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A DECISION SUPPORT SYSTEM
FOR COMMODITY MARKETING MANAGEMENT

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Commodity marketing management is a major area of concern for farmers. Increased market volatility, falling prices, and the rapid expansion of marketing alternatives and opportunities have all made farmers more aware of the importance of effective marketing management. As is true in any managerial activity, information and information processing can play a central role in marketing management, and advances in information technology are rapidly expanding both the range and level of support computer based systems can provide. In recent years agricultural economists have placed increased emphasis on the development of models and microcomputer software to support marketing management, and they have made significant contributions through the development of decision aids, forecasting models, and information dependent marketing strategies.

During this same period, researchers in the field of management information systems (MIS) have emphasized broadening the range and level of support MIS can provide for analysis, planning, and control in large organizations. Efforts directed toward the design and development of decision support systems (DSS) have been particularly important in this strengthening of the management support provided by MIS. Sprague and Carlson (p. 4) define DSS as "interactive computer-based systems that help decision makers use data and models to solve unstructured problems." This definition identifies four key characteristics of DSS. First, and most important, it emphasizes help or support for decisionmakers. A DSS is a tool to be used by decisionmakers rather than a substitute for them. This feature is the overriding consideration in the design of DSS. Second, DSS are interactive--they are meant to be used directly by decisionmakers and, so, need to provide both quick and flexible response. Third, they contain and integrate both data and models, giving users easy access to data and to tools for combining and analyzing data from several sources. Finally, DSS are designed for use in unstructured decision situations. Often, these are situations where computer based support can improve both the efficiency and effectiveness of decisionmaking, but the need for human judgment makes complete automation of decisions undesirable or infeasible.

Clearly, the concept of a DSS provides a useful framework for the design and development of computer based systems to support farm level commodity marketing management. Marketing decisions often require the synthesis of data and information from several sources and can be complex enough to be improved significantly by well designed models for analyzing alternatives. They are also ill structured enough to make an objective of supporting decisions much more realistic than an objective of automating decisions.

In this paper I describe the structure and components of Marketing Management System (MMS), a microcomputer based DSS I am developing for the support of commodity marketing management. In describing MMS, I also touch on a number of general issues related to the design, development, and implementation of DSS. In the sections which follow, I first characterize the design objectives and potential users of MMS. I then describe its major subsystems, giving examples of inputs and outputs where possible. In my concluding remarks, I look ahead to issues related to the further development and implementation of MMS.

Design Objectives and Potential Users

The specification of design objectives for any DSS begins with a characterization of the managerial processes it does and does not support. Simon's three categories of decisionmaking activities--intelligence, design, and choice--provide a useful framework for thinking about this issue. Intelligence is the process of identifying opportunities and problems. Design is the process of identifying alternative problem solutions or courses of action. Choice is the process of selecting one of a set of possible problem solutions.

In the intelligence mode, MMS should help the user monitor market conditions and the fundamental forces that underlie them. It should help identify short run pricing opportunities and situations where longer term adjustments in the marketing plan may be warranted. Finally, it should support the collection of data needed to analyze marketing performance and should help the user spot consistent weaknesses in overall marketing management.

In the design mode, MMS should support the specification of feasible long term marketing strategies to be evaluated in developing an overall marketing plan. This may require consideration of cash flow requirements for the firm as a whole as well as forecasts of future market conditions. In the shorter run, MMS should provide support for identifying alternative solutions to problems arising from unanticipated cash requirements, production shortfalls, and unexpected shifts in price levels.

In the choice mode, MMS should provide support for evaluating the consequences of alternative long and short run decisions and should help the user collect and organize the data required for such analyses. Support for implementing the strategies selected and monitoring their subsequent performance may also be needed. For example, when strategies are complex and dependent upon current market information, MMS should support the collection and analysis of the data needed to derive current recommendations.

In simpler, more concrete terms, MMS should support the collection of data about marketing transactions within the firm and about market conditions external to it. It should support the development of forecasts both for market intelligence and for strategy evaluation, and it should support budgeting the consequences of a wide range of short and long run choices. While this scope of activities is broad, all are narrowly focused on marketing management. MMS is structured to minimize, at least initially, the linkages to production and financial management systems within the farm firm. Such linkages do exist, but MMS is not intended to be a primary support tool for these important management activities.

