CORNELL
AGRICULTURAL ECONOMICS
STAFF PAPER

ANALYSIS OF AUTOMATED GRAIN FEEDING SYSTEMS
ON DAIRY FARMS IN NEW YORK STATE

Michael J. Kelleher*

Robert A. Milligan*

June 1985

No. 85-14

*Graduate Research Assistant and Associate Professor, Cornell University. This paper was presented at the annual meetings of the Northeast Agricultural and Resource Economics Association, June 24-26, 1985.

Department of Agricultural Economics
Cornell University Agricultural Experiment Station
New York State College of Agriculture and Life Sciences
A Statutory College of the State University
Cornell University, Ithaca, New York, 14853

ABSTRACT

Computer controlled concentrate feeders allow farm managers to allocate concentrates to each cow. The purpose of this study was to investigate the use and profitability of these systems on New York dairy farms. A mail survey, sent to farmers using automated feeding systems, found a $179 per cow return. Further, it was found that the newer technology of microcomputer based systems generated a return of $189 per cow from the investment. Net present value analysis found that 90 percent of the farms with microcomputer feeding systems had a positive net present value for the investment. This research suggests that investment in automated feeding equipment can be a profitable decision for many farms.

During the past 20 years the size of dairy farms in New York State has increased dramatically. The Census of Agriculture[1] shows that average cows per herd increased from 29 in 1964 to 51 in 1982. In 1964, seven percent of all cows were on farms with 100 or more cows per herd. By 1982, 29 percent of all cows were on farms with 100 or more cows. Most larger farms utilize freestall barns and milking parlors for labor efficiency and worker convenience. While freestall housing has reduced labor requirements considerably, it has created some unique problems. In freestall barns, cows are often handled and fed in one or more groups; whereas tie stall barns allow for individual handlings, feeding, and monitoring.

Recent advances in microelectronic and microcomputer technology have provided the ability to monitor and feed concentrates to each cow individually. A cow wearing a transponder can be automatically identified as she enters a feeding stall with an electronic link to a microprocessor controlling the quantity of grain delivered to the cow. The system can also monitor the consumption of concentrates by alerting the manager to cows which are not consuming the quantity of concentrates allocated to them through the automated feeding system.

An advantage of automated grain feeding systems is the reduction or elimination of grain feeding in the milking parlor allowing for faster milking - and more concentration of workers on the task of milking. With concentrates and labor the two largest cost categories on dairy farms and with the expected lowering of the milk support price, cost control and high productivity are crucial. There is a need to determine how investment in automated feeding systems affects farm profitability and cash flow.

---

[1] From USDA Census of Agriculture, 1982 and 1964.

Three different technologies (generations) of automated feeding equipment have been used by farm managers. The oldest type of system was based on the high producing cows wearing a magnet around their necks to allow access (free choice) to concentrates. The other two types of systems reported are based on cows wearing a transponder around their necks which allow them access to concentrates on a controlled basis. Older transponder systems are adjusted manually by a dial on the transponder worn by each cow. The manually adjusted systems are referred to as transponder feeders in this paper. More recent transponder technology has allowed the operator to adjust the level of concentrates fed to each cow from a centrally located microprocessor or microcomputer. In the comparative analysis of this paper, the microcomputer based systems are considered with the transponder systems. For the profitability and cash flow analysis the microcomputer systems is considered alone because the investment cost data refers only to that type of system.

LITERATURE REVIEW

Cow Response and Behavior

Considerable research has been conducted to test cow response to automated out of the parlor grain feeding systems. Broster et al. (1982) found, during a three year study, that cows consumed five to six kilograms per day of grain and milk production increased slightly with low parlor grain feeding supplemented by an automated feed system. Several other papers provide considerable agreement with Broster; Owens et al. (1978) and Rossing (1979) reported six to seven kilograms per day intake from automated feeders. These studies also show considerable agreement on an increase of milk production of 0.5 to 1.5 kilograms per day. Owens observed a slight decrease in milk fat, but an increase in solids not fat.

None of the studies observed bullying cows or reluctance of cows to enter the feeding stalls.

