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ECONOMIC FEASIBILITY OF EARLY RETIREMENT AND DISINVESTMENT IN FARMING

Charles Kraenzle and Marvin Kottke[1]

I. INTRODUCTION

A. The Problem

In the United States, a large number of farmers are or should be considering plans for retirement. According to the 1969 Census of Agriculture, 42 percent of the total farm operators were 55 years old and over [17]. Approximately 17 percent of the total farm operators were at the traditional non-farm retirement age of 65 or above.

Planning for retirement is a critical stage in a farmer's life and according to Lee [11], disinvestment might be easily mismanaged because of (1) inexperience with disinvestment, (2) possible abruptness of the changes from farming to retirement, and (3) the possibility of personal problems within the family. The amount of retirement income needed depends on life expectancy, family desires, cost of living, and health. The method and time of disinvesting farm resources, the choice of non-farm investments, re-investment, tax management, and social security benefits all have to be considered in determination of income for retirement years [15].

One of the major uncertainties facing a farmer in making decisions for retirement is his life expectancy. At age 50, the average remaining lifetime of a male farm operator is 23 years. This reduces to approximately 13 years as the farmer reaches age 65 [18]. Hence, a farmer can only roughly estimate how much capital will be needed to provide a satisfactory level of living for his and his spouse's remaining lifetime.

B. Objectives

The purpose of this study is to examine specific decision policies related to disinvestment and retirement. How early in life could a farmer with a given resource situation retire and continue financially secure? What economic difference is there between retiring early or late in life?

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[1]Charles Kraenzle was formerly Graduate Assistant and Marvin Kottke is Professor, University of Connecticut. This report is based on research reported in a Ph.D. Thesis by Kraenzle [10]. The helpful review of the manuscript by George Ecker and the suggestions made during the research project by T. C. Lee and E. J. R. Booth are gratefully acknowledged.

The specific objectives of this study are:

1. To determine the earliest age a farmer can retire with sufficient net worth accumulated from farming to support him and/or his spouse through the retirement years.

2. To describe the effects of longevity upon disinvestment decisions when "life expectancy" probabilities are used to simulate uncertainty.

3. To compare the outcomes from disinvestment at different ages and to evaluate alternative disinvestment policies.

The criterion used for determining the earliest, economically feasible, retirement age is based on the "lifetime assets equals lifetime consumption" principle [6]. The minimum planned retirement age which provides positive or nonnegative remaining net worth for all levels of longevity is considered as meeting the criterion. Basically, the criterion assumes that the farm family has a goal of maximizing utility over time and this is accomplished if lifetime accumulation of assets is just sufficient to cover lifetime consumption.

C. Previous Work

A great deal of research has focused on farm transfers, estate planning, estate taxes, tax consideration of farm sales, and surveys of retirement of farm operators. Only within the last decade, however, have researchers begun using quantitative models to study some of the problems involved in farm transfers, estate planning, and estate taxes during the disinvestment stage.

In the 1950's, researchers [1] focused on the economic security of farmers, and their retirement plans. Publications were distributed to answer some of the questions regarding family farm transfers. This included alternatives such as co-ownerships, wills, trusts, outright sale and gifts.

During the 1960's, research [7, 8, 9] was conducted on the patterns of dairy farm exits, factors influencing farmers to leave, the meaning and attitudes that farmers held regarding retirement from agriculture, their financial positions, retirement goals, and the constraints on retirement from agriculture.

Due to increasing agricultural production units, and inflation during this time more intergeneration property transfers became subject to federal estate taxes. One of the first quantitative models dealing with intergeneration property transfers was developed by Harrison [5]. Through the use of a multi-period linear programming model with a five-year planning horizon, he was able to maximize the net value of the estate transferred to the heirs at the end of the planning period.

The most recent work in the area of disinvestment was completed by Boehlje and Eisgruber [2] through the development of an estate management model. Their model was, perhaps, the first attempt to study estate management with a dynamic model. Boehlje and Eisgruber [2] indicated that, "During the stage in the life cycle when most farm estate transfers take place, the processes of disinvestment (exit) and establishment (entry) are occurring simultaneously. Currently, little is known about the processes and the problems of either disinvesting from or getting established in farming, let alone how to coordinate these processes."

D. A Computer Simulation Approach

In order to evaluate alternative consequences of specific decision policies related to timing and method of disinvestment, a dynamic computer simulation model was designed. Simulation was chosen because it is easier to incorporate uncertainty, multiple goals, and management and organizational theories than with optimizing models such as dynamic programming or multi-period linear programming. The procedure followed in this study is based on computer simulation plans as suggested by Naylor, et al. [13].

II. THE COMPUTER SIMULATION MODEL

A. Situation Simulated

A dairy farm operation was chosen as the system to be simulated because dairying has a significant role in Connecticut's agriculture. It was assumed that a farm operator was in a situation where disinvestment and retirement could be considered. For example, the simulation model was constructed to begin with a 1950 dairy farm operation owned and operated by a couple, each age 50.

B. A Generalized Flow Chart

A flow chart representing the general operation of the whole computer simulation model is shown in Figure 1. In the beginning, the input data for the initial situation of the farming operation and the strategies for herd size, disinvestment, and planned retirement are read by the computer. Simulation of the dairy farm operation then continues until death or planned retirement at a designated age causes termination of farm operations. If the husband dies while farming, the wife disinvests the farm business and retires on the accumulated assets. If both the operator and wife live to retirement, a simulation of the retirement period continues until death of the surviving spouse. The remaining net worth is the response variable of the simulation model.

