X_5 - 0.009X_6 + 1273.788X_7$
$(0.009) \quad (0.135) \quad (296.373)$

(2) $\hat{Y} = -257.727 + 0.025X_3 + 0.444X_4 + 0.002X_5 + 1292.644X_6$
$\quad\quad (109.449) \quad (0.008) \quad (0.069) \quad (0.009) \quad (293.616)$

results may be valid only for the area covered in the study. If the geographic area had included respondents where tillable acreage was more diverse or a more extensive type of agriculture practised, tillable acreage might have affected tractor expenditures.

The second reason has to do with the possible difference in buying habits of smaller compared to larger acreage operators. The latter usually buy larger and therefore more expensive tractors but may trade more often and in so doing may spend no more per purchase than those who keep less expensive tractors for longer periods.

Hired labor cost per year also proved nonsignificant. A similar explanation to that used for tillable acreage could be advanced.

The failure of change in disposable income to influence significantly tractor expenditures is not hard to understand. Tractors and therefore expenditures are largely made in advance of knowledge as to what change in disposable income will be forthcoming.

In considering both years, it is apparent that a much higher percentage of the variation in expenditures is explained in the second year than in the first. Why this is the case is not known but it may be that respondents learn from filling out the questionnaire in successive years and try to be more accurate in indicating their strength of intent and their intended expenditure.

Much of the variation in tractor expenditures has not been explained. The unexplained variation may be due to random variation or it may be due to other independent variables not considered in the regression. Even though the model is incomplete, it should be recognized that the regression model is much more complete with the incorporation of the intentions factors than without them.

It would be desirable to increase the variance explained and with this thought the "no chance" respondents are excluded in the next analysis. This should bring out the factors responsible for the tractor expenditures of those who had indicated some chance of buying.

Factors Affecting Actual Tractor Expenditures by Those Who Indicated from "Very Certain" to "Slight Chance" Strength of Intent

The preceding analysis included respondents who had indicated "no chance" as their strength of intent and those who had qualified their "some chance" intentions of buying, i.e., very certain, quite certain, fair chance and slight chance. The factors which influence the expenditures of this "some chance" group needs to be ascertained.

This section investigates the dependence of their tractor expenditures on a linear combination of accessible variates. The criteria for evaluating the importance of each variate are (1) the value of t, and (2) the coefficient of multiple determination multiplied by 100.

The sample model used was as follows:

$$Y = a + b_1X_1 + b_2X_2 + \ldots. b_8X_8 + e$$

where:

b_i = the regression coefficients that describe the linear relation between Y and X_i, where i extends from 1 to 8, a is a constant, and e the random disturbance

and where:

Y = actual expenditures on tractors by only those who indicated a "some chance" intent or probability of purchase.

X_1 = probability of purchase (based on the actual buying proportion of each strength of intent group in Chapter 4) in 1960 and 1961.

Strength of Intent	1960 Probabilities	1961 Probabilities
Very certain	0.79	0.91
Quite certain	0.79	0.91
Fair chance	0.50	0.69
Slight chance	0.37	0.37

X_2 = amount of intended expenditure ($)

X_3 = tillable acreage (ac)

X_4 = previous year's net cash available (disposable income) ($)

X_5 = current year's net cash available (disposable income) ($)

X_6 = change in net cash available (current-previous) ($)

X_7 = machinery inventory value January 1 ($)

X_8 = annual hired labor cost in current year ($)

This regression and the remainder were run on a different computer and used a different program than those already reported. A stepwise regression technique was utilized,i.e., at each successive step that variable is added which accounts for the largest proportion of the remaining variation of the dependent variable. This information is important because it permits an understanding of the column labeled $100R^2$ in the subsequent tables. The column label $100R^2$ is the unadjusted coefficient of determination (R^2) multiplied by 100 but the figures in the column have a specific meaning. Turn to the next table and note the column marked "rank". The numbers in this column designate the order in which the variables entered the regression equation. Rank (1) indicates the most important explanatory factor, and (2) the second most important factor and so on. Locate the factor with the

TABLE 23

STATISTICAL SIGNIFICANCE OF THE FACTORS AFFECTING ACTUAL TRACTOR EXPENDITURES BY ONLY THOSE WHO INDICATED FROM "VERY CERTAIN" TO "SLIGHT CHANCE" INTENTS OF BUYING