Comparison of Feeding Systems

Several experiments have compared the feeding of a total mixed ration (TMR) with feeding forages supplemented by automated grain feeding. Devore et al. (1974) and Tomlinson et al. (1980) found no significant different milk yield, milk fat, dry matter intake, and feed cost between cows fed with either system. Schillings et al. (1982) found agreement with the previous studies that there was no significant difference in milk yield or milk fat, but did find significant difference in bodyweight changes. The cows gained an average of 28 kilograms during lactation on TMR, but the cows gained an average of eight kilograms for transponder type systems. These studies were run over a period of years, so it appears that concerns of cows not adapting or rejecting automated feeding systems are unfounded.

Cassel (1983) and Cassel et al. (1982) compared transponder type systems with a one and two group TMR feeding strategy. The study was conducted over a 17 month period on 211 dairy cows plus subsequent calving heifers. It was found that cows fed with the transponder system produced significantly more milk than either of the TMR strategies. Further, the study found that the transponder system was the more profitable feeding strategy. The investment in the transponder system was compared to the purchase of a new mixer wagon for the TMR strategies. The investments were analyzed using the annual cost of ownership method, and then partial budgets were calculated. One weakness with the annual cost of ownership method is that it does not consider costs when they are incurred, and the time value of money may not be properly considered. This study focused on the response of one dairy herd to transponder feeding systems. There is a need to determine the response from a cross section of dairy farms using automated feeding equipment. The cross section of farms is necessary to evaluate the variation in system response under the different management strategies employed by commercial dairy farmers.

Whitehead et al. (1979) compared four automated supplemental grain feeders. One was a magnetic feeder and the other systems were transponder based. There was no significant difference in milk yield, but grain consumption and feed costs per 100 kilograms of milk was significantly lower for the transponder type systems. Laidlow and Snyder (1982) compared three groups; the control was fed ad libitum grain in the parlor, the second was fed additional supplemental grain with a transponder based system, and the third group was fed with supplemental grain from magnetic type feeders. Milk yield was the same for all groups, but the transponder based system had significantly higher milk fat than the other two groups.

Economic Analysis of Automated Feeding Systems

Three studies have researched the profitability of automated feeding systems, including the study discussed above. Smith and Prichard (1983) surveyed farmers nationwide and reported increases in milk yields of three to four pounds per day per cow after automated feeding systems were installed. The study found that 95 to 98 percent of the farmers were satisfied or very satisfied when evaluating: cow identification, equipment reliability, ease of programming, and usefulness of computer reports. There was no regional distribution of the system locations and no mention of variation of important variables across regions. The survey also asked farmers to calculate a payback period for the investment. The average payback reported was 15.6 months. There are several serious limitations with using payback period analysis to evaluate investment decisions. Smith and Prichard include a table of specific system characteristics and required investment costs from various manufacturers.

Wildhaber et al. (1984) compared five different automated feeding systems available commercially in the state of Washington. A payback period analysis was done for farm sizes ranging from 100 to 400 cows in increments of 50 cows. Data was used for average farms in Washington. There was no mention of variation in the cost and return data which could drastically affect payback period.

OBJECTIVES

1. To describe how automated grain feeding systems currently in use in New York State are being used.
2. To examine the effect these systems have on dairy performance as measures by milk production, purchased feed costs, and labor requirements.
3. To determine what type of management strategies are most successful in utilizing the equipment.
4. To evaluate the effect automated feeding systems have on farm profitability.

METHODOLOGY

Before any analysis could be performed, accurate information on the current performance of automated feeding equipment in New York State was necessary. The only data available on systems in New York were from manufacturers' promotional information. The authors designed a mail questionnaire to collect information on all types of feed automation equipment. The names of farm businesses using some type of system in place were obtained from county Cooperative Extension personnel.

Data Collection

The mail survey was sent in August 1984 to 197 dairy farm businesses.

There was a 64 percent return rate. Some of those returned could not be used because they had just recently installed the system or they were involved in the diversion program, resulting in 113 usable surveys. However, only 87 of the farms had complete information that allowed for statistical testing for all pertinent variables. The survey asked respondents to indicate physical characteristics of the farm related to milk production and cow numbers. The type of automated feeding system being used and the length of time the system had been in use were also indicated by the respondents. Some information on management and feeding strategies used on the farm were also asked of the farmers. The survey asked respondents to indicate important factors in making the investment decision. Also indicated were changes farms had experienced in milk production, labor and management time required, and purchased feed costs since they had started using the system.