C. The Farming Operation

The dairy farm operation was constructed as a subsection of the whole simulation model. A simple flow diagram of the farm operation section is shown in Figure 2.

At the start of simulating the farm operation, depreciation and value of machinery, buildings, and milking equipment are brought up to date. Each simulated year, average investments are made for the above items and if the operator is forced to borrow, the debt has to be paid back in eight annual payments. Since the length of operation is uncertain because of probable illness or death, it is necessary to know each year the value of all farm resources.

Non-productive cows are culled each year and sold. Heifer calves are kept for replacement and the rest sold. Crop production is determined by the amount of corn, corn silage, hay, and pasture required. Additional feed, such as corn for grain, can be bought or sold.

The variable costs of all enterprises are calculated and added to the fixed costs of farming. The costs are deducted from gross farm income to determine net

Figure 1

A GENERALIZED FLOW DIAGRAM FOR THE COMPUTER SIMULATION MODEL OF RETIREMENT AND DISINVESTMENT DECISIONS BY A DAIRY FARMER AND HIS WIFE

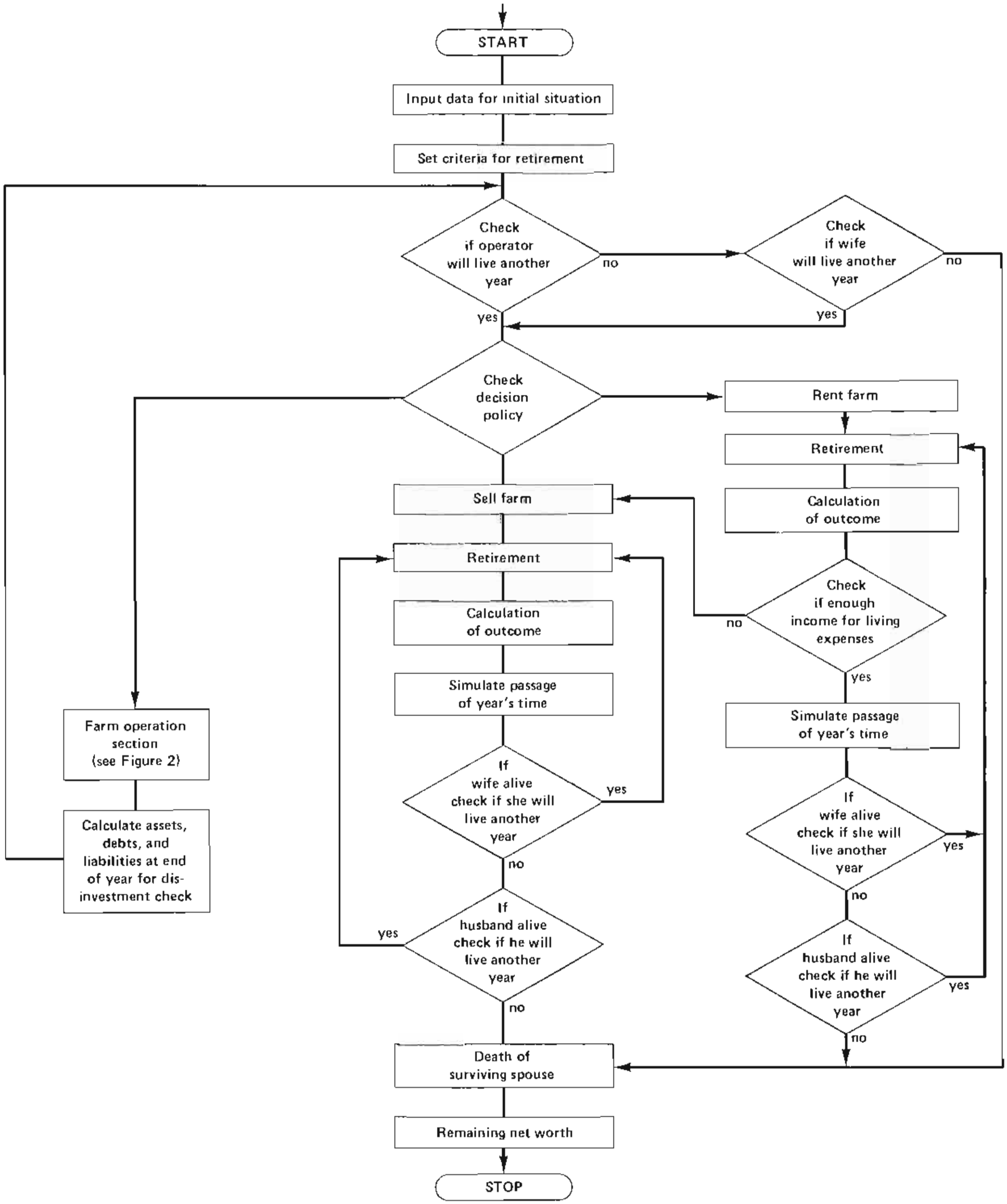
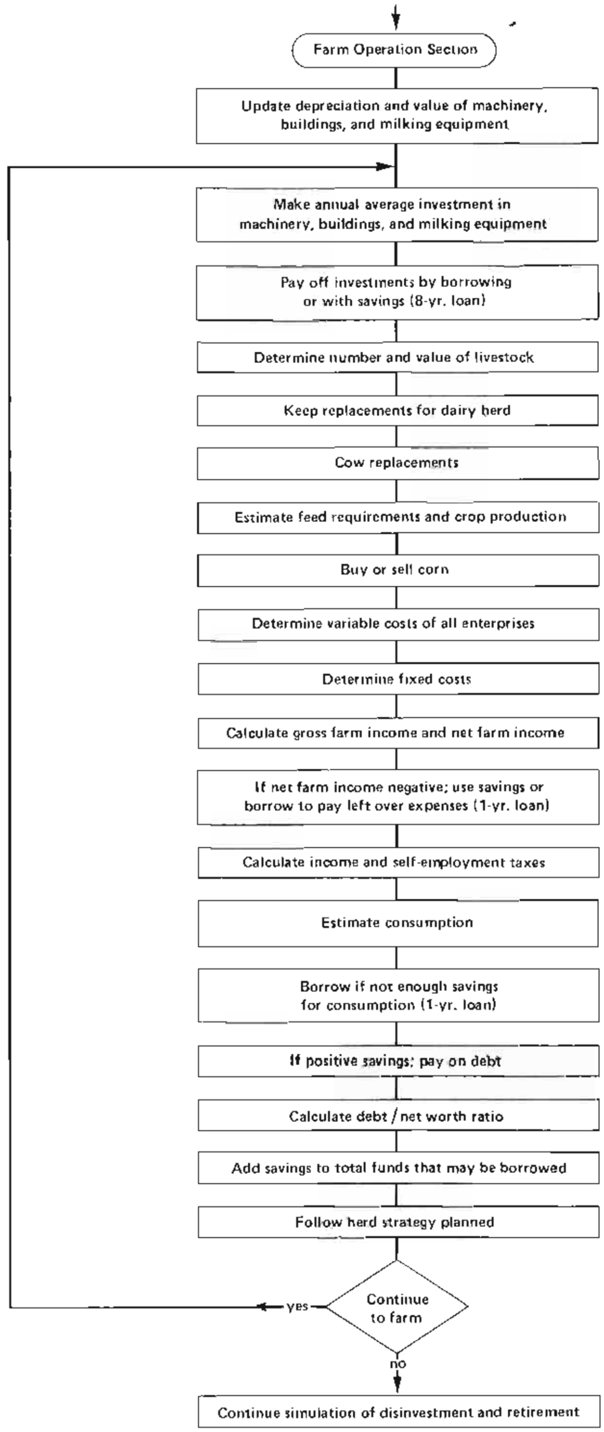


