ASSESSMENT OF FARM BUSINESS HEALTH AND LONG-RUN FORWARD BUSINESS PLANNING--EXPERIENCES WITH THE TOP MANAGEMENT FARM BUSINESS SIMULATION MODEL

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ABSTRACT

As farms become larger and more capital intensive, long-run forward planning and risk assessment become increasingly more important. The Top Management Farm Business Simulator is designed to assist producers in assessing the profitability and risk of alternative farm business opportunities. This is done in three steps: prognosis, diagnosis and prescription. Prognosis is based on projecting business income, cash flows and net worth over periods of up to 15 years. Farm business health is assessed based on the ability of the firm to generate positive cash flows and a reasonable return to equity within an acceptable level of risk. Diagnosis is based on the comparison of firm cost efficiency and financial structure to peer performance benchmarks. Prescriptive analysis is based on the comparison of the risk-return efficiency of the base scenario to up to seven business alternatives. Risk efficiency tests include first and second degree stochastic dominance and stochastic dominance with respect to a function.

In the present computer age, many agricultural producers are data rich but information poor; they have access to a tremendous amount of accounting, commodity price and research data, yet their ability to transform these data into meaningful information for long-run forward planning purposes has not kept pace. Moreover, in a capital intensive industry such as agriculture, the importance of assessing financial feasibility (or long-run financial planning) of current operations and new technologies and opportunities is paramount to business survival in an uncertain world. The importance of risk and business survival in producer goal setting is borne out by empirical research. For example, in a study of the 1984 Top Management Workshop participants, Van Kooten et al. (1986) examined the importance of eight farm goals. The most important personal and business goal was business survival and out of the top four goals examined, three goals were risk related.

The lack of progress in the development of long-run whole farm planning under risk models is due to a number of factors. First, long-run forward planning demands far more than can be supplied by existing farm accounting systems. This is because most farm accounting systems were designed primarily to fulfill income tax requirements. Most modern, advanced farm accounting systems are transaction based. Consequently, farm fertilizer, seed, herbicides and other input expenditures represent that cannot be traced to their application on individual fields. In addition, individual field production is aggregated into farm crop sales which may be spread over several years. The result is that key past farm production decisions cannot be linked to farm cash flows or profitability. Second, long-run forward planning is complex. Many biological and growth processes are dynamic, non-linear and uncertain. The combination of time and risk results in increased model complexity and dimension. The problem of model dimension is the "curse of dimensionality," where computational difficulty tends to explode when both multiple periods and multiple outcomes are considered (Hillier and Lieberman, 1972). Accordingly, most extension farm level models have tended to address either annual risk-returns, or long-run financial planning, but not both. The dearth of farm level long-run planning under risk models that can be applied to "real world" farms led Klein and Narayanan (1992) to conclude that

> " the study of risk and uncertainty has been mostly confined to theoretical investigations since the mid-1970's. Farm modellers still regard risk and uncertainty to be a serious problem, but little effort has been made to incorporate risk in farm models in the past 15 years."

The TMFBS is a designed to assist producers in assessing business health and alternatives through long-run forward planning under risk. In the following sections, the structure and use of the TMFBS is outlined and its use in assessing farm health and appraising business alternatives is addressed.

THE TOP MANAGEMENT FARM BUSINESS SIMULATOR

The TMFBS was developed as part of the Top Management project which was established in 1982 and funded by the University of Saskatchewan. The main project objectives were to link data collection, analysis and decision making into one overall model, and to establish a producer panel to provide technical and financial data for teaching and research purposes (Schoney, 1984). The TMFBS is a multi-period, stochastic simulation model that incorporates production, cost and financial linkages, as well as stochastic prices and yields. The TMFBS is an integrated approach to whole-farm financial prognosis, diagnosis, and remedial/ corrective action of existing farm operations and to the economic assessment of new projects. The producer panel and financial planning workshops provide the basic production and cost relationships for peer performance benchmarks and for representative farms required in project evaluation. In addition, the same basic model is used for both individual farms and for more complex research project evaluation. TMFBS is widely used in the University of Saskatchewan School of Agriculture for teaching farm business management principles and in undergraduate and graduate courses on decision-making and risk assessment.