A phone survey of retailers was completed in May 1985 to determine the approximate investment cost for a typical 100 cow computer type feeding system. Five retailers were called in areas of New York State which had the largest distribution of mail survey respondents. The investment costs reported by the retailers were consistent with those reported by Smith and Prichard (1983). The investment costs reported reflect only the cost of the computer type feeding system: microcomputer, feedstall or head box, transponders, and, with certain systems, some management software. Not included in the investment costs are the cost of grain storage and the distribution system. Many of the farmers installing automated feeding systems have existing grain storage, and the determination of an "average" size for the distribution system would be arbitrary. More importantly, however, is the fact that with any type of concentrate feeding system some form of grain storage and distribution system are needed. The investment decision to be evaluated is whether to invest in a computer feeding system and not whether the farmer should feed concentrates.

Method of Analyzing the Mail Survey

The data were analyzed using the SAS statistical package. The surveys were separated into groups based on type of system, farm situation, and management strategy. The mean of pertinent variables were obtained and then analysis of variance was used to determine whether the differences between groups are statistically significant. Analysis of variance was chosen because many of the variables were of the form of two or three discrete levels rather than continuous data.

Method of Evaluating the Investment Decision

There are several common methods of analyzing capital investment decisions. Payback period, return on investment (ROI), and net present value (NPV) are all methods of analysis used by managers in making investment decisions.

The NPV method of analysis was chosen as the appropriate technique to evaluate the decision to invest in computer type feeding systems. Three NPV analyses were performed on the investment data and cash flows from the survey. First, the investment decision was evaluated on a before tax basis using the mean values for returns generated by the investment. Then, a second analysis was performed on an after tax basis, still using the mean value for generated return. Because the return data was highly variable across farms, the third NPV was a breakeven analysis. This provided the return needed to have a NPV greater than or equal to zero. The survey data were re-examined to determine how many farm businesses did not have a positive NPV for this investment. Means and frequencies of the farm characteristics were generated for positive and negative NPV groups to determine general characteristics of situations with a negative NPV.

RESULTS AND ANALYSIS

Of the farms involved in the study, 76 percent reported using transponder type systems and the other 24 percent used magnet type feeders. Table 1 contains the mean and standard deviation of the key variables in the study. As expected, the responses show great variability in changes that have been occurring since system installation.

Based on the average values of the farm characteristics, the sample farms appear to be similar to all New York State dairy farms with freestall housing systems. In 1983 DHIA rolling herd average was 16,264 pounds (Holsteins) with an average of 71 cows. As expected, the cow numbers in the survey are slightly larger since only freestall barns were included in the survey. The number of months since the system was installed is large because magnet type feeders, many of which have been used for 10 or more years, are included. The results for changes which have occurred on farms after installing the systems are substantial. Typical systems presently cost \$200 - \$150 to install per cow. The average return from investment in a system is \$179 per cow. This suggests a rapid payback period. Data was not collected about maintenance costs or expected life of a system, so actual payback period was not calculated. Also, the large variance in reported returns would make payback period calculations of questionable value.

Table 1
Typical Farms Represented in the Survey

Variable	Mean Value	Standard Deviation
Farm Characteristics:		
Number of cows	115	50
Rolling herd average	16,799 lbs.	1,756
Changes After System Installation		
Months using system	31	25
Milk production	+1,028 lbs./cow	1,277
Purchased feed costs	-$45/cow	88
Labor & management time	+$0/cow	10
Total return from using the System*	+$173/cow	166

*See Appendix for assumptions and calculation.

Farmers reported various reasons for investing in the automation equipment. Increasing milk production, decreasing feed costs, and increased ability to monitor cows were the most common (Table 2). Most of the farmers believed the system would provide opportunities to increase milk production. The transponder systems provide the ability to control the amount of grain fed and to monitor the cows' intake of grain. Consequently, decreasing purchased feed costs and increased monitoring of feed intake are indicated as important factors for investment in transponder type systems. The expectations of the farm managers are different, depending on the type of system selected.

Table 2
Farmers' Reasons for Installing Automated Feeding Systems

Reason	All Farms	Transponder Systems	Magnetic Systems
	(percent of farmers reporting reason)		
Increase milk production	72	71	81
Decrease feed costs	62	75	22
More monitoring of cows	51	63	11

Most farm businesses report changes in milk production and feed costs since installing the systems (Table 3). Milk production increases were reported by 73 percent of the respondents with only six percent reporting a decrease. Some of the farm managers reporting decreases stated that they were purposely decreasing production to eliminate the excessive levels of grain feeding they had before the system was installed. They felt the feed cost savings would exceed the reduced returns due to decreased production. There were 54 percent of the farmers reporting purchased feed cost decreases, and 22 percent reported purchased feed cost increases. Most of those that reported feed cost increases were farmers with magnetic type feeders who also had substantial milk production increases. There were very few reported changes in labor and management time requirements. There was no attempt to separate labor and management time in the survey so it is unknown if there was a shift in relative amounts of labor or management time required. Farmers also reported better herd health and improved condition of cows with the system, although not on a quantitative basis.

