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An Evaluation of Dairy Farm Adjustment Potentials Using Cross-Sectional and Time-Series Analyses

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Abstract: Dairy Farm Adjustment Potentials

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This paper is a research report on the process of economic adjustment within individual dairy farm firms and industry-wide changes and adjustments in the dairy industry. It is primarily concerned with changes in milk production and labor efficiency on individual dairy farms over a period of years sufficiently long to permit long-term farm organization and operation adjustments to take place. A stratified random sample of dairy farms in a major dairy area of Maryland covering the 1956-1971 time period has been used as a source of data to measure past changes and project future adjustments in farm numbers, size and levels of human resource efficiency. Over the past two decades, many approaches have been used to study the economic adjustment process on individual dairy farms and the interaction and linkages of the micro-level with the aggregate industry level adjustment process. While none of these approaches has been fully satisfactory when used in isolation, a combination of approaches has provided considerable insight into the restraining and impelling factors in the development and improvement of farm resource productivity on individual farms.

Between 1956 and 1971, the sampled dairy farms increased labor productivity variables from 54 to 86 crop acres per man-equivalent, from 19 to 35 cows per man, from 130 thousand to 320 thousand pounds of total digestible nutrients per man and from 142 thousand to 375 thousand pounds of four percent fat corrected milk sold per man. Numbers of farms shipping milk declined rapidly from 203 to 88 farms as the average number of dairy cows per farm increased from 36 to 74 cows per farm

Key Words: Empirical Analysis, Farm Adjustment, Dairy, Markov chains, Time-series, Cross-sectional, Labor productivity ratios.

An Evaluation of Dairy Farm Adjustment Potentials Using Cross-Sectional and Time-Series Analyses

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Numerous research studies over the past several decades have reported data and projections extending the long-term trend in the farm sector of the U.S. agriculture toward fewer and larger farm operating units. The general trend in numbers and sizes has affected both specialized livestock farms and specialized crop farms. The introduction of new labor-saving technology has shifted the outer bounds of resource adjustment toward higher human resource utilization and output levels. This study, unlike many others of short-run duration, attempted to quantify the sources and magnitudes of the long-run changes in selected measures of resource productivity and size variables to determine the probable limits of this larger farm size, fewer farm numbers adjustment in industry structure.

The purpose of this paper is 1) to provide real-life data and empirical relationships of resource use for the individual dairy farm level of analysis, 2) to relate, compare and contrast aggregate changes in selected variables with individual farm business changes, and 3) to contrast and compare the accuracy and cost of several analysis techniques for predicting future changes in dairy farm business organization and operation.

Present Situation

Cross-sectional and time-series analysis of a sample of dairy farms of

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different sizes in terms of numbers of cows generally results in establishing that the productivity of certain resources within the farm firm, such as labor, management and fixed capital inputs increases as the number of milk cows per herd increase from 10 to 100 or more cows. However, beyond some point along the cow numbers expansion path, the labor resource intensity ratio stops increasing and may even decline somewhat.

Farms with 100 or more dairy cows are expanding in most dairy areas throughout the United States. Between 1965 and 1969, the farms with 100 or more milk cows increased from 8,697 to 9,854 in the United States. Additional increases in numbers of farms with 100 or more milk cows have occurred since 1969.

Some states with relatively large dairy cow herds have been losing farms since 1964 even in the 100 or more cows classification. For instance, California, long noted for farms and ranches with large numbers of dairy cows, had a reduction in numbers of farms with over 100 cows from 2,585 to 2,104 between 1965 and 1969. Similarly, declines in this large herd classification were noted for Florida, Arizona, Hawaii and Alabama. In these states, the change from decreasing to increasing numbers of farms occurs at large cow herd size levels such as 200 or more cows.