Model Structure

The TMFBS consists of four basic management modules: 1) farm production, 2) finance, 3) income tax, and 4) risk management. The farm production module uses a "bottom up" budget-generator approach of linking detailed inventories of land, purchased inputs, home-grown inputs, machines and machine systems, and crop inventories via production "recipes" to generate total farm production flows (Figure 1). These cropping recipes are the basic building blocks of production systems and represent a given technology through the detailed specification of inputs (e.g., seed, fertilizer, herbicides) and machine and building requirements. Grain yields can be fixed or probabilistic. Two basic probability distributions are available: normal and triangular. In addition, the probability distributions can be truncated to exclude the possibility of negative yields.

Key to the farm production module is the inventory and management of land resources. Farmland is divided into relatively small sub-field production units or "land management units" (LMU's) which can vary from 1 to 1,000 hectares and up to a total of 100 LMU's. Each LMU may have a unique cropping system which consists of a series or a rotation of cropping recipes. For example, a fallow-wheat-wheat (F-W-W) rotation requires three production phases: 1) fallow, 2) wheat on fallow and 3)

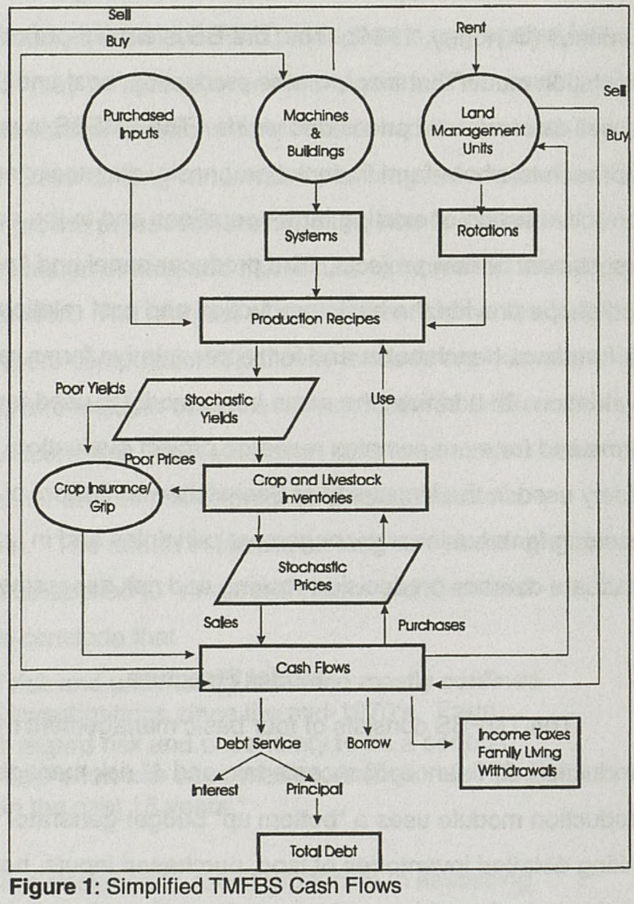

Figure 1: Simplified TMFBS Cash Flows

wheat on stubble. While different LMU's may share the same recipes, they may differ in order, according to the phase of the rotation.

Annual production is determined by acreage and simulated yield. However, total production may not be the same as the total amount sold in a given fiscal year due to lags and on-farm use for feed, seed or inputs to other enterprises. Actual crop and livestock sales/purchases are based on traditional inventory accounting rules subject to projected demands for home-grown feed and livestock and annual production quotas. Once beginning inventories, production, use and ending inventories are established, farm sales (purchases) result from projected crop and livestock surpluses (deficits) above (below) the required ending inventories. Gross income is the sum of actual cash sales and gross cash expenses are the sum of purchased fertilizer, chemical, seed and feed inputs, fuel, repair, hired labour, and interest charges.

The tax module computes income taxes for a single proprietor or a corporation. Since income and expenses are determined elsewhere, this is a relatively simple module with only one management decision variable-- the amount of capital cost allowance (depreciation) claimed for each asset type. CCA claims are set so as to maximize their effectiveness over time. Another important feature of the tax module is the estimation of contingent income tax liabilities, which are income taxes that become due if the farm business is terminated. These liabilities are commonly created by a) over-depreciation of machines and buildings, b) build-up of crop and livestock inventories, and c) increased capital asset values. It is important to consider these potential liabilities, because different investment projects such as livestock versus land can generate very different contingent income tax liabilities and their omission can result in biased ending net worths.