Figure 2

A SIMPLE FLOW DIAGRAM REPRESENTING THE DAIRY FARM OPERATION INCLUDED IN THE RETIREMENT-DISINVESTMENT COMPUTER SIMULATION MODEL



farm income. If total costs are greater than gross farm income, savings or credit is used to pay off left-over expenses. Borrowed money is paid back the following year if income is available.

Self-employment and income taxes [4] are deducted from net farm income. The remaining income is used for consumption and savings. If consumption is greater than the remaining income, savings from past years are used or if savings are short, a one year loan is made. If savings exist, debts due for the current year are paid. If debts cannot be paid, they transfer to the following year.

D. Input Data for the Model

Average data representing dairy farm trends from 1940 or 1950 to 1970 were used for many of the variables in the model. In addition, information collected from farm financial records of elderly dairy farmers was used to provide a basis for design of the simulation model.

Due to the dynamic characteristics of the model, exogenous variables had to be updated for each year simulated. This was done by regressing the variable in question on the last two digits of the year.

1. The Resource Situation

In order to verify the simulation model of a farm it was necessary to select a specific actual farm for which observations over time had been made. The farm operator was 60 years old, had no son interested in farming and was decreasing the size of his herd. The farm's acreage was 110 acres of cropland and 80 acres of pasture. The model was designed to have buildings, farm machinery and equipment, and milking equipment to fit the actual farm situation. Costs and depreciation in the model were based on the original costs, age, and useful life. It was assumed that the operator had 2400 hours a year available for labor requirements. Any additional labor required would be hired and paid the average rate per hour.

2. Operational Activities

Corn, corn silage, pasture, and mixed hay were the crop production choices. The variable costs of producing an acre of each crop were computed by adding variable machinery costs per acre to costs of fertilizer and seed per acre. Milk production was the basic livestock enterprise. Milk output per cow was made a stochastic variable by adding to the estimated pounds of milk per cow a normally distributed random number with a mean of zero and a standard deviation of 559.5 pounds. Other stochastic variables were variable costs per cow, grain corn prices and milk prices. Property taxes, insurance, interest on total debts, and depreciation were calculated as fixed costs for each simulated year.

3. Investment Choices

Replacement investment was made for buildings, machinery and milking equipment. In some cases, investment in milk cow replacements was also made if insufficient calves were available for herd maintenance.

4. Family Living Expenses

A linear consumption function was used to estimate family living expenses of the operator and his wife. Basic living costs were deducted from the annual income and if the remaining income was positive, an additional 20 percent of that income was added to consumption expenses. If annual income did not cover consumption expenses, then the operator was forced to borrow money and repay the following year provided income was available.