Dairy farms with fewer than 200, but more than 100 milk cows, show a superior level of resource efficiency relative to dairy farms above and low this size of cow herd grouping. Dairy farms of this size range which raise their herd replacement cattle and grow a large portion of their forage and concentrate feed inputs are relatively low in costs per unit of output. The larger-sized farms of 200 to 1,000 or more cows relying heavily on hired farm labor resources and dairy farms having fewer than 100 cows may have

difficulty in meeting the low levels of costs per unit of output attained by the 100 to 199 cow dairy farms.

Research at the Maryland Agricultural Experiment Station has indicated that farms with 200 milk cows can attain most of the internal economies of labor and capital resource use that larger herds of up to 400 milk cows can achieve. The shift toward larger herds even though little or no per unit cost reduction occurred has been caused largely by the desire of dairy farm managers to increase their levels of living by raising their total management incomes. As long as the managerial resource capacities available are under-utilized more units of output at the same or even slightly higher costs per unit of output will increase the total returns to the management personnel of the farm firm. This factor together with higher wage rates and improved technology have been basic causes of the trend toward larger dairy cow herds throughout Maryland and the United States in recent years.

Modern plant and equipment installed on dairy farms permits each worker in the business to accomplish more production per time period than was possible in earlier years. This substitution of capital for human resources is still in progress so further increases in farm unit size and declines in dairy farm numbers can be expected in the future.

In general, the trend toward larger milk cow herds and larger crop acreages per farm has not been accompanied by a shift toward large numbers of workers per farm. As long as the typical and traditional small labor force farms with two to four workers continue to keep production costs under control and retain access to market outlets for wholesale milk, they are expected to remain competitive with the supersized dairy farms with large hired labor forces now coming into existence in some areas of the United States.

In 1969, more than 568 thousand United States farms reported one or more milk cows, but only 360 thousand farms sold dairy products. Five years earlier, 1,134 thousand farms reported milk cows, and 549 thousand farms reported selling dairy products. This post-war trend toward increased specialization of dairy production on fewer but larger farms has continued into 1973.

The number of milk cows on United States farms totalled 16.5 million in 1959, but declined to 14.6 million in 1964 and declined again to a new low level of 11.2 million in 1969 according to the most recent U.S. Census of Agriculture data. The number of milk cows has continued to decline at a more gradual pace into 1973. Further declines in total milk cow numbers nationally are to be expected throughout the 1970's if milk production per cow continues to increase faster than the total market requirements for milk and milk by-products.

The average number of cows per farm in the United States has increased sharply in recent years from nine cows in 1959, to 13 in 1964, and 20 cows in 1969. In Maryland, the increase was from 18 cows per farm in 1959, to 25 in 1964, and 35 cows in 1969. Commercial Maryland dairy farms in 1971 averaged over twice as large as the average for all farms reporting milk cows. The average size of cow herd is expected to continue to rise rapidly during the coming decade as the number of farms with milk cows drops at a faster rate than the total number of dairy cows.

The increases in the average size of herd have been caused by the rapid decline in the number of farms with small dairy enterprises for home consumption purposes as well as the rise in the average size of herd on commercial dairy farm units. In 1969, there were 38,467 farms in the United States with 50 to 99 cows compared with 37,345 farms in the same size of herd grouping

in 1964. The smaller commercial farms with fewer than 50 cows were under the greatest economic pressures during the decade of the 1960's.

The pressures to expand size of herd are increasingly being felt in the 1970's on those farms with fewer than 100 cows. In fact, in many states, dairy farm numbers dropped between 1964 and 1969 in the 50 to 99 cow herd size category. Additional consolidation, merger and horizontal integration of dairy farms in the future will assist operating dairymen in increasing their resource productivity. These expected increases in productivity should result in improved levels of net income per farm (8).

Alternative Approaches to the Farm Productivity Problem

Many approaches have been used in the United States during the past several decades to delineate the range of dairy herd sizes that would permit efficient use of on-farm resources in future time periods. The personal interview farm survey method, the farm business accounting and management service method, the economic-engineering method, the mathematical and statistical programming method, the mathematical chain (Markov) method, and the multiple regression analysis method have been among the most frequently used sources of data and types of analysis used by students of the problem of farm and farm-related resource use efficiency.