Probability distributions of yields and prices, as well as their price-price, yield-yield and yield-price cross-correlations are specified in the risk module. Yield-yield and price-price correlations are important in assessing the diversifying effect of alternative crops. For example, barley prices and yields are highly correlated with those of wheat and, hence, barley is a poor candidate for diversifying a wheat farm. Another important risk management variable is crop insurance participation levels.. If yields fall below a pre-specified level for the given soil type, crop insurance payments are triggered. Crop insurance is important because it tends to offset the benefits of diversifying the crop portfolio.

The financial module determines the management of cash flows, borrowing and repayment activities. Gross cash income and expenses are combined with income taxes, loan repayments and capital investments to generate whole-farm cash flows. Cash flow management is important because interest rates charged/earned differ among borrowing/investing opportunities. Projected cash flow deficits trigger additional borrowing activities as required. If deficits arise because of investment activities, they are financed by intermediate or long term loans subject to upper limits on credit availability. Operating deficits are financed by operating loans that must be repaid the following year. Cash surpluses trigger loan pre-payment or off-farm investment activities. At the end of each year, asset inventories are revalued at current fair market value and contingent tax liabilities estimated.

The TMFBS is programmed in Pascal and operates under DOS or as a DOS application under WINDOWS. The TMFBS requires 1MB of RAM and less than 1MB of hard disk space. Up to 250 observations of farm income, expenses, cash flows and net worth can be simulated for periods of up to 15 years. For a problems incorporating a 5 year planning horizon and requiring 250 observations, solution times are typically less than 20 seconds on a P5-133. In addition to the base run, up to 7 alternatives or trials can be simultaneously maintained. Because the data are subdivided into ten separate data bases, alternatives can be combined to form new alternatives (trials).

Assessment of Farm Business Health

A convenient metaphor in assessing farm business health and prescribing a course of action is the medical health model (figure 2). In this metaphor, there are three stages of analysis: prognosis, diagnosis and prescription. The first stage is farm business prognosis. After the data are verified and validated, non-stochastic cash flows and net worth are generated in order to assess farm viability or health. Unlike, the medical field where diagnosis is performed first, farm business health is ultimately conditional on the projected or anticipated economic environment. A business may be healthy under favourable economic environment but ailing under a less favourable environment. This is particularly important in an economy where the environment has experienced severe economic gyrations. Accordingly, particular emphasis is placed on projecting annual cash flows, change in financial structure, and change in ending net worth. To be economically viable and healthy, the farm business/project must simultaneously meet projected short-run cash flows and maintain long-run growth within an acceptable level of risk. These are the familiar

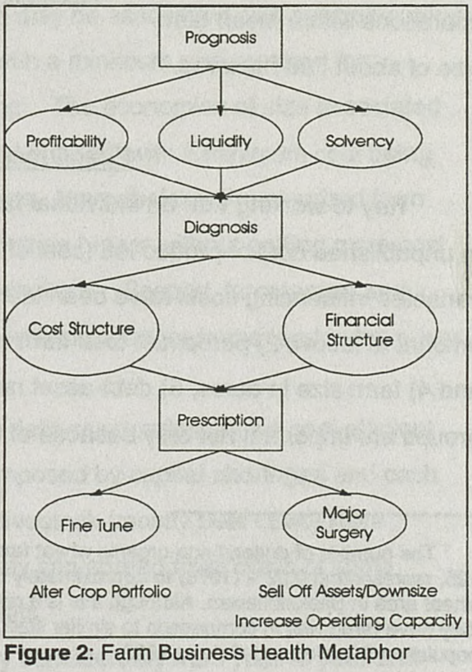

Figure 2: Farm Business Health Metaphor

profitability, liquidity and solvency benchmarks.