Table 3

Reported Changes in Dairy Performance After Installing Feeding System

	Number of Farms
A. Change in Milk Production	
Increased >10%	31
Increased 5-10%	42
No change	27
Decreased >5%	6
Did not report	7
B. Change in Purchased Feed Costs	
Decreased >10%	27
Decreased 5-10%	27
No change	25
Increased >10%	22
Did not report	12
C. Changes in Labor and Management Time	
Decreased >10 hours per week	1
Decreased 5-10 hours per week	15
No change	65
Increased >5 hours per week	26
Did not report	5

The data were disaggregated by system (Table 4). As expected, there was still much variation in cow numbers and rolling herd average within each type of system. The difference in average cow numbers was statistically significant at the 0.10 significance level. As expected, there was a statistically significant difference in the number of months the system had been installed. The difference in change in milk production was somewhat statistically significant while the change in purchased feed costs were highly statistically significant.

Table 4
Typical Farm in the Survey by Type of System

	Type of System		
	Transponder	Magnetic	F
Farm Characteristics			
Number of cows	119	102	1.92
Rolling herd average	16,798 lbs.	16,792 lbs.	0.00
Changes After Installing System			
Months using system	22	62	73.92
Milk production	952 lbs./cow	1,283 lbs./cow	1.04
Purchased feed costs	-$61/cow	+$10/cow	11.16
Labor & management time	0/cow	0/cow	0.11
Total return from using the system*	+$179/cow	+$151/cow	0.45

*See appendix for assumptions and calculations.

Table 5 presents details in changes that have occurred on farms with a system installed for greater than four years versus those with system installed for four years or less. Although there is no difference in total return, the relative importance of the components has changed drastically. Those farms with systems in for more than four years have a statistically significantly larger increase in milk production while farms with systems in for four years or less have a statistically significantly larger decrease in purchased feed costs. The farms with systems in for several years have larger milk production increases, but they have also had purchased feed cost increases with system use. This is consistent with what would be expected with the older technology of magnet type feeders since the amount of grain fed is not controlled for each cow. Those farmers who have installed systems more recently are experiencing smaller increases in production, but are utilizing purchased feed more efficiently to reduce costs.

Table 5
Difference in Returns Over Time

Variable	Months System has been Installed <48	>48	F
Total Return*	+$171/cow	+$183/cow	0.07
Return from:			
Increased milk production	+$108/cow	+$217/cow	6.41
Decreased feed costs**	+$62/cow	-$34/cow	18.71

*See appendix for assumptions and calculations.
**A negative return for feed is a cost increase.

There were 72 percent of the farm managers reporting some method of supplemental grain feeding (Table 6). The results were very type specific as 93 percent of the farms with magnetic systems reported feeding by some other method. Feeding grain in the milking parlor was also type of system specific, with only 23 percent of the transponder type systems reporting feeding grain in the parlor. Feeding additional grain in the feed bunk as part of a total mixed ration (TMR) was common to both types of feeders.

Table 6
Additional Methods of Feeding Grain

Method	Farms Reporting* All Farms	Transponder	Magnetic
	percent		
Any supplemental feeding	72	54	93
Fed in milking parlor	32	23	59
Bunk feeding as TMR	41	42	37
Topdressed in feed bunk	6	6	7
Lead-feeding of dry cows	5	6	4

*Rounded to the nearest whole percent.

The data were tested to determine if feeding grain by another method in addition to the automated equipment had any effect on the changes in milk production and feed costs (Table 7). The difference in total return for using the system is statistically significant with farms not feeding grain elsewhere benefiting more from the system. The difference in feed cost savings is also statistically significant. There is no statistically significant difference in milk production between the two groups. This implies that farms which only feed grain through the automation equipment utilize the grain fed more efficiently than those farms which feed grain in various locations. This seems reasonable because the farms feeding grain by only one method should have greater control and monitoring on cow consumption.