The economic-engineering method suggested by Bressler in the mid-1940's as a method for studying future changes in firm sizes and numbers has been widely used since then throughout the agricultural sector of the economy in analyzing micro-level adjustments and adjustment potentials. This method of analysis had established in the U.S.A. by the early 1960's, the potential that existed for improving the technical levels of on-farm human resource productivity (6, 12, 16). The adoption of this new technology has continued up

to the present time and more adjustments are expected in the future as the cost of human resources increases per unit of time (hour, day, week, month or year) (13). The long-term reorganization of resources on U.S. dairy farms has shifted techniques of production of milk and dairy-beef and veal toward higher ratios of physical and financial capital and natural resources per full-time farm worker equivalent (5, 9).

During the past quarter of a century, the shift toward more use of mathematical models in farm sector economic research and graduate economic and management training has led to a decrease in the emphasis on and importance of the empirical data base used to illustrate the ways in which the theoretical mathematical models could be used by decision-makers for solving real-life problems (2). Too many research projects have been prematurely terminated before attaining their full long-run potential in explaining the underlying causative factors and relationships responsible for the long-run observed effects. Long-term research benefits frequently can be attained only by incurring long-term research commitment costs on the part of agricultural research organizations, sub-divisions of these organizations and individual research workers.

Introduction to Problem Situation

The physical and economic efficiency of milk production on U.S. and Maryland commercial dairy farms has improved gradually over a number of years. Society has benefited from these improvements in production efficiency through the release of the excess farm labor and land resources for non-farm uses and through lower real resource costs per unit of farm output.

An individual farm business, whose production and sales typically account for only a small portion of the total milk market supplies, has no individual influence on the overall market blend price of milk when considered in isolation from other milk producing firms. The individual firm can sell more and more output at the existing and anticipated classified market prices as long as its production is a negligible part of the total milk market supply and the milk production base can be reestablished and expanded each year. Expansion or contraction of area-wide or industry-wide production significantly beyond present levels under inelastic demand situations will result in a sharp drop or rise in the industry price levels. This type of price change will be reflected back to individual farm firms in terms of the dealer-wide or market-wide pool blend prices (3, 4).

The modern milk-producing firm must continually seek out ways and means of reducing costs per dollar of sales as well as developing a volume of output per firm which is sufficient to provide adequate returns to capital and human resources. The long-term nature of the farm adjustment process, relative to productive resource use within individual firms, has been to increase the productivity of labor and land resources by the enhancement of capital and management resources per input unit of labor and land.

Procedures and Methodology

Personal interview field surveys of a stratified random sample of individual dairy farms in the Central Piedmont Area of Maryland were conducted during the winter of 1957, the summer of 1966 and the fall and winter of 1971-72. Only dairy farms with 10 or more cows were included in this study when the initial survey was made in 1957. The location of each of the 203 dairy farms included in the original 1957 survey was visited in both 1966 and 1971-72. Only 120 of the original 203 commercial farms were still shipping milk at the time of the 1966 survey. By 1971, only 88 farms still shipped milk. (Dairy farm firms enumerated in 1957 were considered to be still in business in 1966 and 1971 if the same or another operator was selling milk and utilizing some or all of the land and buildings enumerated in 1956 to produce milk for sale during the 1965-66 and 1970-71 production and marketing years. The other 115 farm firms had shifted their land, labor, capital and management resources to other farm or non-farm activities by 1971.)

Selected physical and financial data were obtained from the dairy farmers cooperating in this study for the three business years covering the calendar year 1956; the 1965-66 year (beginning on May 1, 1965 and ending on April 30, 1966); and the 1970-71 year (beginning on May 1, 1970 and ending April 30, 1971). Data were obtained by personal interview questionnaire on land resources and their utilization, cropping systems and practices, livestock enterprises, buildings and facilities, farm labor force, and the power and machinery inventory. The volume and value of milk marketed was obtained from milk marketing cooperatives and managers of milk processing plants. All direct farm labor input data were converted to a full-time man-equivalent basis whether supplied part-time or full-time by the farm operator, the farm family members or hired workers.