A second key design question is that of deciding how MMS will support these activities. Agricultural economists working on marketing management have tended to focus their efforts on the formulation of models designed to identify optimal problem solutions. Therefore, they have devoted most of their efforts to relatively well structured decisions that can be completely automated.

MIS researchers working on DSS design and development, on the other hand, have tended to focus their attention on less structured problems and have based their work on behavioral decision models that describe how people make decisions rather than how decisions should be made. Newell and Simon's information processing model of human problem solving (Newell and

Simon; Simon and Newell) has had the greatest impact on DSS research. This theory begins with the assumption that humans share four essential characteristics that are relevant for describing decisionmaking behavior. First, people process information in serial rather than parallel fashion--i.e., they think about things one-at-a-time rather than simultaneously. Second, short term memory is quite limited. As Miller's classic results demonstrate, we can only keep seven, plus or minus two, bits of information in short term memory. Third, humans have essentially unlimited long term memory. Retrieval from long term memory is rapid, but the time required to "write" information to it is long. Finally, people can and do make use of external memory devices, such as scratch pads, books, and databases. The theory then characterizes the problem solving process as a sequence of small improvements in the decisionmaker's state of knowledge that result from operations such as asking an expert, querying a database, or budgeting the consequences of an alternative.

This behavioral theory of decisionmaking is clearly reflected in the four basic DSS components Carlson (p. 21) identifies in his framework for DSS design:

1. Specific representations (e.g., graphs, tables, and pictures) to assist in conceptualization and to provide a frame of reference for using the DSS.

2. Operations on the representations to support intelligence, design, and choice activities in decision making.

3. Memory aids to support the use of representations and operations.

4. Control aids to help the decision maker control the representations, operations, and memory aids.

Representations are designed to help the decisionmaker formalize his knowledge, and operations are designed to help change that knowledge. Memory and control aids are, ideally, designed to help overcome some of the limitations on human information processing capabilities. This is a design framework that de-emphasizes automation of decisions and emphasizes support of them.

The challenge in DSS design is to draw on insights from both rational and behavioral decision theories in order to build tools that take advantage of the power of normative models and yet one well adapted to the strengths and weaknesses of human problem solvers. In considering the kind of decision support to be provided by MMS, then, appropriate support tools must be based on a synthesis of these two approaches. As suggested by Sprague and Carlson's definition of DSS, they will need to be flexible and interactive and yet they must also rely on models that analyze data and evaluate alternatives as efficiently as possible.

A final design question is that of what kind of decisionmakers will MSS support. MMS is designed primarily for use by farmers, though it is recognized that few farmers today have the skill or need to use such a complex system. By exposing farmers and farm software developers to a prototypical DSS that is fairly comprehensive, however, individual components may be singled out for earlier adoption. In the shorter run, marketing management consultants are a more likely audience for MMS. They have the time and the skill to use a relatively broad based support tool.

The Structure of MMS

MMS is still in the design phase. Relatively little code has been written. It is being programmed in Turbo PASCAL because this language facilitates modular programming design and because general purpose software modules designed to support database management functions, graphics, and input/output code development are available at low cost. In addition, modules to support stochastic budgeting and regression analysis have been developed as part of the Agricultural Risk Management Simulator (ARMS) program.

In this section, I describe the four major subsystems of MMS. They perform the following tasks: (1) record keeping, (2) external data acquisition, (3) forecasting, and (4) strategy evaluation and implementation. The record keeping and external data acquisition subsystems are the major memory component MMS. They also support operations and representations associated with the intelligence activities of monitoring the firm and its environment. The forecasting and strategy evaluation and implementation subsystems support operations and representations associated with design and choice as well as intelligence. Rational models are used extensively, but not exclusively, in these subsystems.

Record Keeping Subsystem - Data on current inventories and future marketing commitments are the starting point for any long or short term marketing strategy evaluation and are often needed to implement strategies that rely on current information. Data describing past marketing transactions are essential for any evaluation of marketing management performance. Despite the central role of this kind of data resource, the developers of marketing management support tools for farmers have given relatively little attention to marketing record systems.