Explanatory Factors		1960 t value	1960 Rank[a]	1960 $100R^2$	1961 t value	1961 Rank[a]	1961 $100R^2$
probability	(X_1)	2.89**	(2)	5.24	3.61**	(2)	7.64
amount intended	(X_2)	5.38**	(1)	17.66	4.61**	(1)	18.14
tillable acreage	(X_3)	0.46	(7)	0.11	-0.47	(6)	0.11
previous year's net cash	(X_4)	0.00	(6)	0.30	-0.00	(8)	0.00
current year's net cash	(X_5)	0.00	(8)	0.00	0.00	(4)	0.34
change in net cash	(X_6)	0.00	(3)	0.52	-0.00	(5)	0.14
machinery inventory value	(X_7)	1.07	(4)	0.23	1.43	(3)	1.41
hired labor cost	(X_8)	-1.71	(5)	1.17	0.26	(7)	0.04
Total explained variation				25.24			27.82
Number of observations			154			115	

[a]Number in parenthesis is the order in which the factors entered the stepwise regression.

**Significant at the 0.01 level.

rank designated as (1). Under the $100R^2$ column is the corresponding figure that indicates the percentage of the variance in tractor expenditures explained by this particular factor. Now locate the factor with rank number (2) and the corresponding figure in the $100R^2$ column. This latter figure indicates the added percentage of explained variance contributed by the second most important factor after the percentage of explained variance of the most important factor has been determined. Similarly, the value in the $100R^2$ column opposite rank number (3) indicates the added percentage of explained variance contributed by the third most important factor after the percentages of explained variance contributed by the first two most important factors have been calculated. The same system can be used to explain the balance of the figures in the $100R^2$ column.

One of the weaknesses of the computer stepwise regression program used is that it will force entry of variables which should not be entered. This forcing occurred in only one of the three disposable income variables per regression. Note in Table 23 that current year's net cash available was forced in 1960 and previous year's disposable income in 1961. This is the same problem of three perfectly interrelated variables previously explained. This problem was not considered serious enough to warrant reruns because of the relatively small explanatory contributions that the income variables made. The t values for disposable income variables go to zero because of the forcing in of all three income variables which, as a group, are perfectly correlated.

The stepwise regression analysis reveals that 25 percent of the variance in expenditures is explained by all factors in 1960 and 29 percent in 1961 (Table 23). With this model only the probability of

purchase (strength of intent) and the amount of intended expenditure can be considered important explanatory variables. They rank first and second under both criteria. The removal of six of eight variables dropped the $100R^2$ value by about 2 in both years. Variables X_3 to X_8 are the variables which are recorded in account books and they only add about 2 (to the percentage of explained) variance in the dependent variable. They add so little in the way of explanation of expenditure that they should be considered the weak or marginal variables. The unexplained variance may be due to other independent variables not considered in this analysis or to random variation.

The regression equations containing the significant variables were as follows:

(1) Year 1960 $Y = -731.414 + \underset{(592.948)}{1899.760X_1} + \underset{(0.081)}{0.447X_2}$

(2) Year 1961 $Y = -805.342 + \underset{(572.869)}{1945.250X_1} + \underset{(0.118)}{0.604X_2}$

where:

Y = estimated tractor expenditure of a "some chance of buying" respondent and the numbers in parentheses are the standard errors of the regression coefficients.

It would be desirable to increase the percentage of variance explained. It was thought that if a respondent indicated a specific expenditure, then whether he spent this amount or not was dependent in part on the particular strength of intent which he had indicated on the questionnaire. Thus an interaction term containing these two variables might reduce the variation in expenditures. The separate terms were replaced with the interaction term in the regression equation. This

interaction term resulted in an increase in the percentage of variance explained of about 1 in the first year and 4 in the second (Appendix Table 4). Judgment will be reserved as to the value of including in the regression this interaction term until the results of the next analysis are presented.

Factors Affecting Tractor Expenditures by Those Indicating from "Very Certain" to "Slight Chance" Intents to Buy "Without a Trade-In" Compared to "With a Trade-In"

The preceding analysis involved farmer respondents who indicated some intent to buy without a tractor trade-in plus those with a trade-in. The questionnaire permitted the separation of these two groups. For clarity and brevity purposes, we shall term these two groups as "no trade" and "with trade", respectively.

It was expected that the "no trade" group would be able to indicate better estimates of their actual expenditures than the "with trade" respondents since the latter would have at least the added difficulty of estimating the value of their trade. Therefore, with two estimates to make, i.e., the new price and the value of their trade-in, the "with trade" group might be expected to have less accurate estimates of their intended expenditures than the "no trade" group which simply had to know the retail price. On an intuitive basis, one would expect that the retail price of the tractor could be estimated within a relatively narrow range. The estimation of the value of a trade-in would not be so easily defined.