These farm survey data have been analyzed by cross-tabulation techniques to establish the presence of significant physical and financial relationships within and among the firms. The empirical estimates of these relationships represent a combination of causes and effects within each individual farm firm. The statistical relationships for groups of farms cannot be transferred directly to individual case study farms. But the empirical estimates for various groups of farms, classified by selected factors, indicate the underlying physical and financial relationships which must be considered by managers and policy-makers in forward planning processes at the individual farm firm and local area levels (12).

Over the past two decades, many approaches have been used to study the economic adjustment process on individual dairy farms and the interaction and linkages of the micro-level with the aggregate industry level adjustment process. While none of these approaches has been fully satisfactory when used in isolation, a combination of approaches has provided considerable insight into the restraining and impelling factors in development and improvement of farm resource productivity on individual farms (14, 15).

Long-Term Farm Survey Data Relationships and Changes

The past 15 years have been a period of rapid movement to higher levels of farm productivity and efficiency. The crop acres per man-equivalent increased from 54 to 86 acres between 1956 and 1971 on the surveyed dairy farms. The number of cows increased from 19 to 35 cows per man over the same period. Therefore, the sample average increased one cow per year per man on the average and the increase in acreage of crops was over two crop acres per year per man. It should be noted, however, that part of this statistical change was the

result of the rapid decline in the number of small and medium sized businesses with low resource productivity levels included in the original study. The farms that survived in the milk production business over the past 15 years were generally above average in productivity and efficiency in 1956 and 1966. Likewise the most efficient farms today are most likely to be those that survive in 1976 and into the 1980's (Table 1).

The average dairy farm studied sold 780,900 pounds of four percent fat-corrected milk in 1971. An average of 181 crop acres were used to support 74 milk cows per farm. Average crop acres per cow were 2.4, but farms with 100 or more cows used 2.0 acres compared with 2.8 acres per cow on farms with fewer than 100 cows. Sales of four-percent fat-corrected milk averaged 10,476 pounds per cow annually, and sales at the 3.7 percent actual fat level averaged 11,130 pounds per cow. Farms with 50 or more cows averaged nearly 1,000 pounds of milk sold per cow above farms with fewer than 50 cows. Average production of 3.7 percent fat milk was 10,568 pounds per cow in 1971 for the total Maryland industry. This compares with a U.S. average of 10,009 pounds per cow and an average of 12,726 pounds per cow in California, the leading state in productivity per cow.

The most dramatic change over the past 15 years has been in the productivity of on-farm labor. Milk sold per man-equivalent averaged 374,600 pounds per worker in 1971 compared with only 141,800 pounds of four percent fat corrected milk in 1956. There were two major forces behind this improvement in output per worker: (1) average number of cows handled per man increased from 19 to 35 cows and (2) average milk sold increased from 7,241 to 10,476 pounds per cow per year. Farms with 60 or more cows averaged 196,300 pounds per worker in 1956 compared with 427,100 pounds of four-percent fat corrected

Table 1. Relationship Between Cows Per Farm, Cows Per Man, and Pounds of Milk Sold Per M , Central Piedmont, Maryland, 1956, 1965-66 and 1970-71, and Projected 1976 and 1986.

Cows per farm	Number of farms					Average cows per man					Average lbs. of milk sold per man (000)				
Year	1956	1966	1971	1976	1986	1956	1966	1971	1976	1986	1956	1966	1971	1976	1986
10-29	92	12	4	2	1	14	19	20	23	25	96	165	199	269	315
30-39	46	27	20	13	3	20	21	27	28	30	148	183	264	328	411
40-49	28	22	12	7	3	20	23	28	30	33	150	204	272	351	452
50-59	16	22	13	8	3	26	25	30	32	35	223	222	319	374	480
60 or more	21	37	41	40	41	27	31	40	44	53	196	309	427	515	726
100 or more	5	9	16	22	30	30	35	43	47	56	188	370	473	550	767
All Farms	203	120	88	70	51(43-65)	19	26	35	40	50	142	247	375	468	685