The record keeping subsystem of MMS is designed to help meet this need for firm-specific data resources. It is also intended to serve as a prototype for more comprehensive production and financial record systems--a prototype which meets the five database design objectives defined in Table 1. In the most general terms, the record keeping subsystem is a double entry accounting system for the marketing enterprise. Data describing each marketing transaction are stored in appropriate transaction data files, and these data are used to update standard account files, such as cash, inventory, accounts receivable, cost of goods sold, accounts payable, and sales. The transaction and account data files are a data resource that can support ad hoc queries, the generation standard reports, and the creation of input files for strategy design and evaluation models.

To facilitate design and prototyping, the record keeping system in MMS is artificially insulated from the rest of the firm. The marketing enterprise is treated as though it were a separate division of the firm. As crops are harvested, they are transferred into the marketing enterprise and valued at the current cash price. They are "purchased" by making a counterbalancing transfer from the marketing cash account to the production cash account. There is much to be gained from such a separation, since it permits new ways to analyze and evluate marketing activities. In a prototyping context it is useful, but in practice the maintenance of two accounting systems would not be feasible.

Table 1. Design Objectives Under the Database Approach

Database Objectives	Description
Availability	Data should be available for use by applications (both current and future) and by queries.
Shareability	Data items prepared by one application are available to all applications or queries. No data items are "owned" by an application.
Evolvability	The database can evolve as application usage and query needs evolve.
Data independence	The users of the database establish their view of the data and its structure without regard to the actual physical storage of the data.
Data integrity	The database establishes a uniform high level of accuracy and consistency. Validation rules are applied by the database management system.

Source: Management Information Systems - Conceptual Foundations, Structure, and Development, Second Edition, Gordon B. Davis and Margrethe H. Olson, p. 504.

Figure 1, a sample transaction data entry screen, helps illustrate the structure and use of this subsystem. In the top section of the screen the user enters the date, crop number, quantity sold, price, payment received, balance due, and general remarks about the transaction. The user can also enter remarks. Account updates are done automatically and are based on the data entered and displayed in the top section of the screen. Standard account updates are specified for each transaction type--e.g. cash market transactions, forward contracts, futures and option market transactions, etc. Note that the account update summary also provides useful current information on inventory levels and marketing enterprise profitability for the year (Sales - Cost of Goods Sold). The document number is generated

TRANSACTION TYPE: Cash Sale

Date:	04/10/85
Crop Number:	1
Quantity Sold (bu):	3000
Price ($/bu):	2.60
Payment Received ($):	0
Balance Due ($):	7800

Remarks:
Delivered to Stewartville from on farm storage.

ACCOUNT UPDATES — Document Number: CAS18504101

Account	From	TO	Change
Inventory (bu)	13000	10000	-3000
Inventory ($)	29900	23000	-6900
Cash ($)	2240	2240	0
Accts Receivable ($)	600	8400	7800
Cost Goods Sold ($)	51000	57900	6900
Sales ($)	60000	67800	7800

A)ccept E)dit

Figure 1. Sample Transaction Data Entry Screen

automatically and depends on the transaction type, crop number, and date. It serves as the primary key used to support ad hoc queries and standard report generation. Finally, transaction data are not stored nor are account updates made until the user enters "A" for Accept. A copy of this screen is printed when the user accepts it, providing a hard copy record of all transactions entered. The user also has the option to enter "E" to Edit the transaction data.

This record system supports ad hoc queries defined by transaction types, crop, and date as well as the generation of transaction summaries for user defined periods. Other representations and operations supported by this database include position reports and marketing enterprise analyses. Because the data are stored at such an elemental level, these representations and operations can be modified considerably without requiring changes in the underlying data structure.

External Data Access Subsystem

The record keeping subsystem creates a major portion of the "memory" of MMS. It does not systematically capture data on commodity prices and market fundamentals, however. Such data are needed to support price forecasting, basis analysis, and the evaluation of alternative marketing strategies. Because the same data are relevant for all farms in a locality, it is inefficient for each farmer to collect, enter, and maintain an extensive database on external conditions and events. Rather, these services can be provided by any one of the growing number of on-line data delivery services--e.g., ACRES, AGNET, AGRIDATA, and GRASSROOTS.

In the overall structure of MMS, such a data delivery system is viewed as a subsystem of the DSS. Existing services provide a wide range of representations based on current and historical market conditions--futures price charts, tables of current cash and futures prices, tables and reports on market supply and demand, world weather maps, etc. They also provide access to market newsletters and daily analyses of market conditions, and some systems contain interactive computer programs designed to help evaluate marketing alternatives. They give the user access to large, well organized databases and are designed for easy and efficient use.