New regressions were estimated for these two groups and contained the same variates as previously designated. The results are tabulated in Tables 24 and 25.

TABLE 24

STATISTICAL SIGNIFICANCE OF FACTORS AFFECTING ACTUAL TRACTOR EXPENDITURES BY THOSE WHO INDICATED FROM "VERY CERTAIN" TO "SLIGHT CHANCE" INTENTS OF BUYING WITHOUT A TRADE-IN

Explanatory Factors		1960 t value	1960 Rank[a]	1960 $100R^2$	1961 t value	1961 Rank[a]	1961 $100R^2$
probability	(X_1)	-0.04	(7)	0.00	3.71**	(1)	20.73
intended amount	(X_2)	4.23**	(1)	32.95	3.66**	(2)	14.23
tillable acreage	(X_3)	-0.93	(3)	1.32	1.18	(5)	1.59
previous year's net cash	(X_4)	-0.00	(6)	0.01	-0.00	(6)	1.19
current year's net cash	(X_5)	0.00	(2)	0.69	-0.00	(7)	0.22
change-in net cash	(X_6)	-0.00	(8)	0.00	0.00	(8)	0.00
machinery inventory value	(X_7)	-0.18	(5)	0.07	2.02*	(3)	8.26
hired labor cost	(X_8)	0.40	(4)	0.18	-1.44	(4)	2.52
Total variation explained				35.21			48.74
Number of observations			59			46	

[a]Numbers in parenthesis are the order in which factors entered the stepwise regression equation.
*Significant at the 0.05 level.
**Significant at the 0.01 level.

Regression Equations containing Significant Variables

$$\hat{Y} = -46.764 + \underset{(-0.08)}{0.428X_2}\ {}_{1960}$$

$$\hat{Y} = -1904.050 + \underset{(554.635)_1}{2389.602X_1} + \underset{(0.108)_2}{0.378X_2} + \underset{(0.023)_7}{0.058X_7}\ {}_{1961}$$

Where: $\hat{Y}$ = the estimated expenditure in dollars and the magnitudes in parenthesis below the coefficients are the standard errors of the coefficients.

TABLE 25

STATISTICAL SIGNIFICANCE OF FACTORS AFFECTING ACTUAL TRACTOR EXPENDITURES BY THOSE WHO INDICATED FROM "VERY CERTAIN" TO "SLIGHT CHANCE" INTENTS OF BUYING WITH A TRADE-IN

Explanatory Factors		1960 t value	1960 Rank[a]	1960 $100R^2$	1961 t value	1961 Rank[a]	1961 $100R^2$
probability	(X_1)	1.24	(1)	2.85	1.85*	(1)	6.51
intended amount	(X_2)	1.44	(3)	1.24	2.04[b]	(2)	3.92
tillable acreage	(X_3)	-0.17	(7)	0.03	1.07	(4)	1.74
previous year's net cash	(X_4)	0.00	(6)	0.26	-0.00	(8)	0.00
current year's net cash	(X_5)	0.00	(2)	1.88	-0.00	(3)	2.43
change net cash	(X_6)	0.00	(8)	0.00	-0.00	(6)	0.07
machinery inventory value	(X_7)	1.58	(5)	2.96	-0.43	(5)	0.34
hired labor cost	(X_8)	-1.65	(4)	0.73	-0.04	(7)	0.00
Total variation explained				9.95			15.02
Number of observations			95			69	

[a]Number in parenthesis is the order in which factors entered the stepwise regression equation.

[b]Variables X_1 and X_2 are highly correlated and in regression X_2 was significant. However, when only the two variables are entered in a regression, neither are significant. If one only X_1 is entered it is significant at the 0.05 level.

*Significant at the 0.05 level.

Regression Equations Containing the Significant Variables

1960 Nil

1961 $\hat{Y} = 6.488 + \underset{(823.058)}{1778.145}X_1$

Where: $\hat{Y}$ = estimated expenditure and the magnitudes in parentheses below the coefficients are the standard errors of the regression coefficients.

Under the conditions which existed when the data were obtained expenditure predictions would be more accurate for the "no trade" group than for the "with trade" group, since the percentage variance explained was 35.21% and 48.74% compared to 9.95% and 15.02% for the years 1960 and 1961, respectively.

In a comparison of significant variables of the two groups intended expenditure was very significant in both years for the "no trade" group but was not significant for the "with trade" group. No other variables appeared statistically significant in 1960 in either group although probability of purchase (strength of intent) became very significant in 1961 for the "no trade" group and significant for the "with trade" group. One other variable also became significant for the "no trade" group in 1961 and this was the value of the machinery inventory.