milk sold per man in 1971. Throughout this 15 year period, the typical dairy farm with 60 or more cows has been more efficient in the use of farm resources than the farms with fewer than 60 cows. This superior level of resource efficiency on the larger farms is reflected in the fact that farms with 60 or more cows increased in number from 21 to 41 farms between 1956 and 1971. All sample herd size groups under 60 cows have declined in numbers over time since the 1956 base year survey.

The 1971 data indicate that Maryland dairy farms with 100 or more cows may be the most profitable in the future. The 1956 sample included only five out of 203 farms in this size category. However, by 1971, a total of 18 farms out of 83 were in this grouping. This means that 13 of the farms in 1956 had found it profitable to expand in cow numbers to take advantage of new milking systems utilizing pipelines and milking parlors, new labor-saving silage and grain feeding systems and new crop production, harvest and storage systems.

The efficiency of resource use on the 100 or more cow farms has not been static over this 15 year period. The average herd size increased from 141 to 166 cows at the same time that average farm labor force declined from 4.7 to 3.9 man-equivalent. These farms handled an average of 43 cows per man in 1971 compared with an average of 30 cows per man in 1956 and 34 cows per man in 1966. In 1971, there were 40 cows per worker on all farms with 60 or more cows and 35 cows per man on the total sample of farms which averaged 74 cows per farm. In contrast, there were 27 cows per man-equivalent on all farms with 60 or more cows in 1956, and 19 cows per man on the total sample of farms which averaged 36 cows per farm. The five farms with 50 or more cows per man in 1971 ranged from 80 to 200 cows in size. Farms with more than 200 cows averaged below the farms with 100 to 199 in both cows per man and crop acres per man.

Large dairy farms in terms of milk cow numbers have the potential to generate high levels of labor use intensity. Based on the 1971 survey, Maryland farms with 100 or more cows used on the average 3.8 man-equivalent of labor to handle 165 cows resulting in 43 cows per worker. These sample survey farms had above state average levels of cows per man and ranged as high as 50 cows per man on a 200 cow dairy farm with a four man-equivalent labor force. However, this labor intensity level of 50 cows per man also was reached on a one hundred cow dairy operation with two men and two 150 cow farms with three men included in the study. The within plant advantages of the 200 cow or larger farms compared with farms with smaller cow herd sizes lie in economies of capital and management resource use, not in better utilization of labor and land resources. In fact, Maryland research indicates that farms with large numbers of hired workers required to handle the large numbers of cows have difficulty in maintaining high labor use intensity levels over time.

The proper adjustment of the work load in terms of cow numbers to the labor force available to do the work continues to be one of the prime responsibilities of modern dairy farm managers. In 1971, 13 Maryland dairy farms with 100-199 cows averaged 133 cows and a three-man labor force. This resulted in an average of over 44 cows per man. Similarly, five Maryland farms with 200 to 320 cows averaged 246 cows and used six men to handle them. This was 41 cows per man. Apparently, the strong upward pressure of large size of herds on labor use intensity is offset to some extent by greater reliance on hired labor resources. Problems in human resource organization constitute a major barrier to increased productivity on large labor force dairy farms.

The Use of Markov Processes in Predicting Farm Changes

During the past two decades a number of research publications concerning prediction of farm changes such as number of farm firms, size of farms, farm production, and others were presented using Markov chain processes (7, 11). The Markov process method assumes that the patter of change exhibited in the past period will continue into the future. This method provides information on changes by frequency distribution categories as well as for the whole cohort for the past, and projects these changes into the future. Most studies have used short-run periods up to five years as the data base time span. This study has emphasized the use of longer-run periods of 10 to 15 years in projecting long-term trends in numbers and sizes of farms.