Table 7
Differences in Returns by Grain Feeding Strategy

Variable	Additional Grain Fed		F
	Yes	No	
Total Return*	+$155/cow	+$220/cow	2.77
Return from:			
Increased milk production	+$133/cow	+$116/cow	0.21
Decreased feed cost	+$21/cow	+$107/cow	20.76

*See appendix for assumptions and calculations.

A management strategy which affects the cost of installing the system is whether a transponder is put on all the cows in the herd. As expected, none of the farms which used magnets put them on all the cows in the herd. The returns for the farms with all the cows wearing transponders should be greater than those with only a portion of the herd wearing transponders in order to pay for the added investment costs. This hypothesis is supported with the difference in total return statistically significant at a 0.90 confidence level. The greater increase results from a larger decrease in purchased feed costs. The large difference in the means suggests that there is substantial response to placing ransponders on all cows in the herd.

Table 8
Comparison of Transponder Placement on Groups

Variable	All Cows With Transponders Yes	No	F
Total Return*	+$213/cow	+$147/cow	3.36
Return from:			
Increased milk production	+$108/cow	+$141/cow	0.87
Decreased feed costs	+$106/cow	+$5/cow	39.60

*See appendix for assumptions and calculations.

SYSTEM INVESTMENT COSTS

The results from the phone survey of retailers appear in Table 9. The investment costs[2] indicated are for a typical 100 cow system without a grain storage or distribution system. Most of the systems required an investment cost of $11,000 to $16,000 for a 100 cow herd. The systems which cost over $22,000 for a 100 cow herd had additional capabilities and software included as part of a package investment cost.

Table 9
Investment Costs for a Typical 100 Cow Computer Feeding System

	Range of Costs
Feeding stall or head box	$1,000-$1,800
Transponder	$16-$37
Microcomputer or microprocessor with software	$4,000-$11,000
Total Investment Required	$11,000-$22,000

2 There are certain economies of size related to the investment costs. The microcomputer or microprocessing unit are capable of handling very large herd sizes, and the cost for the microcomputer is the same for different herd sizes. Other components of the system are size neutral. Each of the feeding stalls or head boxes can be used by 20 to 25 cows without overcrowding problems. Farmers can add feeding stalls for larger herds and can adjust cow numbers in the herd to avoid overcrowding problems. The transponders are sold as individual units and no retailers mentioned quantity discounts.

Net Present Value of Investment

The data needed to analyze an investment decision using NPV are cash flow predictions for the expected life of the investment, cost of the investment, and the discount factor used to reflect the time value of money. Table 10 summarizes the estimates and assumptions used in the NPV analysis. Computer returns are from the results for systems since those are the state of the art systems being installed today. Investment costs were estimated by averaging the data obtained from the phone survey of retailers. Repair costs, transponder failure rate, and expected system life were estimated after discussion with Smith who has considerable research and field experience with computer feeding systems. The real cost of capital is used as the discount factor since the cash flows and investment cost estimates are in terms of 1985 dollars. NPV analysis provides the same profitability measure using either real cash flows or actual cash flows as long as the cash flows chosen are consistent for the analysis.[3] The return data and investment costs are for a 100 cow farm and assumes transponders are placed on all 100 cows.

Table 10
Assumptions and Estimates Used for NPV Analysis

Returns	$18,900/100 cows/year
Investment costs	$16,500 per 100 cows
Maintenance costs	3% of investment
Transponder failure rate	5% per year
Transponder warranty	1 year
Real cost of capital	5%
Expected life of system	5 years
Expected salvage value	0

Before Tax NPV Analysis

Table 11 contains the before tax NPV analysis for the investment

---

[3] For further discussion of NPV and inflation, see Casler, Anderson, and Aplin, pp. 85-96.

required for a computer feeding system on a 100 cow dairy farm. Because of the warranty on the transponders there was no cost associated with the five percent failure rate for transponders in the first year of the investment. The NPV analysis was $62,779 and shows that the investment in a computer feeding system is profitable on a before tax basis for the average 100 cow dairy farm.