Some comments on the marginal variables are necessary. About 90 percent of explained variance in the "no trade" group comes from one variable in 1960 and from three variables in 1961. Probability of purchase was the only significant variable for the "with trade" group in 1961 and this contributed only about 43 percent of the explained variance. Therefore, based on only two years' results, tillable acreage, disposable income (previous, current and change in net cash available) and annual hired labor cost are considered marginal factors in that they have little to offer in the way of predicting tractor expenditures. Furthermore, machinery inventory value and intended expenditure are of little value for the "with trade" group.

The regression equations containing the significant variables only in each group were as follows:

"No Trade" group

(1) 1960 $Y = -46.764 + \underset{(-0.08)}{0.428X_2}$

(2) 1961 $Y = -1904.050 + \underset{(554.635)}{2389.602X_1} + \underset{(0.108)}{0.372X_2} + \underset{(0.023)}{0.058X_7}$

"With Trade" group

(1) 1960 NIL

(2) 1961 $Y = 6.488 + \underset{(823.058)}{1778.145X_1}$

It was deemed desirable to test whether the interaction of probability of purchase and intended expenditure would increase the variance explained. A new regression for the "no trade" group, incorporating the interaction term and deleting the separate variates, yielded a percentage variance explained of 28.66 in the first year and 53.52 in the second (Appendix Table 5). This substitution resulted in a decrease of 19 percent in explained variance in 1960 and an increase of about 10 percent in 1961 in variance explained by the factors considered separately. Such inconsistency in the results makes it impossible to evaluate the merits of entering this interaction term in place of separate entries for these two variates in regression equations predicting tractor expenditures.

The interaction of strength of intent and intended expenditure appeared on an intuitive basis to be the one to test. Because of the inconsistency noted above the author did not pursue the opportunities for testing other combinations.

CHAPTER VII

SUMMARY AND CONCLUSIONS

Farm operators enrolled in Michigan State Mail-In Account Project and responding to a "Plans to Buy" mail survey questionnaire for the years 1960 and 1961 provided the data for this study of the factors influencing tractor purchases and tractor expenditures. "Intentions" data were derived from their questionnaires and information on tillable acreage, previous and current year's disposable income, change in disposable income, machinery inventory value and annual hired labor cost originated in their corresponding farm account books. The same records were used to ascertain whether or not the respondents had purchased a tractor and the expenditures made.

The original "Plans to Buy" project on tractors covered the years 1959 to 1961 inclusive. The 1959 results were briefly presented in the literature review chapter. Some comparison of the results is deemed appropriate even though the methods used and some of the factors studied were not the same. In this section the 1959 results will be referred to as the "1959 report".[1]

The chi-square statistic was used in the bivariate analyses to test whether differences in observed and expected buying frequencies were due

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[1]K. T. Wright and W. H. Vincent, "Intended and Actual Tractor Purchases in Michigan, 1959," Quarterly Bulletin of Michigan Agr. Exp. Station, Vol. 44, No. 2, (East Lansing, Michigan State University, No., 1961), pp. 334-360.

to chance or to the variate under consideration. The contingency coefficient was used to ascertain the strength of the relationship in question. Both statistics were thus used to detect the factors influencing tractor purchases.

In considering only the effects of single factors on tractor purchases, tillable acreage, current and change in disposable income (four levels of each factor) produced buying proportions which were significantly different at either the 0.05 or 0.01 level of probability in both years. The strength of the relationships were judged to be quite weak.

When strength of intent was indicated as "some chance" and the above factors permitted to vary (4 levels) none of the factors were effective in altering buying proportion differences in the direction expected. This statement could not be made as to their effectiveness in creating differences in buying proportions of the "no chance" respondents. Increasing positive levels of current year's disposable income and change in disposable income were effective in creating differences in buying proportions in the direction expected but only in the second year. In the 1959 report the statement was made that "there appeared to be a closer relationship between level of income and actual purchases among farmers who said there was no chance of them buying, than in the "some chance" group. With the additional evidence gained one might infer that the income effects are confined to the "no chance" respondents. Apparently, a "some chance" intent overrides or masks any added effects which the income variates may have on tractor purchases.