E. Disinvestment Alternatives

1. Pre-retirement Farm Operation Options

As farmers grow older, the number of cows kept for milk may change. Some older farmers gradually reduce their herd size below existing capacity of buildings. In some cases, herd size may be increased beyond capacity and existing facilities used more extensively. Other farmers have no desire or they are not financially able to expand the size of their herd so that they continue to farm with enough cows to fill their existing capacity. For this study, it was assumed that in a stable herd situation 30 milk cows would be kept right up to the time a farmer retired and in a declining herd situation a farmer would reduce his size of herd from 30 to 20 cows three years prior to planned retirement at age 58, 62, or 65. If there was no planned retirement at the above ages, size of herd was alowly decreased from 30 to 20 cows during the 62 to 70 years age span of the farmer. The latter case not only represented gradual disinvestment, but it also represented cases where the productivity of older farmers decreases with age.

2. Farm Disinvestment at the Time of Retirement

Selling the farm or renting the farm were two alternatives considered in the test. Comparison of the two alternatives was made for each of the planned retirement ages.

a. Selling of the Farm

If the choice was to sell the farm, the sale included machinery, buildings, milking equipment, land (which included the value of farm home), and livestock. Values for the farmer's personal possession and home were included. A capital gains tax was paid assuming that the purchase cost of the farm was 25 percent of the farm value [11] and the sale commission was 10 percent of the farm value. Once the farm was sold, all debts were paid and a new house was bought. Any savings left after deducting the cost of the new house were invested at a 5 percent rate of return for retirement purposes.

b. Renting the Farm

If the choice was to rent the farm, then livestock, machinery and milking equipment were sold at their present value. A 10 percent sales commission was deducted from the value sold as well as any remaining debts from the farm operation. The rental rate was set so that a three percent return on the investment in land and buildings was obtained. If at any time during the retirement years, cash savings of the retired couple or surviving spouse became less than $4,000, the farm was sold.

F. The Retirement Conditions

During retirement, consumption was changed so that no allowance was made for additional consumption due to income. In the retirement years, many people become dependent on fixed incomes and usually experience a tight budget constraint on consumption. If there was not enough income from savings to meet the cost of retirement, then funds were drawn from the remaining net worth. Simulation of the retirement situation continued until death of the surviving spouse.

G. Life Expectancy

Since longevity is so uncertain, part of the computer simulation model was constructed to estimate the age of death for the operator and his spouse. This was accomplished by using the probability of living to the next age for a male and for a female. This method produces the same average remaining lifetime as that given in the life tables by the U. S. Department of Health, Education and Welfare [18].

H. Probability of a Serious Illness

Probability of a farmer contracting a serious illness was included in the simulation model because it is an important reason for unplanned early retirement. Statistical reports indicate that 7.3 percent of persons in the total labor force were either limited in their ability to work or were unable to work. Data on the health status of farmers were not available, therefore, the 7.3 percent figure was used in simulating the probability of a farmer becoming seriously ill and being forced to retire.

I. Social Security

A record of self-employment tax and credited earnings for social security were built into the model. Thus, any time the farmer or his spouse became eligible for social security, the benefits could be calculated. In order to include social security benefits, several assumptions had to be made in order to keep the model workable: (1) The farm operator and his wife no longer had dependent children. (2) The wife had no annual income so that she was eligible for social security only through earnings credited by her husband. (3) If the husband died, she could collect social security benefits only as early as age 62. (4) No disability benefits were considered. (5) A farmer who was credited with minimum earnings after 1954 was eligible. (6) No annual increase in retirement benefits for cost of living was assumed.

III. VALIDATION AND OPERATION OF THE SIMULATION MODEL

The initial situation of the simulated dairy farm was made to coincide with an actual farm for model validation purposes. In 1950, the actual farm had total receipts of $12,000 and a net worth of $31,218. It had barn capacity for 30 cows and was a one-man operation.

A. Validation of the Farm Operation

In validating a simulation model an experimenter has a choice of several statistical techniques to test whether the model is representative of the system under study. For this study, two techniques mentioned by Naylor [12] were used. They are Theil's Inequality Coefficient [16] and regression analysis. However, actual and historical data were not available for the whole time path of the disinvestment and retirement stages, therefore, only a part of the model was validated. Both methods call for comparing the data generated by the computer simulation model with actual and historical data.

The dairy farm operation was simulated for the period 1950 to 1971 to obtain total farm receipts and net worth to compare with the farm's actual values for the corresponding period. Tests were calculated and if not acceptable, the model was evaluated, corrected and simulation was repeated. This process was continued until the tests results were acceptable. For example, in the final test run, simulated net worth increased from $31,124 in 1950 to $162,032 in 1971. According to the statistical test this was sufficiently close to the farm's actual net worth time path ($31,218 in 1950 to $120,804 in 1971) to be acceptable as a simulation of the farm's economic behavior.

B. Examples of Simulated Decision Policies

1. Disinvestment Commencing Prior to Retirement Followed by the Retire-Rent Alternative

A phasing-out of farming by reducing herd size followed by a planned retirement at age 70, is presented as one example of the simulation runs (Table 1). In this run, the male lived to age 73 and his spouse lived to age 81. With a net worth of $140,931 at the year of retirement, no financial difficulties arose before the death of the surviving spouse. In fact, the five percent return on non-farm investments and the 7.5 percent annual increase in land value plus social security benefits and income from rental of the farm provided them increased wealth each year. When the wife died, the remaining net worth was $269,816.

