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A PROFITABILITY PERSPECTIVE ON THE FURTHER DEVELOPMENT AND USE OF FORMALIZED DAIRY FARM CONTROL AND PLANNING SYSTEMS

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PROFITABILITY IS A LIMITED PERSPECTIVE

Will the development and adoption of even the most economically idealized and formalized management control system, and the other components of a decision supporting system (DSS), assure profitability at acceptable levels of liquidity and solvency? The answer is: not necessarily. "Profitability in Agriculture", as the phrase is now being used, is an oversimplified idea. Many things have to happen outside of the farm fence as well as within it to result in profitability to the sector as a whole or to a specific farm. Many are beyond a farmer's or the Land Grant system's control.

High and stable prices alone won't do it. High crop prices get capitalized into land values, and we've seen how that's worked out recently. High milk prices get capitalized into dairy cow prices almost as quickly, as we can also see in recent data. Everything else being equal, anything that increases the capital required to do business cuts the rate of return to

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[1]A contribution to Minnesota Agricultural Experiment Station projects 14-036, Management Information Systems for Farm Firms and 14-026, The Impact of Changing Technology, Institutional Arrangements and Economic Conditions on Dairy Farms.

Prepared for presentation at a workshop entitled "National Invitational Workshop on Microcomputer Usage in Dairy Herd Management," at Informart, April 28-30, 1987, Dallas, Texas.

capital, a measure of profitability. It may increase the net worth of the owners but that is an increase in equity and solvency, not profits[2] (Luening).

Milk supply control alone may or may not do it. Supply control does not guarantee a sufficient volume per farm to make an economic production unit. If quota purchase is involved, that too adds to capital investment.

High and stable revenues do not guarantee producer attention to input cost control. Nor will it assure that producers will see adequate incentives to assure an acceptable level of efficiency in the use of agricultural resources (so as to satisfy society's objectives in funding government programs, including the Land Grant System).

If then, the objective of "Returning profitability to agriculture or to dairy farming" promises more than we can deliver as Land Grant scientists, what are we to do? Can the development and use of more formalized Management Information Systems (MIS), Decision Support Systems (DDS) and enterprise control systems improve the gross margins from dairying on individual farms? Perhaps not on all farms. And perhaps not in the long run because of the way a market system works. On most business oriented, commercially operated dairy farms, the potential net economic payoff incentives or profit potentials are there. They can improve the control of ongoing farming operations by the adaptation of a greater degree of formality into the management systems used to plan, monitor, and control

[2]Incidentally, accounting conventions ignore asset value changes in calculating profitability measures, but creditors do not, hence the appearance of a cost and market value column on a balance sheet.

various components of the high bio-technology production processes of modern dairy farming. They can either make management less stressful and/or allow an expansion in the scope of activity a manager can economically control. Most evidence to date is antidotal on this, but not all (Smith).

Each Step Should Be Economically Sound

Each increment in the process of formalization needs to stand on its own in terms of the added benefits obtained versus the added time and capital costs of its implementation and use. For many operators a change in management style must also occur to make that happen. More time is required in the office (at a micro, or examining and discussing properly structured written analysis) if a net economic benefit is to result. For many managers, action oriented as they are, this will be a difficult adjustment to make. But the economic benefits will not be there to those who do not adjust their management styles.

For some, the use of a breeding wheel is a first step. This is an example of 20% of the cost providing 80% of the returns, as noted in the 80/20 rule. In that way it becomes a defender technology against the more costly alternatives.

Use of Consultants

Some will chose a style that uses consultants such as accountants, DHI, preventive health care veterinarians and professional nutritionists to assist in structuring, analyzing and interpreting the data. This can be a reasonable approach. But resident management must still be on the alert between consultant reports and visits for emerging health care problems and changes in feed consumption and milk production. They must also discipline themselves to communicate frequently with the consultants. They must also organize required follow-through that implements the recommendations provided by the consultants. For most managers, some increases in attention to data collection and in processing responsibilities will still be required.