While these systems are well developed, the ability to link them to the other components of MMS is still quite limited. In some respects, the user of MMS is the best linkage possible. Data and information accessed through on-line data services can be integrated into the user's beliefs and reflected in the data input to analysis programs. For frequently used numeric data, on the other hand, standard formats can be developed to allow downloading into analysis programs within MMS.

MMS is not being designed with any particular data service in mind. As design efforts progress, however, they can help articulate to the providers of these services how their data can be used by farmers with computers. Suggested data structure standards will also be an outcome of these efforts.

Forecasting Subsystem - Forecasts of future market conditions are a key input to nearly all the intelligence, design, and choice activities associated with marketing management. In this context, forecasts refer to assessments of the probability distribution of future price movements rather than to single valued projections of those price movements. Probabilistic forecasts of both futures prices and basis levels are required within MMS.

As was the case for external data acquisition, it may be more efficient to access market forecasts through an on-line data service than to build forecast models into MMS. Few farmers have the expertise or the time to develop and maintain their own forecasting models. Again, however, a major obstacle to this approach is the need for effective linkages by which externally provided forecasts can be incorporated into other representations and operations within the system. This problem is particularly serious in this case because presentation formats for forecasts are much less standardized than are market data presentation formats. This makes it much more difficult to capture and store externally provided forecast information so that it can be used by other components of the DSS.

Workable and effective forecasting tools can be incorporated directly into MMS, however. The commodity option based forecasting procedure presented in King and Fackler yields easily updated assessments of futures price distributions. Copies of the input and output screens from an application of this procedure to March 1986 corn futures on December 9, 1985, is given in Figure 2. A graphic representation of the output data are given in Figure 3.

Turning to the generation of basis forecasts, standard regression model specifications can be developed to analyze trends and seasonal patterns in historical basis data. Initial estimates can be made at the county level by, for example, extension agents using historical price data they have collected. Given these initial estimates, sequential regression procedures described in Fackler and King can be used to update parameter estimates within MMS using price data downloaded from an on-line data service or entered by the user.

CROP PRICE INFORMATION

Data Entry Option: Option-based

Crop: MAR86

	NOTES
Contract Month............MAR	- Enter the the three letter abbreviation.
Trading Date..............12/09/85	- Change only if different from the date shown.
Option Expiration Date....02/15/86	
Number of Strike Prices...10	
Interest Rate (%)......... 7.000	- Yield on the Treasury Bill that matures nearest the expiration date is a recommended value.
Expected Basis (cash minus futures) at Maturity (cents)..... 0	- Be sure to enter a minus sign (-) if the expected basis is negative.

CROP PRICE INFORMATION

Data Entry Option: Option-based

Crop: MAR86 Contract Month: MAR

Strike Price	Option Premium Call	Put
200	-9	1/8
210	34 3/4	1/4
220	24 3/4	1/2
230	15	1
240	7 3/4	3 1/4
250	3 1/4	8 3/4
260	1 1/8	16 1/4
270	3/8	25 1/4
280	1/8	35 1/4
290	1/8	-9

NOTES

All strike prices and option premiums are in cents.

Enter option premiums as they are reported -- e.g. 20 1/8.

Enter -9 if no option premium is quoted for a particular strike price. This will be treated as a missing value.

Minimum Cash Price (cents): 180
Maximum Cash Price (cents): 320

These are calculated by the program. You may change them if you wish.

CROP PRICE INFORMATION

Crop: MAR86 Data Entry Option: Option-based

	Implied	Modified
Minimum	1.80	1.80
1st percentile	2.02	2.02
5th percentile	2.25	2.25
10th percentile	2.28	2.28
20th percentile	2.32	2.32
30th percentile	2.37	2.37
40th percentile	2.40	2.40
50th percentile	2.43	2.43
60th percentile	2.47	2.47
70th percentile	2.52	2.52
80th percentile	2.57	2.57
90th percentile	2.64	2.64
95th percentile	2.71	2.71
99th percentile	2.80	2.80
Maximum	2.95	2.95

Notes

The PRICE levels in the "Implied" column describe the probability distribution implied by the data you have entered.