2. Disinvestment Commencing at Retirement with the Retire-Sell Alternative

As another example, we present the results of a run made for situations where a stable dairy herd size is maintained until the planned retirement year is reached and then an abrupt disinvestment is made by selling the farm (Table 2). The farmer retired at age 62 and lived until age 66. His wife had died at the age of 56. Once the farm was sold, the annual gain in net worth due to increased valuation of land was lost. However, enough income was available from the farm operation to provide sufficient income for retirement.

IV. DESIGN OF THE COMPUTER SIMULATION EXPERIMENT

In order to test and evaluate the results, a statistical layout of the simulation runs had to be designed. Basically, the objective of the design was to provide a framework for determining whether significant differences exist among the resulting net worths for the various disinvestment-retirement options.

Table 1. Simulated Results for a Declining Dairy Herd and Retire-rent Decision Policy

Age of Oper.	Age of Wife	No. of Cows	Milk Price Rec'd	Net Farm Income	Husband's Social Security	Wife's Social Security	Income Tax	Value of Farm Assets	Debts	Net Worth
50	50	30	5.38	4278			394	33792	2415	31377
51	51	31	4.86	4367			406	36944	2838	34106
52	52	30	4.96	2086			94	38472	3030	35442
53	53	30	5.54	3922			342	41741	3601	38140
54	54	30	5.69	4961			495	45189	3626	41563
55	55	30	5.50	3632			304	46959	2846	44113
56	56	30	5.87	5203			535	50620	2932	47688
57	57	30	5.61	6102			678	54039	2110	51929
58	58	30	5.35	4880			489	57062	1500	55562
59	59	30	5.45	6509			750	61792	1609	60183
60	60	30	5.24	7145			865	66145	1084	65061
61	61	40	5.61	8475			1098	71409	745	70664
62	62	28	6.92	12434			1901	79356	509	78847
63	63	27	6.21	8978			1223	85746	277	85469
64	64	26	5.64	8939			1231	92402	174	92228
65	65	25	5.55	7658			1030	98792	87	98705
66	66	24	6.07	8371			1164	105739	0	105739
67	67	23	6.02	9315			1341	113674	0	113674
68	68	22	6.02	8539			1231	121803	0	121803
69	69	21	6.70	9852			1508	131139	0	131139
70 [1]	70			2568	3121	1559	4797	140931	0	140931
71	71			2771	3121	1559	271	152321	0	152321
72	72			2990	3121	1559	278	164485	0	164485
73 [2]	73			3225		1559	467	174637	0	174637
	74			3479 [4]		1559	502	185524	0	185524
	75			3752		1559	509	197205	0	197205
	76			4046		1559	580	209741	0	209741
	77			4362		1559	622	223199	0	223199
	78			4703		1559	668	237651	0	237651
	79			5070		1559	726	253164	0	253164
	80			5465		1559	794	269816	0	269816
	81 [3]									

[1] Age at retirement.

[2] Age at death.

[3] Age at death.

[4] Income from rent of farm.

Table 2. Simulated Results for a Stable Herd Size and the Retire-sell Decision Policy

Age of Operator	Age of Wife	No. of Cows	Total Farm Receipts (dollars)	Total Farm Expenses (dollars)	Value of Farm Assets (dollars)	Net Worth (dollars)
50	50	28	13125	7392	34812	32391
51	51	26	13347	7875	38064	35989
52	52	28	12112	7527	40996	39267
53	53	30	13587	8753	44037	42653
54	54	29	13694	9577	46685	45648
55	55	30	14773	9965	49749	49057
56	56 [1]	30	13871	9200	52659	52313
57		30	16737	11582	55938	55938
58		30	16988	10933	60285	60285
59		30	19564	11444	66097	66097
60		30	18590	10874	71926	71926
61		30	17783	12210	76663	76663
62 [2]						69850
63						71305
64						72747
65						74176
66 [3]						74176

[1] Age at death.

[2] Age at retirement.

[3] Age at death.

There were two pre-retirement options, four age-designated retirement plans and two farm disinvestment options. Thus 16 runs were required to cover the various combinations of alternative decision policies. For simplicity, each decision policy was given a code name. For example, a farm operator's decision to reduce herd size, retire at age 58 and rent the farm was called I-58-R. The 16 different decision policies and their codes are shown in Table 3. Age 58 was chosen so that the effects of early retirement could be analyzed. Ages 62 and 65 correspond with eligibility for social security and age 70 represents the average age of retirement for many farmers.

A. Control Factors

In simulation, a factor is said to be controlled when its levels are purposefully selected by the experimenter [12]. In this study, planned retirement age, preretirement herd option and farm disinvestment option were control factors. These factors were chosen because they represent actual decisions that many farmers face in the disinvestment-retirement stage. Thus, by changing factors different responses are simulated.

Another factor considered was life expectancy, which is called an observed factor. It is recorded as part of the data but is not controllable and does not represent a decision policy.

Table 3. Decision Policies Considered in the Experimental Design and their Code Names

Pre-retirement Farm Operations Options	Planned Retirement Age	Method of Farm Disinvestment [1]	Code Name
Reduce herd size	58	rent	I-58-R
" " "	"	sell	I-58-S
" " "	62	rent	I-62-R
" " "	"	sell	I-62-S
" " "	65	rent	I-65-R
" " "	"	sell	I-65-S
" " "	70	rent	I-70-R
" " "	"	sell	I-70-S
Maintain herd size	58	rent	II-58-R
" " "	"	sell	II-58-S
" " "	62	rent	II-62-R
" " "	"	sell	II-62-S
" " "	65	rent	II-65-R
" " "	"	sell	II-65-S
" " "	70	rent	II-70-R
" " "	"	sell	II-70-S

[1] The term "rent" means that cattle and machinery are sold and the farm is rented.