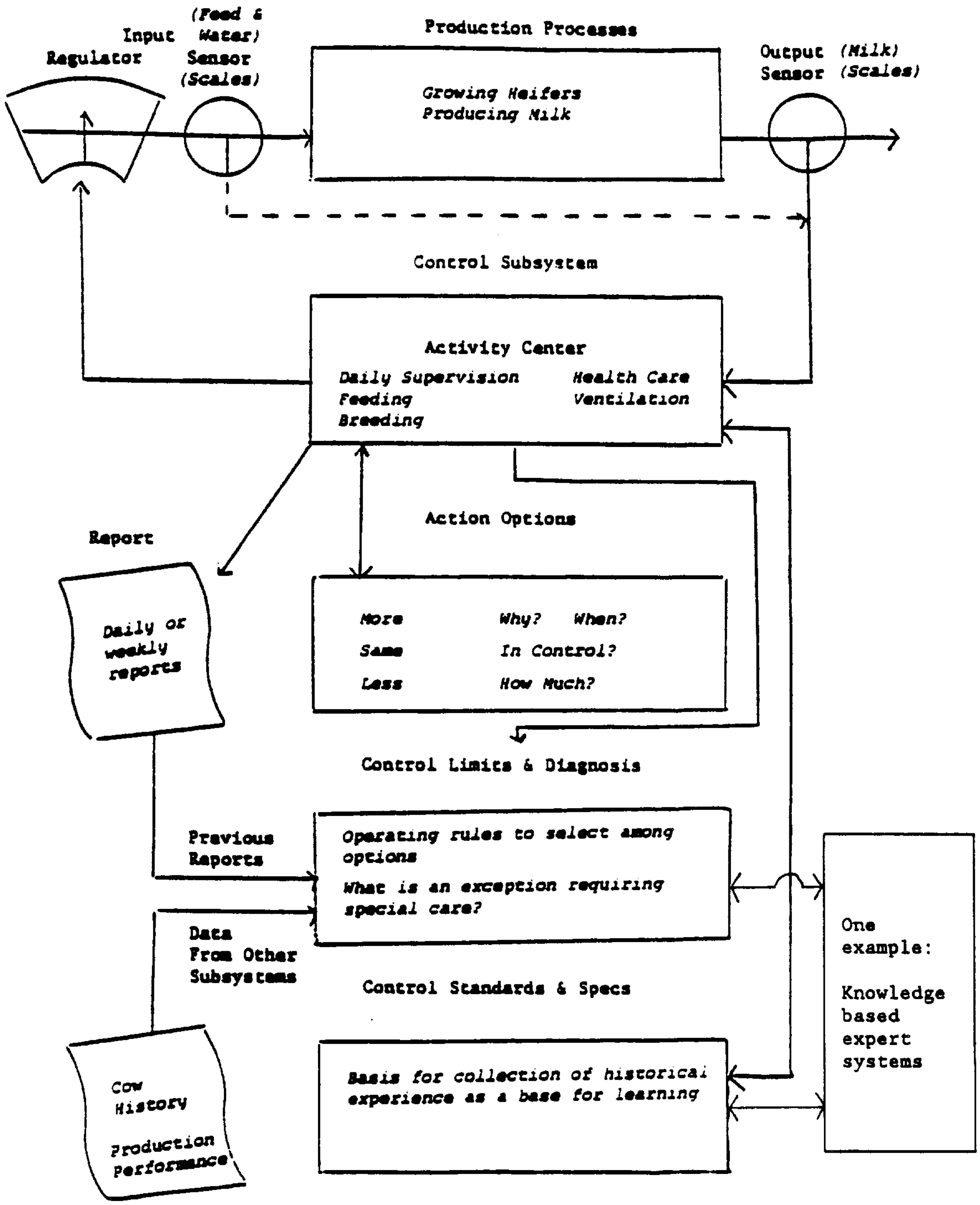
Expert Systems

The tools of artificial intelligence, especially knowledge based expert systems, are seen by some as a less costly, time saving, more economic alternative than are more complete data based systems. To consultants frustrated by a lack of a sustained on farm data base, they will offer time efficient targeted responses to soft and fuzzy problem situations. But beyond that, as a later section of this paper will argue, their most productive applications will be where they can be used to complement the dynamically changing problem specifications of a formalized control system when management by exception conditions arise (see figure 1).