If you wish, you can modify the distribution by entering revised PRICE levels in the "Modified" column.

Modified values must be in ascending order.

Figure 2. Option Based Price Forecast for March Corn

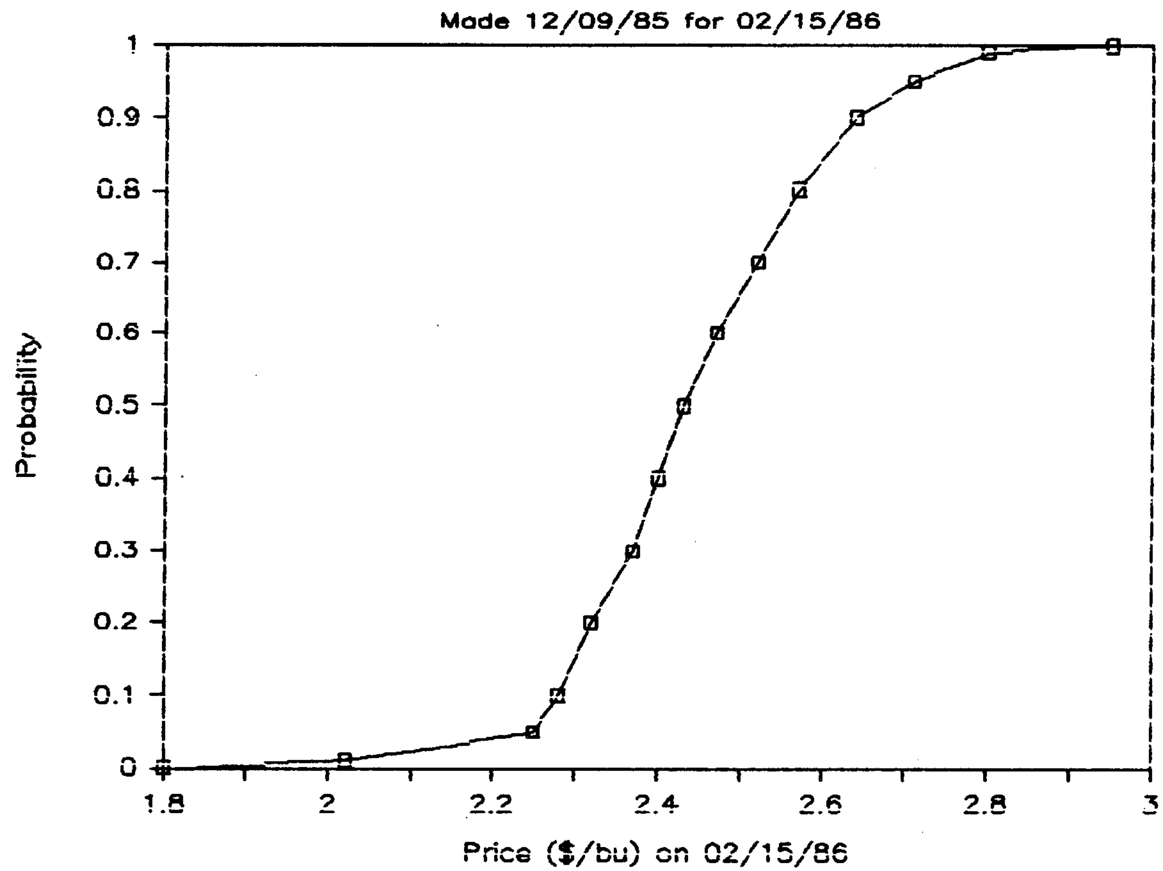

Figure 3. March 1986 Futures Price Distribution

An example of the seasonal basis charts already available through extension is given in Figure 4. Average basis levels from Figure 4 were combined with option based probability assessments for March, May, July, and September corn to generate the cash price confidence interval graph in Figure 5. These representations are useful for market intelligence activities and the data that underlie them are a key input to the long and short term strategy evaluation models discussed in the next subsection.

Prototyping the input/output formats and the analytical procedures needed to generate forecasts of this kind within MMS serves two useful functions. First, it provides concrete examples of probabilistic forecasts and their application. People can learn to use new tools only by working with them. Second, this prototyping effort will generate general purpose software that private software developers and information providers can modify, adopt to the needs of their customers, and market.