A further subdivision and analysis of the "some chance" intents

into "very certain plus quite certain", "fair chance" and "slight chance" groups indicated that these designations were more effective than the "some chance" designation in further explaining the buying behavior of this group of respondents. When either of these two "more precisely defined" categories of strength of intent, i.e., "fair chance" and "slight chance" were held constant and three disposable income factors permitted to vary in turn (3 levels) statistically significant differences in buying proportions resulted but these were not in the expected direction and therefore the income factors were judged to be ineffective in further controlling the purchases of either of these groups.

In a multivariate linear regression analysis annual hired labor cost and machinery inventory value were incorporated with the four main factors previously outlined. Strength of intent ("some chance" and "no chance") emerged as the dominant explanatory factor in both years studied. A new factor, i.e., machinery inventory value, emerged as a significant factor in the second year only. Tillable acreage, previous year's disposable income, current year's disposable income, change in disposable income and hired labor cost were not significant variables and are therefore judged the marginal or weak explanatory variables of this study.

The statistically significant or explanatory factors were not the same for expenditures and purchases. In the expenditure regressions, intended expenditure was the variable added and current year's disposable income was the factor deleted. Intended expenditure emerged as the dominant explanatory factor and strength of intent formed the second most important factor. Either previous year's disposable income or machinery inventory value became the third explanatory variable.

On the basis of the positive effects of previous year's income on expenditure in the "1959 report" and the supporting evidence of this variate's effectiveness in one of the two years in this study, previous year's disposable income was accepted as an explanatory factor. Further studies are required to ascertain the importance of machinery inventory value as an explanatory variable. The rather rapid increase in farm mechanization that is taking place at present would indicate that the variable should have some effect on expenditures. Therefore, it should be included whenever practical in regressions predicting purchases and expenditures of farm machinery.

In separate expenditure regressions for the "some chance" group, tillable acreage, disposable income and annual hired labor cost had very little to offer in the way of predictive ability. Furthermore, machinery inventory value and intended expenditure were of relatively little value in explaining the expenditures of those indicating this intent to buy without a trade-in. Intended expenditure was the best explanatory variable for those with this intent who expected to buy without a trade-in. Strength of intent was judged to be the next best explanatory factor.

Although not reported in this study a significant factor influencing intended expenditure was identified. This was annual hired labor cost (Appendix Tables 7, 8 and 9).

Thus, there is much evidence to support the main hypothesis that "intentions" can be used to improve the predictions of tractor purchases and tractor expenditures. Strength of intent was found to have more value for the prediction of purchases than for expenditures. Intended expenditure was found to have substantial value for the

prediction of expenditures. Of the variates recorded in the account books and tested, previous year's disposable income and machinery inventory value had the most value for the prediction of tractor purchases and expenditures. The balance of the account books variates had little to offer in the way of explanatory value.

More concrete data are required to more completely explain tractor purchases. Dealer policy regarding length of time tractor parts are stocked for particular models, tractor operating hours per year, total tax deductions for depreciation of farm machinery and age of tractor are those which probably warrant inclusion in tractor prediction models.

A P P E N D I X

TABLE 1

RELATION OF TRACTOR PURCHASES TO PREVIOUS YEAR'S NET CASH AVAILABLE AND A "SOME CHANCE" INTENT--1960, 1961[1]

	1960 Average Net Cash Available Previous Year				
	$2,270	$6,056	$8,598	$15,626	Total
Buyers	19 (16)	17 (18)	15 (18)	29 (28)	80
Non-Buyers	12 (15)	18 (17)	19 (16)	25 (26)	74
Total	31	35	34	54	154
Proportion Buyers	0.61	0.49	0.44	0.54	(0.52)
SAMPLE: $X^2 < 2$					

	1961 Average Net Cash Available Previous Year				
	$3,130	$7,234	$10,173	$18,007	Total
Buyers	21 (20)	15 (16)	16 (17)	20 (20)	72
Non-Buyers	10 (12)	11 (10)	11 (10)	11 (12)	43
Total	31	26	27	31	115
Proportion Buyers	0.68	0.58	0.59	0.64	(0.63)
SAMPLE: $X^2 < 2$					

[1]Buyers and non-buyers of farm tractors in 1960 and 1961 by those who gave a "some chance" intent, sorted by previous year's net cash available, number expected under the null hypothesis $P_1 = P_2 = P_3 = P_4 = (P)$, values of chi-square ($X^2$).