Data Capture Challenges

Although some costs of data capture will decrease as more automatic capture becomes part of the system in years ahead, management must still see to data quality control. Other staff can do data entry, but unless the management team involved believes in the value of it and strives for a quality data product as a result, these systems will not be very economic. Remember, too, that early alert control systems require frequent data

Figure 1


Input
(Feed & Water)
Regulator
Sensor
(Scales)
Production Processes
Growing Heifers
Producing Milk
Output (Milk)
Sensor (Scales)
Control Subsystem
Activity Center
Daily Supervision
Feeding
Breeding
Health Care
Ventilation
Report
Daily or weekly reports
Action Options
More
Same
Less
Why?
When?
In Control?
How Much?
Control Limits & Diagnosis
Previous Reports
Operating rules to select among options
What is an exception requiring special care?
Data From Other Subsystems
Control Standards & Specs
Cow History
Production Performance
Basis for collection of historical experience as a base for learning
One example:
Knowledge based expert systems

capture to drive them. In managerial economic terms the key questions are, "What do you need to know?" and "When do you need to know it?"

How frequently to collect data is a question of economic benefit and cost. Data use is related to potential use benefits. Unless daily milk weights are used to obtain an early alert to health and feeding problems, are they worth collecting? Not unless feeding can be adjusted or health problems can be treated or estrus found. How rapidly can, or economically should, a herd manager respond to new data? Unless analysis occurs daily, it makes little sense to collect daily data.

If only lactation records are wanted, the skipping of a few day's data per month does little to degrade the quality of the results when proper statistical analysis and adjustment techniques are used. This is much less serious than inaccuracy or bias in the monthly samples now used in a DHI analysis. Besides, cross-checks of total production against the sum of the individual animal's production are possible for official purposes.

The Risk and Profits Tradeoff

Even when viewed from the firm's perspective, improving profitability isn't as simple a goal as some would make it seem. In the first place there is a tradeoff between profitability and risk. In general, greater exposure to risk on average provides greater average profitability. Most managers are willing to limit the risk exposure even if it reduces expectations about profitability in the process. Personal and financial stress are considerations. Well developed algorithmic techniques exist to handle (subjective) probabilistic problem domains.

The name of the game is reducing uncertainty to risk. That requires data and learning and knowledge. Our challenge is to design, develop, test and encourage the adaptation of systems which use the tools available to do so in as complementary a way as is economically possible. It will be economic to use more formalized approaches to risk evaluation than what most current expert system approaches offer. The approaches found in many existing computer decision aids are sound.

Improving Enterprise Gross Margins Is an Economically Sound Short-term Goal

In any given decision setting there are certain conditions which must be taken as given. Given conditions usually have some overhead costs related to them; costs which won't change regardless of the decision made. Analysis can safely ignore such costs. Attempts to improve enterprise gross margins or contributions to overhead make sense as goals even if the eventual profitability of the firm is in doubt. In the shorter lengths of run, managers sometimes minimize losses, not improve profits.

Even under such circumstances there can be lots of questions concerning whether or not we are even using the best possible combination of resources (feed) to produce any amount of product, whether or not we are producing the right amount of product (milk), given the limiting conditions of the moment, as well as the third question concerning whether we are producing the right combination of products (milk, replacements and feed) given those limits.

Yield Targets are Based on Questionable Economics

To target a specific yield goal level, may or may not be dealing with the issue as to whether or not we are producing a given product at the economic rate, given current prices. Some recent maximum economic yield writings in the plant sciences are suspect in this respect. But even given any target yield goal, there are some resources used to attain it which are imperfect substitutes for others involved. In dairying the whole issue as to the appropriate combination of feeds to make up a ration requires specified feedstuff use limits to represent imperfect substitution. Nutrition models also need to recognize the interplay between product prices, feedstuff prices, and to properly deal with the derivation of the proper target production level or yield goal. At issue is the shape and slope of the milk response curve to changes in the nutrition content of the ration given dry matter intake limits, stage of lactation, etc.