B. Experimental Design

The study was designed to investigate the different responses for every combination of the observed factors at each specified level of the control factors. A fractional factorial design instead of a full factorial design was used to accomplish this objective.

If the farmer operator died at age 50, his wife may die the same year or any year up to 110. Thus, to estimate the design point for each age combination would have required 60 x 60 = 3600 computer simulation runs. If each of the 3600 runs were replicated (say 30 times), one factorial grid would require 108,000 runs. This would include only one level of the control factor. The decision point regarding planned retirement age could have been investigated from age 50 to 75 for each farm disinvestment method and herd size option. Use of the fractional factorial design reduced the problem of size. Instead of using every level of each factor in the simulation, the design points for age combinations were grouped together and only the most important levels of the controlled factors were chosen for analysis. The response variable for each simulation was averaged into a group determined by the age at death for the male and female. The five groups included the following ages: 50-59, 60-69, 70-79, 80-89, and 90 years old and over. For example, if the farm operator died at age 58 and the spouse died at age 71, the design point was averaged in the cell including all responses where the farm operator died between the age of 50 to 59, and the spouse died between the age of 70 to 79.

C. Data Generation and Testing

In order to test if the variances were equal and if the decision policies were significantly different, each decision policy represented by 800 replications of a simulation run required the following information in addition to the response variable: the number of observations in each age combination at death, the sum of the responses in each age combination, the sum of responsés in each age combination squared, and the variance of responses for each age combination.

Bartlett's test for homogeneity of variances indicated that the response variances were heterogeneous in this study [14]. Therefore, an analysis of variance could not be used and no multiple comparisons or multiple rankings could be included. However, an alternative method was designed to test for any significant differences by using a t-test. The two sample t-test used was proposed by Welch [3] and is applicable for two samples with unequal variances and unequal sample sizes.

V. ANALYSIS OF SIMULATED RESPONSE DATA

A. Planned Retirement Age Options

Twenty-five observations of the average remaining net worth associated with longevity were obtained for each simulated decision policy. In general, most responses were positive indicating retirement after age 50 would usually be financially sound (Tables 4 and 5). Early retirement would usually be economically feasible unless both husband and wife lived beyond 79 years of age. As expected insecurity would most likely be encountered by widows who outlive early-retiring husbands by 20-30 years.

B. Pre-retirement Herd Size Options

In order to evaluate whether pre-retirement herd size options had any effect, mean outcome and percent of positive outcomes for each decision policy were calculated (Table 6). Overall, there was little difference between the two herd size options.[1] Apparently, reducing the herd from 30 to 20 cows in three years prior to retirement does not seriously affect retirement financing.

Comparison of the decision policies using Welch's t-test is presented in Table 7. Due to the large number of tests, only the major differences are presented.

In the case of declining herd where the farm operator dies in his fifties, the t-statistics showed that there was not much difference among plans. As shown in Table 7, the percent of significant tests ranges from 0 to 49 percent. In actuality, the farm operator did not live long enough to follow any of the other decision strategies so empirically none of the tests should have been significant except for the difference between the sell or rent alternatives. The farm was sold or rented after the operator's death by his widow. However, there was no pattern of significant t-statistics to show that there was any difference between selling or renting the farm when the farm operator dies in his fifties.

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[1] A herd expansion option was also simulated, but is not presented here because of space considerations. Moreover, herd expansion may not be a common practice for farmers contemplating retirement. For the results of the herd expansion simulation see Kraenzle [10].

Table 4. The Average Remaining Net Worth Generated from Simulating the Declining Herd Option and the Alternative Decision Policies

Death of Oper.	Death of Spouse	I-58-S	I-58-R	I-62-S	I-62-R	I-65-S	I-65-R	I-70-S	I-70-R
(age)					(dollars)				
50-59	50-59	37619	36172	35335	44839	37993	39824	42131	47015
50-59	60-69	17170	25951	23937	16970	21253	26263	29392	28724
50-59	70-79	- 406	5685	- 3964	1928	2159	11854	3084	7242
50-59	80-89	-40019	-32090	-38564	-13655	-36597	-19133	-43270	-12268
50-59	90+	-63549	-68664	-71790	-52859	-86739	-42787	-74986	-33197
60-69	50-59	42277	50789	67510	78429	79741	93368	82851	103781
60-69	60-69	36997	53051	67774	93456	79392	98506	84224	106795
60-69	70-79	21828	43378	70144	142787	79852	154752	94953	155330
60-69	80-89	- 6865	24940	60866	240450	81810	276425	106423	257084
60-69	90+	-40091	-15831	45536	427657	96829	525581	122786	511314
70-79	50-59	29759	44874	78446	150162	106816	168984	139268	189979
70-79	60-69	25943	54036	82169	158458	116398	181498	148308	189200
70-79	70-79	24243	60966	87633	179937	126095	210727	161971	217885
70-79	80-89	- 1493	36781	91867	298179	148066	334016	198743	354296
70-79	90+	-42178	35302	81035	539513	173917	644320	247310	617962
80-89	50-59	5168	30788	86610	277065	136074	322862	191633	334789
80-89	60-69	7290	35620	93517	274979	147326	316429	204376	338887
80-89	70-79	4804	50657	96410	307536	163494	347249	211690	371842
80-89	80-89	- 2788	71003	105915	350850	182495	400979	240361	419368
80-89	90+	-36008	61797	109884	670730	212768	691000	274679	708976
90+	50-59	-24270	3504	89381	669411	179540	775055	265543	-----[1]
90+	60-69	-12272	7255	82899	583622	179415	673728	273448	727083
90+	70-79	-21060	-11820	113123	526743	210770	739636	279148	660634
90+	80-89	-21467	12782	104372	586428	220836	659991	306499	691432
90+	90+	-38283	2004	148993	606830	252146	899443	338558	942599

[1]Not enough observations.