TABLE 2

RELATION OF TRACTOR PURCHASES TO CHANGE-IN NET CASH AVAILABLE AND A "SOME CHANCE" INTENT--1960, 1961[1]

	1960 Average Change in Net Cash Available				
	-$4,397	-$218	$1,372	$5,338	Total
Buyers	23 (22)	16 (19)	21 (20)	20 (19)	80
Non-Buyers	20 (21)	21 (18)	17 (18)	16 (17)	74
Total	43	37	38	36	154
Proportion Buying	0.53	0.43	0.55	0.55	(0.52)
SAMPLE: $X^2 = < 2$					

	1961 Average Change in Net Cash Available				
	-$4,199	-$274	$1,369	$6,155	Total
Buyers	13 (14)	19 (20)	16 (16)	24 (22)	72
Non-Buyers	10 (9)	13 (12)	9 (9)	11 (13)	43
Total	23	32	25	35	115
Proportion Buying	0.57	0.59	0.64	0.69	(0.63)
SAMPLE: $X^2 = < 2$					

[1]Buyers and non-buyers of farm tractors in 1960 and 1961 by those who gave a "some chance" intent, sorted by change in net cash available, number expected under the null hypothesis $P_1 = P_2 = P_3 = P_4 = (P)$ and the values of chi-square (X^2).

TABLE 3

RELATION OF TRACTOR PURCHASES TO TILLABLE ACREAGE AND A "SOME CHANCE" INTENT--1960, 1961[1]

	1960 Average Tillable Acreage				
	109ac	160 ac	210ac	374ac	Total
Buyers	17 (18)	15 (16)	18 (20)	30 (27)	80
Non-Buyers	18 (17)	15 (14)	20 (18)	21 (24)	74
Total	35	30	38	51	154
Proportion Buying	0.49	0.50	0.47	0.59	(0.52)
SAMPLE: $X^2 = < 2$					

	1961 Average Tillable Acreage				
	113ac	167ac	217ac	346ac	Total
Buyers	17 (19)	13 (11)	20 (20)	22 (23)	72
Non-Buyers	13 (11)	5 (7)	11 (11)	14 (13)	43
Total	30	18	31	36	115
Proportion Buying	0.57	0.72	0.64	0.61	(0.63)
SAMPLE: $X^2 = < 2$					

[1]Buyers and non-buyers of farm tractors in 1960 and 1961 by those who gave a "some chance" intent, sorted by tillable acreage, number expected under the null hypothesis $P_1 = P_2 = P_3 = P_4 = (P)$, and values of chi-square (X^2).

TABLE 4

STATISTICAL SIGNIFICANCE OF INTERACTION OF PROBABILITY AND INTENDED AMOUNT OF EXPENDITURE AND OTHER FACTORS ON ACTUAL EXPENDITURES BY THOSE WHO INDICATED FROM "VERY CERTAIN TO SLIGHT CHANCE" INTENTS OF BUYING

Explanatory Factors		t value	1960 Rank[a]	$100R^2$	t value	1961 Rank[a]	$100R^2$
tillable acreage	(X_1)	0.39	(6)	0.08	-0.61	(4)	0.14
previous year's net cash	(X_2)	-0.00	(7)	0.00	0.00	(5)	0.12
current year's net cash	(X_3)	0.00	(2)	0.62	-0.00	(3)	0.30
change-in net cash	(X_4)	0.00	(5)	0.16	1.52	(2)	1.54
machinery inventory value	(X_5)	1.16	(4)	0.75	1.52	(2)	1.54
hired labor cost	(X_6)	-1.72	(3)	0.87	0.37	(6)	0.09
probability x int. amount	(X_7)	6.77**	(1)	24.19	6.75**	(1)	29.87
Total variation explained				26.66			32.06
Number of observations			154			115	

[a]Number in parenthesis is the order in which the factors entered the stepwise regression.
**Significant at the 0.01 level.

Regression Equations Containing the Significant Variables

$\hat{Y} = 228.616 + \underset{(0.125)}{0.873}X_7$ 1960

$\hat{Y} = 327.533 + \underset{(0.149)}{1.036}X_7$ 1961

Where: $\hat{Y}$ = estimated expenditure with and without a tractor trade-in and the number in parenthesis is the standard error of the regression coefficient.