Conneman compared the application and results of the Markov process with three other methods of agricultural supply analysis on the dairy farms in the New York milkshed for the 1960-64 time period (1). One of his findings was, "Of the methods investigated, the Markov process seemed to best represent the long-run tendency of the process change in the industry despite the apparently changing transition probabilities."

The Markov process gave an overestimation of Maryland dairy farm numbers (103) in 1971 using the 1956-66 data base changes as the projection variables, and comparing the actual 1971 survey numbers (88) with the 1971 estimates, (Tables 2 & 3). Relevant data were collected by personal interview (in three periods: 1956, 1966 and 1971) from a sample of 203 farms in the Central Piedmont Area of Maryland. This area contained, in the 1969 census year, 50 percent of the farms with dairy cows in Maryland, and 61 percent of the total

Table 2. Projected Changes in the Numbers and Sizes of Dairy Cow Herd in 1986 (Base of 86 farms projected for 1976) (Based on the changes between 1956 and 1966).

Size of Herd Milk Cow Numbers	Projected No. of farms in 1976	Out of Business 1986	Size categories and no. of farms projected for 1986										
			10-19	20-29	30-39	40-49	50-59	60 or more	60-69	70-79	80-89	90-99	100 or more
10-19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20-29	2.1	0.9	0.0	0.3	0.5	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0
30-39	10.2	2.7	0.0	0.2	2.0	2.0	1.1	2.2	0.7	0.2	0.7	0.0	0.7
40-49	13.8	5.4	0.0	0.0	0.5	2.5	3.0	2.5	1.0	0.5	0.5	0.5	0.0
50-59	17.6	4.4	0.0	0.0	1.1	0.0	3.3	8.8	4.4	2.2	1.1	0.0	1.1
60 or more	42.4	8.1	0.0	0.0	0.0	4.0	6.1	24.1	6.1	4.0	4.0	0.0	10.0
60-69	14.4	1.6	0.0	0.0	0.0	3.2	1.6	8.0	4.8	1.6	0.0	0.0	1.6
70-79	7.8	3.9	0.0	0.0	0.0	0.0	0.0	3.0	0.0	0.0	1.9	0.0	2.0
80-89	7.5	3.7	0.0	0.0	0.0	0.0	3.8	0.0	0.0	0.0	0.0	0.0	0.0
90-99	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.0	0.8	0.0	0.0	0.0
100 or more	12.0	0.0	0.0	0.0	0.0	0.0	2.4	9.6	0.0	0.0	2.4	0.0	7.2
All farms	86.1	21.5	0.0	0.5	4.1	8.7	13.6	37.7	12.2	6.9	6.3	0.5	11.8

Table 3, Projected Changes in the Numbers and Sizes of Dairy Cow Herd in 1986 (Base of 88 Central Piedmont Maryland Dairy Farms, 1971) (Based on the Changes Between 1956 and 1971).

Milk Cow Numbers	No. of farms in 1971	Out of business 1986	Size of Herd Categories and No. of Farms Projected for 1986										
			10-19	20-29	30-39	40-49	50-59	60 or more	60-69	70-79	80-89	90-99	100 or more
10-19	1	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20-29	3	1.7	0.0	0.2	0.7	0.2	0.1	0.3	0.1	0.1	0.0	0.0	0.1
30-39	20	6.5	0.0	0.0	3.5	2.2	2.6	5.2	1.3	1.7	0.0	0.5	1.7
40-49	12	8.6	0.0	0.0	0.0	0.4	0.9	2.1	0.9	0.4	0.4	0.0	0.4
50-59	13	8.1	0.0	0.0	0.0	0.8	0.8	3.3	0.0	0.0	0.0	0.8	2.5
60 or more	39	11.4	0.0	0.0	0.0	0.0	1.1	26.4	5.4	1.0	3.2	3.0	13.8
60-69	10	4.4	0.0	0.0	0.0	0.0	1.1	4.4	2.2	0.0	0.0	0.0	2.2
70-79	8	6.0	0.0	0.0	0.0	0.0	0.0	2.0	0.0	0.0	0.0	0.0	2.0
80-89	2	1.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	1.0	0.0	0.0	0.0
90-99	3	0.0	0.0	0.0	0.0	0.0	0.0	3.0	0.0	0.0	0.0	3.0	0.0
100 or more	16	0.0	0.0	0.0	0.0	0.0	0.0	16.0	3.2	0.0	3.2	0.0	9.6
All farms	88	37.2	0.0	0.2	4.2	3.6	5.5	37.3	7.7	3.2	3.2	4.3	18.5