Table 5. The Average Remaining Net Worth Generated from Simulating the Stable Herd Option and the Alternative Decision Policies

Death of Oper. (age)	Spouse	II-58-S	II-58-R	II-62-S	II-62-R	II-65-S	II-65-R	II-70-S	II-70-R
					Decision Policy (dollars)				
50-59	50-59	26054	37950	32170	47570	35960	45382	35043	41057
50-59	60-69	21793	26248	17474	28010	16978	20618	18584	39428
50-59	70-79	1676	8738	- 3338	6705	2239	14096	- 9077	14498
50-59	80-89	-35317	-16559	-42164	-18064	-30015	-25696	-38672	- 16663
50-59	90+	-74827	-59664	-73707	-34144	-87632	-41313	-74177	- 63917
60-69	50-59	40261	51959	68406	83286	80640	91281	90905	100120
60-69	60-69	38099	53087	70333	93238	79775	95463	83435	105186
60-69	70-79	23208	48249	69594	144117	89080	157598	95351	160508
60-69	80-89	- 6836	21261	63989	241880	105745	274529	107731	245724
60-69	90+	-45561	- 9482	42075	515332	114432	391173	99983	580654
70-79	50-59	30422	49843	74854	147699	113856	179036	144226	195801
70-79	60-69	27148	46701	82670	158975	112746	184452	156955	193947
70-79	70-79	21545	47236	83791	179324	129723	202815	164565	218550
70-79	80-89	- 2918	22768	91563	288570	151871	337183	202804	365051
70-79	90+	-35703	- 2538	77893	510066	188118	616954	274070	690570
80-89	50-59	11951	29333	79494	257055	144821	311057	178330	370263
80-89	60-69	304	32328	86690	286089	150023	311124	210861	359093
80-89	70-79	2153	33326	97672	312216	170103	365422	228437	376173
80-89	80-89	- 2930	36124	100669	333864	178368	389411	241073	450743
80-89	90+	-29616	74688	100585	644432	216970	640568	297961	729545
90+	50-59	-18337	122013	102378	721758	203531	644422	288658	652960
90+	60-69	-30882	81864	92725	598149	191731	519815	312069	733067
90+	70-79	-27901	- 5650	103222	587847	216910	614775	307741	654905
90+	80-89	-28616	15976	111853	563915	224626	714500	303568	705312
90+	90+	-63118	- 3717	124573	---- [1]	262290	650285	335605	1036830

[1] Not enough observations.

Table 6. The Average Outcome and Percent of Positive Outcomes for Each Decision Policy under Declining Herd and Stable Herd [1]

Decision Policy	Mean Net Worth Outcome		Percent Positive Net Worth Outcomes	
	Declining herd	Stable herd	Declining herd	Stable herd
	(dollars)			
58-S	-3,906	-6,317	44	48
58-R	24,757	29,683	84	76
62-S	68,361	66,218	88	88
62-R	286,417	279,078	92	92
65-S	116,473	122,515	92	92
65-R	341,222	307,838	92	92
70-S	157,164	162,241	92	88
70-R	330,698	357,576	92	92

[1]Calculated from Tables 4 and 5.

Table 7. The Percent of T-Statistics which were Significant in Pair-wise Comparisons of Decision Policies for Declining Herd and Stable Herd and the Age Combinations at Death of the Farmer and Spouse [1]

Farmer: Age at Death	Spouse: Age at Death 50-59	60-69	70-79	80-89	90+
	Declining Herd (percent of t-values significant)				
50-59	0	24	15	49	24
60-69	76	87	91	87	80
70-79	93	93	96	100	93
80-89	93	93	95	98	84
90+	-- [2]	-- [2]	91	93	89
	Stable Herd (percent of t-values significant)				
50-59	-- [2]	22	40	47	29
60-69	62	87	87	84	87
70-79	89	87	96	98	98
80-89	93	96	98	96	87
90+	-- [2]	80	84	93	-- [2]

[1]The chosen level of significance was five percent.

[2]Not enough observations.

When the farm operator died in his sixties, the difference between plans became more significant. The percent of significant tests ranged from 76 to 91. This may be due to compounding of effects since the output data were grouped.

C. Rent or Sell Options

The t-statistics as shown in Table 8 for plans where the farm operator died in his sixties revealed the following: (1) The rent or sell alternatives at age 58 were significantly different for all observations. (2) Selling or renting the farm at age 62 was significantly different from the policies to rent or sell the farm at age 58. (3) The rent and sell alternatives at age 62 were significantly different except if the spouse died in her fifties. Observation of the mean net worth outcomes in Table 6 for 62-S and 62-R shows more than $200,000 difference. Thus, the rent alternative provided a much higher net worth.