TABLE 5

STATISTICAL SIGNIFICANCE OF THE INTERACTION OF PROBABILITY AND INTENDED AMOUNT OF EXPENDITURE PLUS OTHER FACTORS ON ACTUAL TRACTOR EXPENDITURES, BY ONLY THOSE WHO INDICATED FROM "VERY CERTAIN TO SLIGHT CHANCE" INTENTS OF BUYING WITHOUT A TRADE-IN

Explanatory Factors		1960 t value	1960 Rank[a]	1960 $100R^2$	1961 t value	1961 Rank[a]	1961 $100R^2$
tillable acreage	(X_1)	-1.35	(3)	2.49	1.28	(4)	1.68
previous year's net cash	(X_2)	-0.00	(7)	0.00	0.00	(6)	0.01
current year's net cash	(X_3)	0.00	(2)	0.92	-0.00	(5)	0.21
change-in net cash	(X_4)	-0.00	(6)	0.01	0.00	(8)	0.00
machinery inventory value	(X_5)	-0.21	(5)	0.05	1.53	(2)	5.85
hired labor cost	(X_6)	0.82	(4)	0.97	-1.88	(3)	3.12
probability x int. amount	(X_7)	3.45**	(1)	24.21	6.07**	(1)	42.47
Total variation explained				28.66			53.52
Number of observations			59			46	

[a]Numbers in parenthesis are the order in which factors entered the stepwise regression equation.
**Significant at the 0.01 level.

Regression Equations Containing Significant Variables

$\hat{Y} = 62.346 + \underset{(0.151)}{0.647}X_7$ 1960

$\hat{Y} = -462.519 + \underset{(0.022)}{0.048}X_5 + \underset{(0.133)}{0.829}X_7$ 1961

Where: $\hat{Y}$ = the estimated expenditure in dollars and the magnitudes in parenthesis below the coefficients are the standard errors of the coefficients.

TABLE 6

STATISTICAL SIGNIFICANCE OF THE INTERACTION OF PROBABILITY AND INTENDED EXPENDITURE ON ACTUAL TRACTOR EXPENDITURES BY THOSE WHO INDICATED FROM "VERY CERTAIN TO SLIGHT CHANCE" INTENTS OF BUYING WITH A TRADE-IN

Explanatory Factors		1960 t value	1960 Rank[a]	1960 $100R^2$	1961 t value	1961 Rank[a]	1961 $100R^2$
tillable acreage	(X_1)	-0.14	(6)	0.02	1.06	(3)	1.85
previous year's net cash	(X_2)	0.00	(2)	1.25	-0.00	(7)	0.00
current year's net cash	(X_3)	0.00	(5)	0.25	-0.00	(2)	2.41
change in net cash	(X_4)	0.00	(7)	0.00	-0.00	(5)	0.03
machinery inventory value	(X_5)	1.66	(4)	2.96	-0.32	(4)	0.20
hired labor cost	(X_6)	-1.70	(3)	1.08	-0.07	(6)	0.01
probability x intended amount	(X_7)	1.74	(1)	2.93	2.87**	(1)	9.88
Total variation explained				8.50			14.36
Number of observations			95			69	

[a]Numbers in parentheses are the order in which the factors entered the stepwise regression equation.
**Significant at the 0.01 level.

Regression Equations Containing the Significant Variables

1960: NIL

1961: $\hat{Y} = 393.005 + 0.599X_7$ (0.221)

Where: $\hat{Y}$ = estimated expenditure with trade-in dollars and the magnitudes in parentheses below the coefficients are the standard errors of the regression coefficients.

TABLE 7

STATISTICAL SIGNIFICANCE OF FACTORS AFFECTING INTENDED TRACTOR EXPENDITURES BY THOSE WHO INDICATED FROM "VERY CERTAIN TO SLIGHT CHANCE" INTENTS WITHOUT A TRACTOR TRADE-IN

Explanatory Factors		1960 t value	1960 Rank[a]	1960 $100R^2$	1961 t value	1961 Rank[a]	1961 $100R^2$
probability	(X_1)	0.47	(6)	0.35	0.40	(4)	0.21
tillable acreage	(X_2)	-1.10	(3)	0.91	-0.22	(5)	0.10
previous year's net cash	(X_3)	0.00	(2)	2.20	-0.00	(6)	0.08
current year's net cash	(X_4)	0.00	(5)	0.41	0.00	(3)	0.19
change-in net cash	(X_5)	0.00	(7)	0.00	-0.00	(7)	0.00
machinery inventory value	(X_6)	0.61	(4)	0.72	-1.06	(2)	7.39
hired labor cost	(X_7)	1.96	(1)	14.43	3.01**	(1)	15.06
Total variation explained				19.02			23.03
Number of observations			59			46	

[a]Numbers in parenthesis are the order in which the factors entered the stepwise regression equation.
**Significant at the 0.01 level.