The second stage is diagnosis. In general, the prognosis will indicate whether the subsequent diagnosis/prescription should concentrate on "fine tuning" or "major surgery." Farm cost and financial structure are examined using peer performance benchmarks (figure 2) developed from producer participants. Participating producers are mostly full-time, commercial operations with a mean farm size of about 780 hectares.[1]

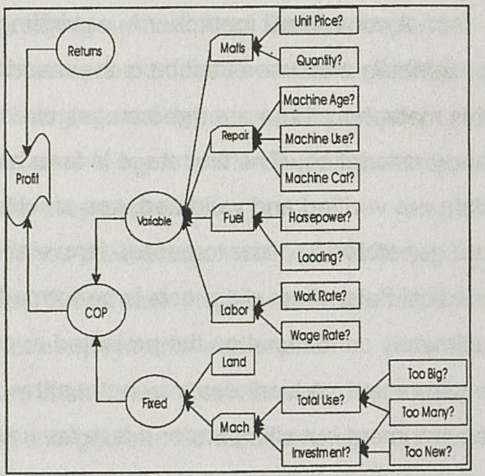

Figure 3: Basic Diagnostic "Walk Back" Procedure

<u>Peer Groups</u>

Key to working with an individual farm is the identifying peer farms. In unpublished cost of production (cost efficiency) research, six key variables influencing costs have been identified: 1) soil zone, 2) the amount of fallow, 2) percent of total farm income derived from livestock and 4) farm size in acres, 5) debt-asset ratio, and 6) the year.[2] Peer groups are important not only because of the notion of comparing "apples

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[1] The number of dryland non-organic wheat farms has varied over time from 76 to 125, representing 0.22% (1976) to approximately 0.4% (1990 and 1991) of the total wheat area in Saskatchewan. Although this is a relatively small proportion of the total, they have fared well in comparison to similar sized farms from the same general population (Koroluk and Culver, 1993).

[2] The estimated regression had an adjusted R^2 of 0.452 and all of the variables listed above except soil zone are statistically significant at the 1% level; soil zone is significant at the 10% level.

with apples" but also because of classification ramifications. For example, soil zone is important because cost structure differs considerably among soil zones due to differences in crops grown and input mix. In addition, the brown soils of Saskatchewan have a slight cost disadvantage in wheat production that is offset by higher prices associated with higher wheat quality. While fallow used is associated with soil zone, it has considerable influence on cost efficiency within a soil zone. Producers with high amounts of sumerfallow tend to also be high cost producers due to higher fixed costs per unit.

Farm size is important for a number of reasons. First, as farms increase in size, they are much more likely to include a much wider variety of crops in their crop portfolio, which tends to improve the risk-return of the overall crop portfolio as well as allowing for better machine and operator time utilization and possibly serving as a disease break. In addition, strong economies of size may be associated with specialty crops due to the lumpiness associated with a minimum size required for producing, processing or marketing. The economies of size associated with cereal producers tend to be "U shaped" with a minimum cost being achieved around 4,500 tillable acres. Nevertheless, the standard farm management truism still applies, getting bigger without getting more cost efficient (or better) is not necessarily wise. Second, farm tenure and financial structure tend to change with size--larger farms tend to have less owned land and more debt.

In addition, farms with high debt-asset ratios are be cost efficient probably because of constraints imposed by capital shortages and cash flows. Likewise, grain farms with livestock (mostly beef cows) have somewhat lower costs because they can spread fixed costs of some machines over more productive units.

Finally, because yields vary considerably from year to year and because there has been considerable adjustment to the new economic environment, the year itself must be taken into consideration.

Costs Associated with Low and High Cost Producers

Another important procedure in cost diagnosis is to identify which costs categories tend make producers low/high cost producers within their class. In an unpublished study, producers were classified low/high groups based on their individual class. Approximately 89% of the low cost observations were correctly classified but only 53% of the high cost producers could be correctly classified. Significant variables explaining class membership were herbicide, seed, repairs, depreciation and overhead fixed costs.[3] The management interpretation of this is relatively straightforward-- there are many different ways (ie. many different costs can be mismanaged) of being a high cost producer and hence, it is difficult to predict a high cost producer because a spike in any cost component can lead to high cost. In sharp contrast, all costs must be correctly managed to achieve low cost status and they are easier to identify.

The third stage is the prescriptive stage where new business alternatives (trials) are identified and evaluated.