Observation of the t-statistics for all of the decision policies shows 84 percent (average of row 2, Table 7) of the t-statistics significant. However, since the operator died in his sixties, nothing could be said about those strategies beyond age 62 because the farm was sold or rented by his surviving spouse at his death.

The t-statistics were more significant for the decision policies when the farm operator lived to his seventies or eighties. Almost all decision policies (94 percent--the average for row 3 and row 4 in Table 7) were significantly different at the five percent level of significance.

Table 8. The Computed-t's for Pair-wise Comparison of Specific Decision Policies where Age at Death for the Operator was 60 to 69 (for the Declining Herd Option)

Spouse: Age at Death	58-S vs. 58-R	62-S vs. 58-R	62-S vs. 58-S	62-R vs. 58-R	62-R vs. 58-S	62-S vs. 62-R
			Computed T-Values			
50-59	2.92[1]	-5.22[1]	-10.11[1]	- 8.15[1]	-13.22[1]	.26
60-69	7.08[1]	-6.03[1]	-20.35[1]	-11.07[1]	-18.19[1]	- 3.57[1]
70-79	7.46[1]	-8.83[1]	-23.30	-21.91[1]	-30.51[1]	-11.84[1]
80-89	7.57[1]	-7.92[1]	-25.99[1]	-18.88[1]	-22.92[1]	-13.52[1]
90+	2.44[1]	-5.67[1]	-11.89[1]	- 9.62[1]	-10.30[1]	- 7.12[1]

[1]Significant at the five percent level.

VI. SUMMARY AND CONCLUSIONS

This study examined various decision policies related to disinvestment and retirement. The problem in retirement is when to retire and the problem in disinvestment is how to disinvest. The risks and uncertainties of life expectancy, health, and inflation make it very difficult to make decisions regarding disinvestment for retirement purposes. The major objective of this study was to determine how early in life a farmer can retire and disinvest with sufficient net worth to support him and/or his spouse through the retirement years.

A. Research Methodology

In order to evaluate alternative consequences of specific retirement decision policies, a dynamic computer simulation was designed for the study. Two pre-retirement options regarding herd size were included in the simulation model, namely, a declining herd size and a stable herd size. These options represent gradual pre-retirement disinvestment and continued pre-retirement replacement investment, respectively.

Control factors are injected or applied to the simulation model to conduct the experiments. In this study, the control factors were planned retirement ages of 58, 62, 65 or 70. Each control factor (each simulation run) was replicated in order to average out any adverse effects due to the stochastic properties included in the model. Thus, an average remaining net worth was used as the response variable. The same initial situation was used for testing the significance of the results. Comparison of the decision strategies was made by the use of Welch's t-test.

Two disinvestment alternatives at the time of retirement were built into the model. A sell alternative included complete liquidation of the farm and home. Another home was then purchased for retirement purposes. A rent alternative included renting-out the land and buildings but selling the machinery, cattle, and part of the milking equipment. During the retirement years the farm was sold if cash savings fell below $4000. The farm operator and his wife were eligible for social security as early as age 62. The benefits they received depended on the farmer's earnings from the year 1955.

A criterion used to evaluate the retirement alternatives was: Choose the earliest retirement age with a positive or non-negative remaining net worth for all age combinations at death. This criterion assumes that the farm family has a goal of maximizing utility over time and that the lifetime accumulation of assets should be just sufficient to cover lifetime consumption.

B. Results

Observation of the responses showed that if the dairy farmer died in his fifties, his surviving spouse would not have enough retirement income if she continued to live beyond her seventies. However, if the farm operator continued to farm until he was 62 years old or over, there would be no problem in regard to income required for the retirement years no matter how long each one survived.

If the farm operator retired at age 58, in most cases the retirement income would not be sufficient if either one lived to an older age. With the given resources and economic situation, it appeared that the farmer would be able to retire as early as age 60 and have enough income for him and his wife as long as they lived.

The rent alternative at the time of retirement appeared to offer higher net worth than the sell alternative. Apparently because of land appreciation and rent from the farm, net worth continues to increase at a faster rate than when land is sold and income is put into non-farm investments.

The herd size did not make as much difference in the decision policies as was expected. In fact, the t-statistics showed that the stable herd and declining herd situations were in general not significantly different.

C. Implications

Since a specific farm was simulated it is not possible to generalize from the results of the study. However, to the extent that the simulated farm situation may be similar to many dairy farms the following qualified implications are offered.

It appears that some farmers probably continue to farm longer than needed. Although in many cases, the decision to keep active in farming is personal, the average farmer should have accumulated enough capital to retire in his early sixties and have enough income for retirement to whatever age he and his spouse should live. This assumes of course that they live a normal retirement life and no high medical or other costs are incurred.

In the simulation model, no consideration was given to additional income from off-farm employment either for the farmer or for his wife. In many cases, retiring farmers take part-time jobs and are able to earn additional income without affecting the benefits they receive from social security. In this case, a farmer may be financially able to retire earlier in life.

A farmer with a situation similar to the system simulated would be relatively secure in retiring at age 60, selling his cattle and machinery and renting the farm. However, sociological reasons may prevent him from retiring. No sociological aspects of retirement were considered in the study.

Although the rent alternative appeared to offer the most remaining net worth, there may be circumstances which would force a farmer to sell. Otherwise, keeping the land in periods of inflation is usually a wise retirement decision policy.

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