Regression Equations Containing Significant Variables

$\hat{Y} = -5.709 + \underset{(0.106)}{0.210}X_7$ 1960

$\hat{Y} = 529.307 + \underset{(0.031)}{0.062}X_6 - \underset{(0.098)}{0.335}X_7$ 1961

Where:

$\hat{Y}$ = estimated intended expenditure in dollars and the magnitudes in parentheses below the coefficients are the standard errors of the coefficients.

TABLE 8

STATISTICAL SIGNIFICANCE OF FACTORS AFFECTING INTENDED EXPENDITURES BY THOSE WHO INDICATED FROM "VERY CERTAIN TO SLIGHT CHANCE" INTENTS OF BUYING WITH A TRACTOR TRADE-IN

Explanatory Factors		1960 t value	1960 Rank[a]	1960 $100R^2$	1961 t value	1961 Rank[a]	1961 $100R^2$
probability	(X_1)	1.76	(2)	2.22	0.96	(2)	1.06
tillable acreage	(X_2)	1.55	(1)	6.35	0.75	(5)	0.49
previous year's net cash	(X_3)	0.00	(6)	0.09	0.00	(7)	0.00
current year's net cash	(X_4)	-0.00	(7)	0.00	-0.00	(1)	10.95
change-in net cash	(X_5)	0.00	(5)	0.34	0.00	(6)	0.16
machinery inventory value	(X_6)	-1.59	(3)	0.99	0.46	(5)	0.37
hired labor cost	(X_7)	1.27	(4)	1.80	0.82	(3)	0.81
Total variation explained				11.80			13.88
Number of observations			95			69	

[a]Numbers in parentheses are the order in which the factors entered the regression equation.

Regression Equations Containing the Significant Variables

NIL 1960

NIL 1961

TABLE 9

STATISTICAL SIGNIFICANCE OF FACTORS AFFECTING INTENDED TRACTOR EXPENDITURES BY THOSE WHO INDICATED FROM "VERY CERTAIN TO SLIGHT CHANCE" INTENTS OF BUYING

Explanatory Factors		1960 t value	1960 Rank[a]	1960 $100R^2$	1961 t value	1961 Rank[a]	1961 $100R^2$
probability	(X_1)	1.56	(2)	1.25	0.59	(6)	0.28
tillable acreage	(X_2)	0.29	(6)	0.05	-0.75	(5)	0.36
previous year's net cash	(X_3)	-0.00	(3)	0.94	0.00	(4)	0.39
current year's net cash	(X_4)	0.00	(5)	0.11	-0.00	(8)	0.00
change-in net cash	(X_5)	-0.00	(7)	0.00	0.00	(3)	0.90
machinery inventory value	(X_6)	-0.94	(4)	0.49	-0.90	(2)	1.08
hired labor cost	(X_7)	2.05*	(1)	7.52	2.89**	(1)	10.36
Total variation explained				10.36			13.37
Number of observations			154			115	

[a]Number in parenthesis is the order in which the factor entered the stepwise regressions.
*Significant at the 0.05 level. **Significant at the 0.01 level.

Regression Equations containing the Significant Variables

$\hat{Y} = 986.633 + \underset{(0.038)}{0.134}X_7$ 1960

$\hat{Y} = 976.128 + \underset{(0.039)}{0.141}X_7$ 1961

Where: $\hat{Y}$ = estimated intended expenditure with and without trade and the number in parenthesis is the standard error of the regression coefficient.

Appendix

"PLANS TO BUY" SURVEY QUESTIONNAIRE

Michigan Mail-In Accounting Project

Name_____ County_____ Farm No. _____

1. In the next year, that is in 1961, what are the chances you will buy a TRACTOR?

   Some chance. *(Go to Ques. 2) No chance (Go to Ques. 7)

IF THERE IS SOME CHANCE OF BUYING:

2. How certain are you that you will buy a tractor? (Mark one.)

   "Very certain" - have already made or am making a deal. (Go to Ques. 4)

   "Quite certain" - considerably better than a 50/50 chance. (Go to Ques. 4)

   "Fair chance" - about 50/50. (Go to Ques. 3.)

   "Slight chance" - considerably less than a 50/50 chance. (Go to Ques. 3.)

IF FAIR OR SLIGHT CHANCE:

3. What does this depend on? _____

_____

_____

4. About when do you think you might buy it?

   January, February, March July, August, September

   April, May, June October, November, December

5. Do you plan to buy it new or used?

   New Used

6. Do you plan to have a trade-in?

   Yes, and I expect to pay about $_____ above the trade-in.

   No, and I expect to pay about $_____ in total.

---

*IF YOU PLAN TO BUY MORE THAN ONE TRACTOR:

Answer for the first you plan to buy and check here _

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