A BROADER PERSPECTIVE ON THE LAND GRANT SYSTEM

The Land Grant Scientist should work towards acceptable levels of profitability, liquidity and solvency for farm businesses and people who run them in the short and intermediate lengths of run. But our economy works to transfer much of the gain in productivity involved to the consumer in the longer run. Monopolies, with or without governmental help, can and usually do slow the rate of transfer to the consumer as well as the rate of adaption of new technology.

A skewed distribution of farm size may create equity problems in the distribution of economic gains to farm families. All developed innovations are not size neutral in their impacts on people engaged in farming. Some kinds of computerized technology are more neutral than others. "We should be responsible for what we can control." "Change is normal; stability is not." "Too much change per time period causes stress on people." "What we do as scientists and as citizens can make a difference." "Ultimately all problems are people problems."

Consider then the good and bad of what we do. We are change agents. Who benefits and who loses by the development of (1) automatic milker take-offs or by (2) robotic milkers? How costly will the "externalities" of vocational displacement of milkers be? Remember what the cotton harvester did to the South.

The Limits of An Economic Analysis Perspective

The traditional benefit cost analysis of economics doesn't work well in a highly innovative R & D setting. It works better when the technology is developed to the point where the major innovations in it are well-defined. It also assumes that the market system has worked to the place where any investments required are at known prices. It also presumes that the adaptation of it has occurred to a sufficient degree that one can readily place probabilities on the economic benefits and costs.

This is not the case with respect to the development of more formalized management, planning and control systems for the dairy farm. Automation of the data collection procedures, while believed by many to be technologically possible, has not really been fully developed. Only bits and pieces of what is perceived to be the potential system are in the market. Early adaptor purchase of components are done primarily with an expectation that they will be obsolete shortly. If the expected payoffs seem high enough, early adopters proceed. Managers are still accommodating to the necessary changes in terms of style and the use of time to make payoffs a reality.

It is not uncommon for these early adopters, who have tested the water by such purchases, to move conceptually to the same position as scientists who are doing the R & D on the development of the next phase. They see the potential payoffs of more complete systems. Ideal systems not only perform the task of data collection and assimilation, but also incorporate the potentials of control model development. Management by exception rule formulation and modification, and the connectiveness with other modules (for example: knowledge based expert system and the control and communication components for other aspects of the business) are all involved.

When analysts have attempted a cost-benefits kind of analysis concerning the adaption of these technologies, they have only been able to capture some of the more mundane considerations. They can determine the capital costs involved fairly well. They can determine the labor costs for data entry but have difficulty in determining its relevance. Labor and time may or may not have an appreciable opportunity cost and in most cases is not nearly the cost that the change in the use of overall management time is to the ongoing operation.

A Management System Perspective

Land Grant Scientists need a view of how computer technology will eventually be integrated into farming operations in a (farming) systems way. The ultimate result can, and should, be more than the sum of the component applications now evident in the early stages of adoption. Vision needs to go beyond current utilization to an era of decision support use of this technology in the "information age." Think: system, management planning, control and information systems.

The charge to Land Grant workers is to offer leadership with a vision about where new technology will take us. Leadership entails a charge to develop component prototypes that have linkages to other components and offer direction to the private sector. In the process, a balance between productivity and equity issues must be found as we explore the impacts of changes in technology.[3]

A Futuristic View of Where We Are

Investment in research and development in many fields of knowledge now means that we farm in an information age where knowledge of the available alternatives and technologies is oftentimes the key resource to manager-operators. It often seems more limiting than labor or land or capital as they go about making decisions which allocate controllable resources. Computer technology has the potential of overcoming the current severity of this limitation. It also has the potential of expanding the control an operator has over the integration of the available knowledge and technology into the production process.

There is a substantial gap between the potential for and the currently observable utilization of this technology. This paper intends to reduce that gap. To do so, we must now take an even broader conceptual perspective and look at the very large picture. The limitations of this paper require that this be done in the most general of terms.