state population of dairy cows. Using the changes during the 10 year period 1956-1966, the numbers and sizes of farms for 1971, 1976 and 1986 were predicted using the Markov process (10). After obtaining the actual 1971 figures, it was found that the difference between the predicted 1971 Markov value, (103 farms), and the actual value (88 farms), was substantial.

Using the actual changes in dairy farms between 1966 and 1971, the farm numbers and sizes distributions were predicted at lower levels for 1976. The predicted 1976 Markov value (86 farms) using the base farm number changes of 1956-66 differed markedly from the use of the 1966-71 period as a projection base (70 farms). There was not much difference in the projections of farms of 60 or more cows in 1976 using the two different base periods for the predictions. The differences in the predictions were mainly for the farms of fewer than 60 cows. For 1986, the projections of farm numbers were 65 farms using the 1956-66 base period, and only 51 farms using the 1956-71 base period for projections.

Interpretation of the differences in the predicted values is dependent on the assumption in the Markov process technique that changes will continue at the same magnitude in the future as in the past. During the second part of the sixties, the economy and labor employment situation were favorable. Jobs off-farm were available at higher than farm wage rates; prices of farm real estate especially in the three counties closest to Washington, D.C. and Baltimore, Maryland were increasing rapidly; farm prices of whole milk were rising slowly; and two drought years in 1966 and 1967 helped push some of the farms out of the milk production industry. Since 1971, these factors have changed somewhat. Prices of milk in 1971, 1972 and 1973 have increased. The

rate of increase in real estate prices has slowed down. Off-farm jobs have been less available. These changes in the factors affecting the dairy industry have made it more favorable for some of the dairy farmers to stay in business who otherwise would have left the industry. We expect that some dairy farms which shifted to other types of farming may come back into dairying if alternative uses of labor and capital decline in profitability between now and 1976.

In conclusion, the Markov process gives an explicit prediction. More detailed distributions have to be taken into account to use it effectively. This method does not account for changes in the factors causing the trend downward in farm numbers and upward in size of cow herds. (2) It cannot give accurate estimates under rapidly changing conditions which cause significant deviations from past trend relationships.

Future Dairy Farm and Industry Structure

Therefore, with the levels of technology currently being used on Maryland dairy farms, there appeared to be little if any cost advantage from improved labor and land resource use on the extremely large dairy farms with more than 200 cows. Some new milking systems now being experimentally used in Europe and in America have indicated that levels of labor resource utilization could be higher than those observed in this study if the new technology becomes widely adopted on a commercial basis in the future. Substantial possibilities currently exist for improving labor and land resource use with existing types of technology on Maryland dairy farms. Therefore, it is anticipated that Maryland dairymen and their competitors in other areas of the United States will continue to raise average level of labor use intensity toward the 50 cows per man level (14, 15). This means that most dairy farms during the coming decade will be in the 100 to 200 cow size range. This assumes that typical farm labor force size continues to range from one and one-half to four full-time worker equivalents and most dairy farms continue to raise their own milk cow replacements and the major portion of their feed requirements.

The critical importance of family labor on typical two man dairy farms is in part a result of decisions by many farm managers to try to operate with little or no hired help from outside the family. Some flexibility in work schedules is sacrificed on farms with only two full-time workers compared with the farms using four full-time workers. The dairy farm sector of the economy continues to rely heavily on self-employed labor and managerial resources. Family operated and managed farms will continue to characterize the milk production industry in the U.S.A. during the coming decade.

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