Table 11
Before Tax NPV for a 100 Cow Dairy Farm

Year	Item	Cash Flow	Factor	Present Value
0	Investment	($16,500)	1.0	($16,500)
1-5	Returns	$18,900	4.3295	$81,827
1	Repairs	($ 495)	0.9524	($ 471)
2-5	Repairs	($ 615)	3.3771	($ 2,077)
			Computer Feeder NPV =	$62,779

After Tax NPV Analysis

Farm businesses or their owners are subject to income taxes. The investment decision can be affected by taxes or the tax shield from depreciation and investment credit. For the purpose of this study, a 25 percent marginal tax rate was assumed. It was assumed that the full amount of investment credit was taken which provided a 10 percent federal and six percent state tax credit. The investment in computer feeding equipment had an after tax NPV = $48,848. The investment was still profitable to farmers with a typical 100 cow farm on an after tax basis.

Table 12
After Tax NPV for a 100 Cow Dairy Farm

Year	Item	After Tax Cash Flow	Factor	Present Value
0	Investment	($16,500)	1.0	($16,500)
1-5	Return	$14,175	4.3295	$61,371
1	Repairs	($ 371)	0.9524	($ 354)
2-5	Repairs	($ 461)	3.3771	($ 1,557)
1-5	Depreciation	$ 3,919	0.8661	$ 3,374
1	Investment Credit	$ 2,640	0.9524	$ 2,514
		After Tax Computer Feeder NPV =		$48,848

Breakeven NPV Analysis

Breakeven NPV analysis was chosen as the method to deal with the variability in the results for individual farm situations. An equation was developed to determine the return needed in each of the five investment years to generate an after tax NPV greater than zero (Table 13). The breakeven NPV was obtained when the return generated by the investment equaled $2,892 for the 100 cow farm. This return was converted to a before tax return of $39 per cow. This before tax return is comparable to the return data from individual farm businesses from the mail survey. It represents the minimum return required for the investment in a computer feeding system to be profitable given the average 1985 investment cost.

Table 13
Breakeven NPV Analysis

Variables:

Investment Costs = C
Return = R
Repairs = S
Depreciation = D
Investment Credit = I

Equation:

$$NPV = R - C + D + I - S$$
$$R = \$2,892$$

Conversion to Before Tax Return per Cow

$$\text{Return} = 2,892/(0.75)(100) = \$39 \text{ per cow}$$

The individual farm business data were analyzed to determine what percent of the farms had not generated sufficient returns from the system for a positive NPV (Table 14). Only 10 percent of the surveyed farms had a negative NPV. The mean values for herd average and cow numbers were similar for the positive and negative NPV farms. Transponders were placed on all cows in the herd on 73 percent of the farms with positive NPV, but only on 20 percent of the farms with negative NPV. Grain was fed in addition to the computer feeding system on 51 percent of the farms with positive NPV and by 80 percent of the farms with negative NPV. This suggests that the most profitable strategy for utilizing computer feeding systems is to place transponders on all cows and to feed all the concentrates through a computer feeding system.

Table 14
Surveyed Farms Grouped by Positive and Negative NPV

	Positive NPV Farms	Negative NPV Farms
	----------- percent of farms ----------	
Surveyed farms	90	10
Transponders on all cows	73	20
Physically grouping cows	27	40
Feeding additional grain	51	80

Cash Flow Implications

The NPV Analysis in the previous section demonstrated that the investment decision in computer feeding systems was profitable for most farms. Another important consideration in making a substantial investment is how the debt payments will affect the farm's cash flow situation. Many farms today are facing severe cash flow problems, so a profitable investment is not always financially feasible because of cash flow restrictions. The returns and costs used in the NPV analysis were also used in the cash flow analysis with the following assumptions:

1. Income tax effects were ignored because many of the farms facing cash flow problems pay little or no income taxes.
2. The investment would be 100 percent financed over five years.
3. The interest rate would be 13 percent fixed rate with required debt payment of $4,691 per year.

Table 15 summarizes the cash flow analysis using the mean value for the return data. The cash flows for all five years of the investment were positive and farms obtaining average response in terms of dairy performance would have no problems meeting cash flow commitments generated by the investment. The total outflow required from the investment was $5,186 in the first year and $5,306 for the remaining years. So, on the average, each cow would need to generate approximately $53 per year more in returns generated from dairy performance to have cash flow remain neutral for the investment.

The individual farm data were analyzed and it was found that 18 percent of the farms had not generated sufficient cash inflows to service the assumed debt and pay for repairs. The farms with positive cash flows for the investment more frequently placed transponders on all cows and did not feed grain in addition to the computer feeding system.