Some Concepts and Terms

We are dealing with new concepts about knowledge and learning as well as

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[3]In the 1920's, 1930's and 1940's agriculture adopted mechanical power. It took many years to do so. The result was a substantial substitution of capital for labor, an increase in timeliness and finally mechanized systems of farming which released many people from the drudgery of farm handwork into other vocations. We are now in the process of adopting knowledge and calculation power. It too will take time. It too will have dramatic impacts. There will be less dairy farms.

technologies. Many of the terms used to describe this domain of knowledge are themselves less than perfectly understood. It seems necessary to define, for purposes of this paper, several such terms. The core ideas concern knowledge, information and message. These need to be defined relationally.

Knowledge

Knowledge is a product of learning. The investment that society has made in scholarship over many centuries, and more particularly by investment in institutions such as experiment stations, has created a knowledge explosion in our time. The existing body of knowledge for all mankind is far beyond the comprehensible knowledge of any one individual. Knowledge as a stock is stored in symbolic forms in minds, folklore, libraries and other institutions.[4,5]

We have developed technologies specifically to facilitate access to acquired knowledge. Under the conditions of the knowledge explosion, the challenge to the individual is oftentimes in gaining timely access to knowledge relevant to one's perceived concerns, interests and problems in an economical way. Computer technologies are being utilized and facilitated for retrievaland display upon user instruction of the knowledge existing in various databases. Substantial resources are being spent on this effort today.

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[4]The public policy oriented economists of the Chicago school would probably refer to knowledge, including knowledge about what to do with available knowledge, as the stock investment in human capital.

[5]Learning is a flow addition to the stock.

Information

Knowledge and information are not synonymous. Workers in mass media are inclined to think that they are. We are often told by the purveyors of news (and extension programs) that they are providing us with information. But are they really? From the perspective of the information sciences and this paper, a specification of what is information and what is not, is not something one individual can declare for another.

Messages and Filters

From the perspective of the decision sciences which have a great deal of validity on these matters, the best that purveyors of messages, such as the news media or the maintainers of computerized data bases or educators can hope for, is that they are performing a reasonable job of filtering appropriate content out of the existing knowledge base and then transmitting that content as well-filtered messages that have potentially useful informational content to the receiver(s) of the message. Any potential message contains data. Data includes both noise and potential informational content (still data) to the receiver of the message.

Message structuring by a sender is an imperfectly performed task. Restructuring upon receipt by the receiver is also imperfect. Imperfect structuring or filtering out the noise will always be the case. But the use of appropriate decision-making/problem-solving paradigms can reduce the imperfections.

In the context of the decision sciences, it is presumed that the message receiver has a decision to make and that a noise-filtered message can be received in an appropriately structured form, such that it's potential informational content is clear and readily usable. This argument implies that the structuring of messages is of substantial importance, and that the principles of quantitative analysis, sound decision making, logical branching and date tree structures can assist the process. Further, "well structured" problems are amendable to formalized decision rules and "traditional" quantitative analysis while "poorer structured" or "fuzzy" problems are the (complementary) domain of <u>expert</u> systems. It is a matter of degree. Reduce uncertainty to risk. Quantify the risks. Use probabilities. Use expert systems approaches to bridge the gaps, save time, and make first cuts to more thorough algorithmic analysis by the use of expert systems.

<u>Some Examples</u>

Consider some examples. The monthly DHI report provides a substantial amount of data. Producers were reluctant to take the time to restructure that data into a set of messages which have to do with specific problems or potential problems they might have. DHI centers developed action sheets to filter the data. Action sheets made up of (1) candidates for culling, (2) animals to observe for estrus, etc., contain less noise and consequently a higher ratio of potential informational content for specific well defined time-sensitive problematic situations faced by dairy herd managers.

Now, given the changes in "information" technology, DHI must ask, "What business are we really in?" What combination of data collecting, processing, analysis (including National Sire summaries plus consulting services) will some set of potential customers be willing to pay for?