Strategy Evaluation and Implementation Subsystem

The support of short and long run market planning is a major design objective of MMS. In effect, MMS should provide a flexible tool kit of models that draw data from internal and external databases and help users analyze problems as they arise. For this reason, a large number of small, relatively simple models may be more useful than a single model that identifies globally optimal strategies. If the record keeping, external data access, and forecasting subsystems are well designed, it should be possible to add new models to the strategy evaluation and implementation subsystem in a modular fashion.

Efforts on the development of long term strategy evaluation models have, to date, focused on extensions of the marketing strategy models

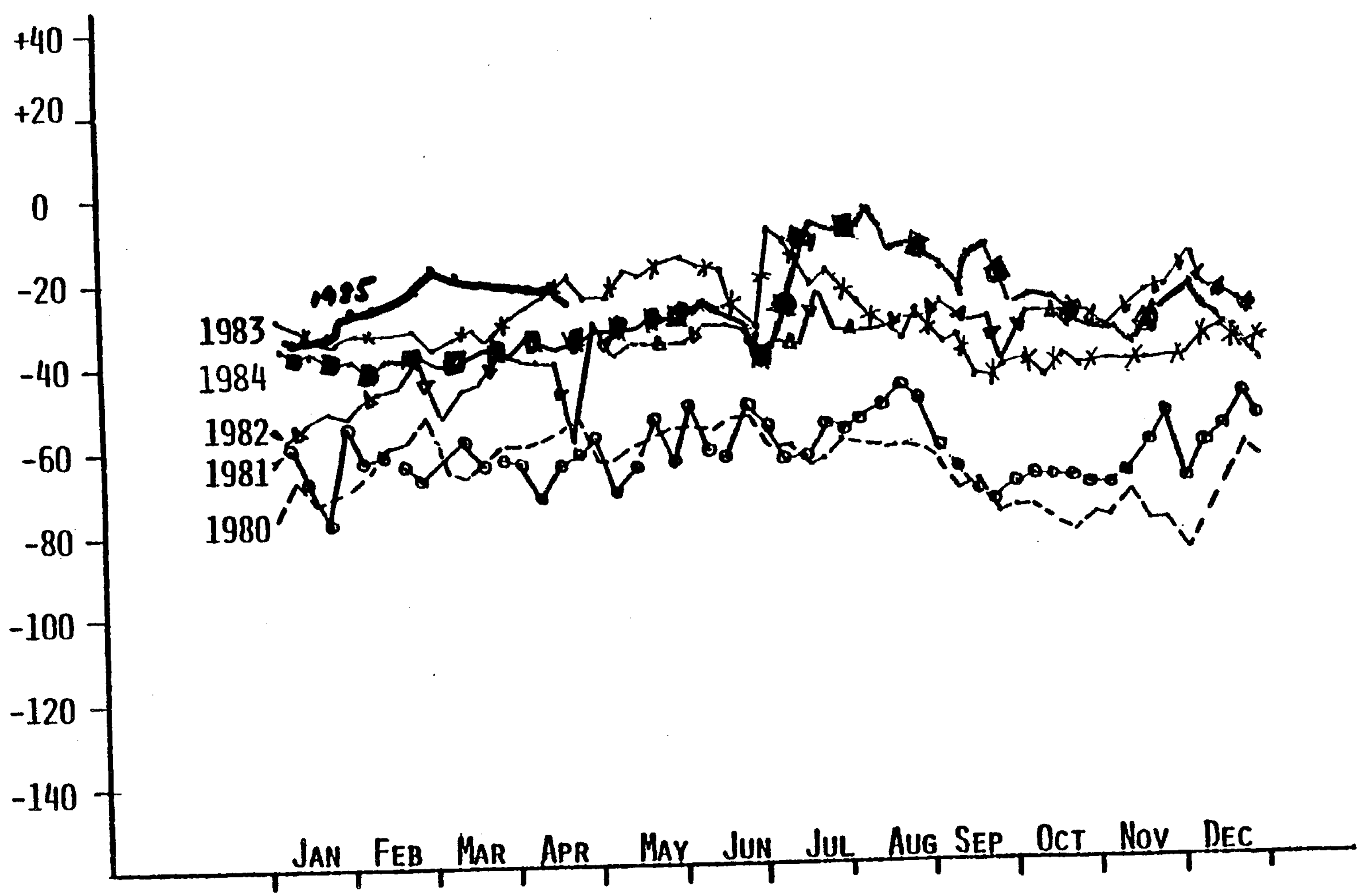

Figure 4. Worthington Nearby Basis, Corn

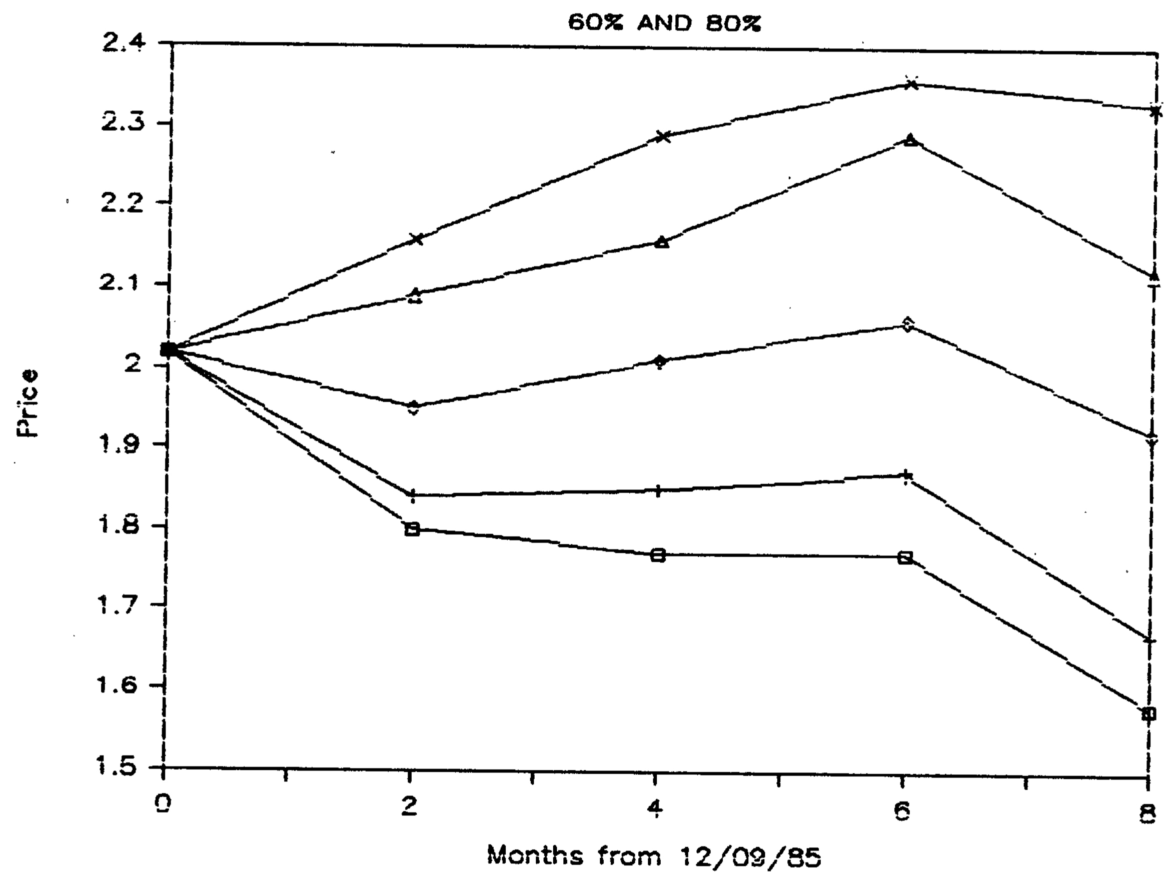

Figure 5. Cash Corn Price Confidence Intervals

presented in King; King and Oamek; and King and Lybecker. Each of these studies evaluated flexible marketing strategies that base current actions on frequently updated price forecasts and market position reports for the firm. In general terms, these strategies establish a default plan and specify rules from deviating from that plan in response to changes in market conditions. For example, the preharvest forward contracting strategies defined in the top panel of Table 2 specify a target level of preharvest forward contracting and work under the base assumption that contracts are made at regular intervals from February through October to meet that target. The other parameters specify rules for deviating from that plan in response to forecasts of short and long run price changes and the current rate of price change. Six such strategies are defined in the middle panel of Table 2. The performance of each strategy was simulated week by week through 20 synthesized marketing years to generate the net cash flow distributions summarized in the bottom panel of Table 2. This information should be useful in selecting a long run forward contracting strategy.