Table 15
Projected Cash Flow for a 100 Cow Computer Feeding System

Year	Cash Outflow		Cash Inflow	
	Debt Service	Repairs	Returns	Net
1	$4,691	$495	$18,900	+$13,714
2	4,691	615	18,900	+ 13,595
3	4,691	615	18,900	+ 13,595
4	4,691	615	18,900	+ 13,595
5	4,691	615	18,900	+ 13,595

Summary of Profitability and Cash Flow Analysis

Results from the NPV and cash flow analysis suggest that most surveyed farms found the investment in computer feeding systems profitable and to have positive effects on cash flow. Analysis showed that farms which had positive NPV and cash flow more frequently placed transponders on all cows and only fed concentrates through the computer feeding system.

CONCLUSIONS

The installation of automated feeding system on farms are having a significant impact on farm income and cash flow. Increased returns attributed to the system averaged $173 per cow per year. The considerable variation in returns suggests that certain farm situations and/or management strategies benefit more from feed automation equipment. Farms which are unable to physically group in the barn is an example of a farm situation which could benefit the most from automation equipment. The feeding system would allow them to feed each cow individually based on production. The management strategy which used the automated feeders most successfully was to place transponders on all the cows and to only feed grain through the automated system. This allowed for better operator monitoring of grain consumption and the farm manager could control the maximum amount of grain each cow could consume. Only farms with transponder type systems used this strategy. When farms fed additional grain in the bunk, cows could consume excess grain and reduce the effectiveness of the automated system.

Profitability and cash flow analysis show that computer type feeding systems were a good investment for over 80 percent of the surveyed farms. These farms are representative of New York State freestall dairy farms in terms of herd average and cow numbers. This suggests that many freestall dairy farms in New York could invest in computer feeding systems and add to farm profits.

APPENDIX

Assumptions for Calculations:

1. The price of milk = $12.50 per hundredweight.

2. The opportunity cost of labor and management time required = $5.00 per hour.

Important Variables:

R = total change in return per cow per year after installing the system.

C = change in purchased feed costs per cow per year after installing the system.

M = change in milk produced per cow per year after installing the system.

L = change in labor and management time required per cow per year after installing the system.

Calculations:

R = ((M*12.50/100)-(C)+(L*5)).

BIBLIOGRAPHY

Braidlow, B.K., Snyder, D.A., Specialized feeding of lactating dairy cows. Journal of Dairy Science, 1982, 65, Suppl. 1, 151-152.

Broster, W.H., et al., Electronically controlled feeding troughs for dairy cows: some nutritional implications. Journal of Dairy Research, 1982, 49, 4, 545-557.

Casler, George L., Anderson, Bruce L., Aplin, Richard D., Capital investment analysis, Third Edition, 1984.

Cassel, E.K., Feasibility and profitability of transponder and total mixed ration feeding systems for group fed dairy cows. Ph.D. Thesis, Cornell University, May 1983.

Cassel, E.K., et al., Evaluation of systems for feeding supplemental concentrates to group fed cows. Animal Science Mimeo No. 59 Revised, March 1982.

Devore, A.L., et al., Dairy cows perform well with electronic concentrate feeders. Illinois Research, 1974, 16, 2, 8-9.

Farm Flashes, Department of Animal Science, April 1984, Vol. 15, 2.

Owens, M.J., et al., Evaluation of magnetic grain feeder for lactating dairy cows. Journal of Dairy Science, 1978, 61, 11, 1590-1597.

Rossing, W., Concentrate feeding of dairy cows. University of Nottingham, Nutritional Conference Feed Manufacturers, 1979, 149-157.

Smith, T.R., personal correspondence, June 7, 1985.

Smith, T.R., Pritchard, D.E., Computerized feeders: a survey of producer users concentrate feeding, costs, cows. Dairy Herd Management, May 1983, v20, p10.

Schillings, J.G., et al., Effect of total mixed ration vs. computerized feeders on performance of dairy cows. Journal of Dairy Science, 1982, 65, Suppl. 1, 158.

Tomlinson, J.E., et al., Effect of total mixed ration vs. automated electronic feeders on performance of dairy cows in early lactation. Journal of Dairy Science, 1980, 63 Suppl. 1, 124-125.

Whitehead, J.D., et al., Comparison of four automated supplemental concentrate feeders for lactating dairy cows. Journal of Dairy Science, 1979, 62, Suppl. 1, 161-162.

Wildhaber, G., et al., Can you justify a computerized grain feeder? Hoard's Dairyman, March 25, 1984.