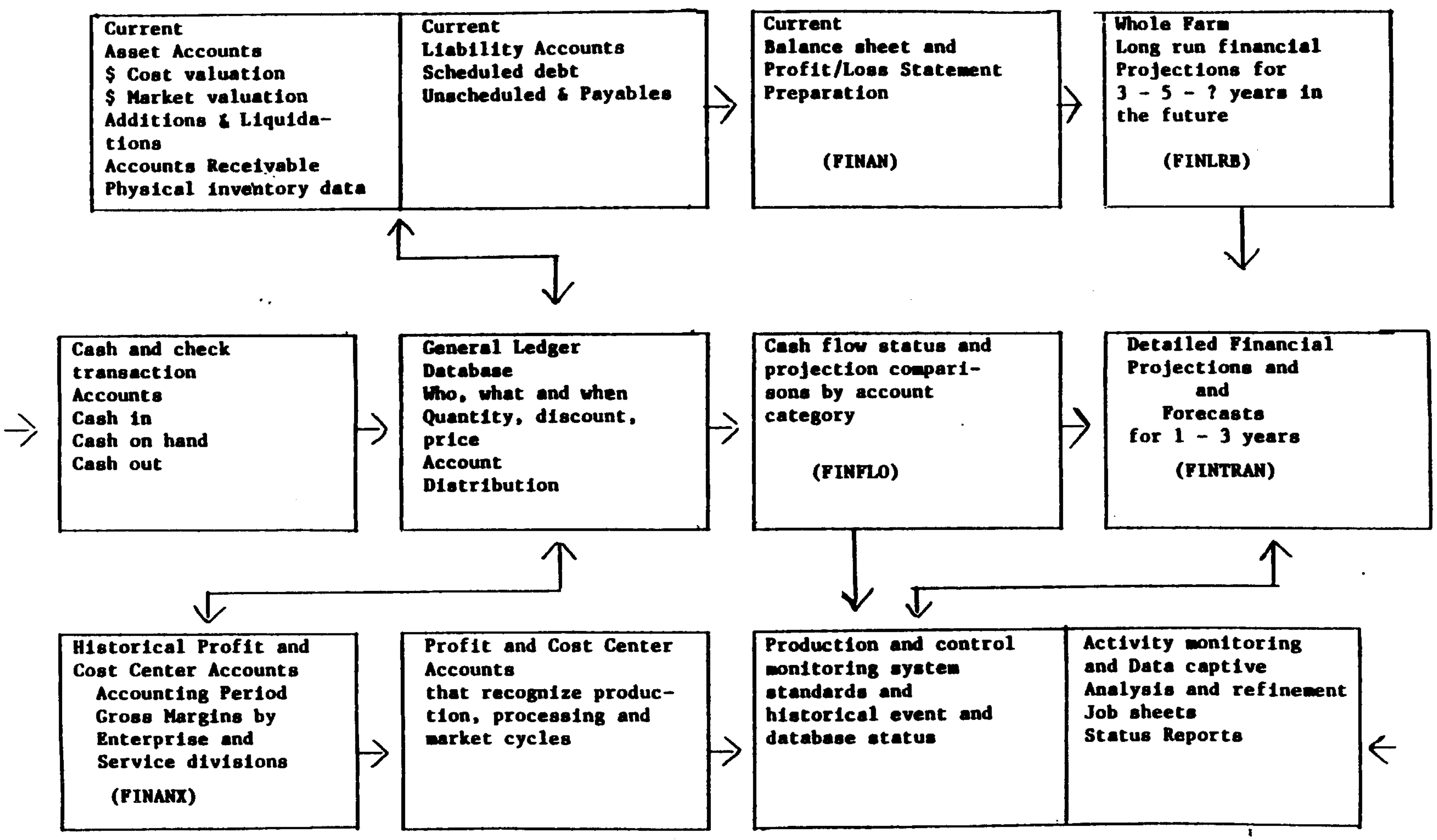
After all, the public benefits from sire summaries, but will they pay for it? Will enough dairymen feel that they benefit enough to maintain the data base without further subsidy/compensation? What minimum quality and quantity levels are necessary to insure economic utility to that data base?

Most dairy herd management micro-computerized data base systems are designed so that the herd manager can set the parameters of exceptionality and predict next day milk rates. They can also produce a list of animals which may need special attention. Such lists can be used to aid communications between manager and worker. For instance, they can be used so that those responsible for feeding and those responsible for the production or purchase of feed supplies, can see the complementarity in their efforts.