Project Evaluation and Risk Assessment

The identification and evaluation of new business alternatives is a crucial stage, particularly when major "surgery" or major changes to the farm business are planned. Each alternative is treated as a separate "challenger" with its own separate data base. The base scenario is labelled the "defender" and is the benchmark of comparison for all challengers. Challengers are assessed in terms of their impact on the benchmark expected growth in net worth, expected annual cash flows and

[3] Note that these variables acccount for most of the total cost and most of the cost categories.

risk. In assessing whole farm risk, CDF's are generated for three measures of financial performance: a) annual farm cash flows b) annual total cash flows including farm and non-farm income and income tax and family living withdrawal outflows, and c) ending net worth (or change in net worth). The CDF's of the first two performance indicators allow the examination of short run risk. They indicate the ability of the farm business to survive catastrophic as well as less averse price and yield events. These performance indicators are reported for each year of the planning horizon because it is important to assess cash flows each year as the ability to survive adverse events can improve/ deteriorate with financial progress/backsliding. The third indicator when adjusted for beginning net worth, allows the examination of long-run profitability and investment risk.

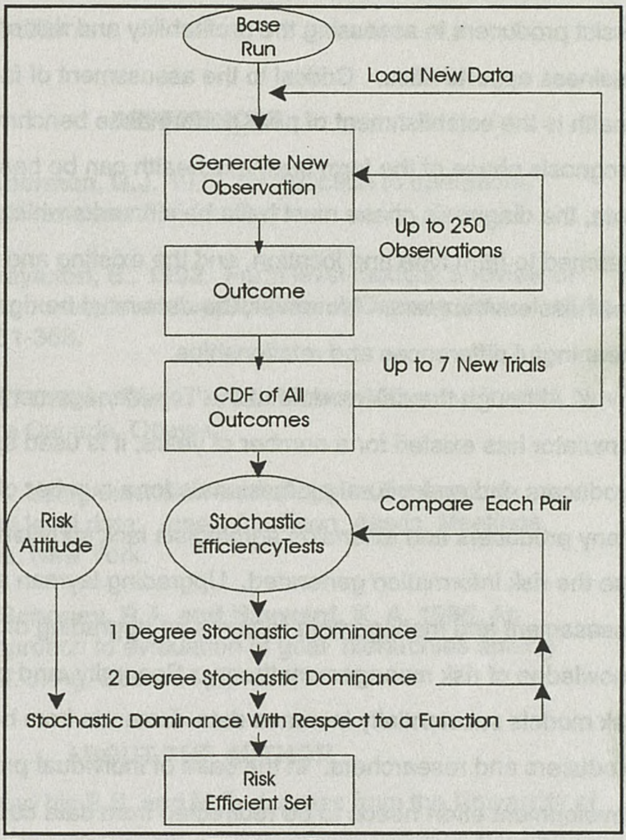

Figure 4: Stochastic Efficiency Tests

CONCLUSIONS

As farms become increasingly larger and more capital intensive, long-run forward planning and risk assessment become increasingly important. The Top Management Farm Business Simulator is designed to assist producers in assessing the profitability and risk of alternative farm business opportunities. Critical to the assessment of farm business health is the establishment of peer performance benchmarks. While the prognosis phase of the farm business health can be based on individual data, the diagnosis phase must have benchmarks which are closely matched to farm type and location, and the existing and projected business environment. Moreover, the data must be rigorously tested for meaningful differences and relationships.

Although the risk module of the Top Management Farm Business Simulator has existed for a number of years, it is used sparingly with producers and agricultural professionals for a number of reasons. First, many producers and extension agrologists lack sufficient knowledge to use the risk information generated. Upgrading layman skills in risk assessment and management requires an upgrading of basic user knowledge of risk management theory. Secondly, and more importantly, risk models substantially increase data demands from both individual producers and researchers. In the case of individual producers, software development effort needs to be redirected from data collection for income tax purposes to improved data collection of resource inventories, production activities and outcomes. However, it is likely that upgrading farm level data may be an easier task than that of increasing the research knowledge base.

In conclusion, advances in risk management theory, computer software and hardware have dramatically increased our ability to solve real world problems. While programming in a compiled language was necessitated by the relatively slow computers of the early and mid 1980's, now most of the TMFBS model components, including the risk model, can be solved with existing spreadsheet software. However, there remains one major constraint to improved risk management and assessment: improved information as to the performance of agricultural systems under less than optimal conditions.

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