This example is presented not because it is the best of all possible models, but because it illustrates how a relatively simple, but flexible, model can draw on data from other subsystems of MMS. The inputs to this model include crop acreage levels, enterprise costs, information on yield variability, and the synthesized weekly price scenarios. The production data comes from outside MMS, but the price scenarios--which would be difficult for farmers to construct and prohibitively time consuming to enter--can be derived directly from the outputs of models in the forecasting subsystem.

Table 2. Strategy Evaluation Support Screen

FORWARD CONTRACTING STRATEGY PARAMETERS

Parameter	
1	Target percentage to be contracted by harvest
2	Weight on forecasted one week change in contract price
3	Weight on forecasted two week change in contract price
4	Weight on forecasted four week change in contract price
5	Weight on forecasted eight week change in contract price
6	Weight on forecasted change in contract price prior to harvest
7	Weight on current rate of price change

	STRATEGY					
Parameter	1	2	3	4	5	6
1	0.0	0.50	0.50	0.50	0.50	0.50
2	0.0	0.0	5.0	10.0	0.0	10.0
3	0.0	0.0	4.0	8.0	0.0	8.0
4	0.0	0.0	3.0	6.0	0.0	6.0
5	0.0	0.0	2.0	4.0	0.0	4.0
6	0.0	0.0	5.0	10.0	10.0	10.0
7	0.0	0.0	5.0	10.0	0.0	0.0

	STRATEGY					
Percentile	1	2	3	4	5	6
5	-19098	-12613	-12308	-12667	-17629	-12756
15	-12419	-10785	-9865	-8059	-13203	-9231
25	-9017	-8138	-4092	-1265	-6411	-5166
35	-3898	-1400	1196	4359	-5457	-106
45	-2110	2420	4502	6841	-2220	3321
55	3425	5400	5735	8037	2215	4578
65	10101	11723	11435	12490	9534	11926
75	19380	18104	18723	19353	17361	18342
85	30878	29022	28713	25876	32719	31412
95	46959	38414	36983	39232	42761	41337
Mean	4270	5167	6905	8023	3818	6571

Implementing strategies such as these can be a complex task in itself, since actions at any point in time depend on the firm's market position and current price forecasts. Data from other subsystems is also useful for supporting implementation. The output screen reproduced in Figure 6 presents market position data from the record subsystem, forecasts from the forecasting subsystem, and price levels that could have been captured from the external data access subsystem. Finally, the recommended action is based on strategy 4 in Table 2.

Models to support shorter term decisions--e.g. which crop should be sold to meet an immediate cash requirement or when should a hedge be lifted--can be integrated into MMS in similar ways. Again, the key design objective is to make them interactive and easy to use and to facilitate access to data from other subsystems so data entry can be minimized.

Concluding Remarks

The design strategy for MMS is incomplete and still evolving. It is well enough formulated, however, to serve as a guide for more intensive prototyping and experimentation. MMS representes a departure from more traditional marketing management support tools in that it directly addresses the problem of collecting, organizing, and maintaining a data resource for intelligence, design, and choice. It is the lack of such data resources that has made otherwise well designed marketing decision aids so difficult to use.

MMS is different from many other DSS in that it has not been developed directly for a specific set of individual decisionmakers. Getting a DSS into the hands of users as early as possible into development cycle is, however, an important feature of an effective development strategy.

WEEK 27	
CURRENT SITUATION	
Percent of crop contracted to date	.15
Average contract price	1.993819
Current contract price	2.299581
Last week's contract price	2.41962
PRICE FORECASTS	
1 week from today	2.302451
2 weeks from today	2.293998
4 weeks from today	2.317024
8 weeks from today	2.332769
Harvest	2.349581
RECOMMENDED ACTION	
Desired percent contracted	.4

Figure 6. Strategy Implementation Support Screen

Without direct exposure to a system, users find it difficult to articulate their needs or to evaluate design alternatives. As soon as a working version of the record keeping subsystem is ready, then, several simple strategy design and evaluation models will be linked to it, and field testing will begin. This will mark the beginning of a new phase in the development of MMS.

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