Financial planning and management are also part of such a system. The accounting data base should therefore be structured to avoid redundance in data capture and retention with other components. A direct cost accounting structure is the general answer. The appropriate level of detail is an individual farm question. Size and ownership complexity are involved. The key element is to build the idea of profit centers and cost centers into the chart of accounts. Profit centers are enterprises that contribute a gross margin. Cost centers capture overhead costs, most of which are joint, across two or more profit centers. Allocation between centers of joint overheads has no value for either planning or control purposes. Structuring accounts in this fashion is consistent with the gross margin ideas expressed earlier. (see figure 2)

Figure 2

A MIS - Integrated Data Base Perspective on the Keeping of Farm Records



Where physical quantity data is best captured depends on use and inventory control measures. Gross margin budget development needs the physical data for planning. Inventory control may be easier if required data are collected elsewhere.

Control Systems Should Assist Learning

A control system should do more than capture, structure and retrieve data from the available stock of knowledge at a point in time. It should contain predictive models of the future, but it should also allow for the development of improved models through experience and learning. After all, the difference between a manager who has 20 years experience and the one who has one year of experience twenty times, is learning! The normal inclination of creative managers, once they have determined the economically feasible set of data for collection and accumulation, is to turn their attention to how these data can be improved over time through a process of data restructuring and predictive model re-design.

The concepts of systems modelling can help. For instance, which set of alternative moving average weights and time periods best projects tomorrow's milk production? How should one relate, in some formal or informal fashion, the response of the animals to changes in feed quality and quantity? How should management by exception rules vary as changes in temperature or relative humidity occur? How should lactation curve projections be changed with the use of somotrophin?

Design to Encourage Learning and Modifications

One of the challenges to workers in the Land Grant System is to guide the manager's learning activity in ways which use our knowledge of scientific relationships, statistics and other quantitative methods, artificial intelligence, risk and conceptual schemes in valid ways to help this decision process. The fundamental principles developed in the late '50s and early '60s related to locating satellites in space, called "successive approximations", offer an example of the approaches that should be well understood by agricultural scientists.

Substantial refinements have been made on the early approaches and good alternatives offered to them as the years have rolled by. The literature on such approaches should not be ignored as we adapt these new technologies to the needs and problems of our clientele. Expert systems development adds tools to the kit, primarily when qualitative data is predominate. But again, the greatest gains are likely through complementary use with other quantitative techniques.

The literature within the knowledge domain of control modelling should not be ignored either. The idea that we can monitor output from a production system and adjust it by regulating input through the action of a controlling entity (be it a manager, or an artificial intelligence based set of semi or fully automated decision rules and processes) is basic to the design and use of control systems.

Message Structure

Perhaps even more of a challenge is how to structure the reports in the best way to insure the desired outcome; a response on the part of the message receiver (i.e., herd manager or employee) to assist in job completion and to respond back to the controlling system in an appropriate manner. There is a substantial amount of anecdotal evidence that even in a family partnership setting, the appropriate structuring of these messages can be most helpful to improve communications and to encourage collective striving towards common objectives in the conduct of the affairs of the farm business.

These basic ideas should help anyone designing or implementing components to dairy farm management information and decision supporting systems. They can improve the payoff with the profitable use of computer technologies on farms. As the components are designed, implemented and integrated into a management system, the farm manager's objectives of doing so need to be clearly kept in mind. Obviously, objectives vary from farm to farm; allowance for that is necessary, otherwise adoption will lag.

SUMMARY

If the observable economies of size in use of capital and labor in dairying available to the majority of dairy farms are to be captured, then the span of control of the management team must increase. As the number of workers involved increase, so must the efforts at communications by and between members of the staff and other stakeholders. Greater formalization of the information system and the control systems is one way to do it. As the available arrays of technologies increase, rational choice between them requires management systems which can handle their complexity. The variety of new electronic monitoring tools can be helpful in the process.

Work is occurring at a number of experiment stations and in the commercial sector which is consistent with the argument here. It is not the intent of this study to call for new directions in this work, nor to downplay its utility in its present form. It is rather to suggest that there is a need for a broader perspective within which the development and use of the components occurs. It is sometimes necessary to spend some time defining the forest of a definable formal farm MIS within which one searches for the trees of practical and potentially profitable decision supporting MIS, control, expert and planning systems.

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