Managing the Modern Farm Business

IDENTIFYING RISK SOURCES

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and
Don Bushe

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PREFACE

Why should managers be interested in this series of risk management modules? These self-directed learning modules demonstrate the basic tools used in the business world today; they are the language and practice of modern business.

My biases on the importance of having a strong understanding of management concepts come from over a decade spent as a researcher and instructor at the University of Alberta blended more recently by several years as manager of a commodity production business. I have worked with many excellent business managers and if there is a central theme it is this; they distinguish themselves by their knowledge and ability to apply the principles of economics and risk management. These modules outline the basic principles and give practical insights, through illustrations and exercises, on how the material can be applied in practical situations.

The following modules lay out the basic process of developing and implementing a risk management program. Although the discussion in the modules is restricted to a highly simplified case, the tools can be applied to any business enterprise. Even if a manager does not use the actual detailed methods in every situation, e.g. calculating that the probability of default will drop by five or ten percentage points, there is power in understanding the sources and relative magnitudes of risk associated with various events. It is impossible to build sound strategies without a solid foundation.

I have thoroughly reviewed these materials; I use the principles in my day to day operations. I strongly encourage managers and those who work with and advise managers, in any capacity, to make use of Dr. Len Bauer's work to ensure a clear grasp of the important concepts and tools. The instructional design provided by Don Bushe makes it easy for busy managers to assimilate the ideas efficiently.

In these modules you gain a lot of understanding about important management ideas by working with a simple set of examples; today's managers had better be able to master these methods. Remember, if you fail to apply sound management principles you are inviting the market place to solve your management problems for you.

Frank Novak, Managing Director
Alberta Pig Company

FOREWORD

Farm business management is the art and science of making decisions about the use of available resources and acting on those decisions in an uncertain world so that the short- and long-term goals of the business owners are as fully satisfied as possible.

This definition is not new, but rather a distillation of the thoughts and philosophies of many writers on the topic. The definition contains several key words. Management is concerned with achieving goals. Decision-making and action are crucial. Resources are limited and the world is uncertain.

As the general manager of your business, you need to plan, organize, control, co-ordinate, and motivate your management team. You must see to it that the details of production, marketing, financing, and personnel management are carried out.

As production manager, you must decide what to produce, how to produce it, and how much of it to produce, and you must set the production process in motion. As marketing manager, you must form expectations of product prices, and you need to carry out the functions of buying inputs and selling the products. As financial manager, you need to decide which assets to acquire, how to raise the funds to acquire them, and also when to exercise financial control. As personnel manager, you need to find and keep the right staff and then make sure they are properly trained to do the job.

'Managing the Modem Farm Business' is a series of modules designed to help in developing the necessary concepts and skills essential to effectively manage the production, marketing, financing, and human resource aspects of the farm business. If you are the owner-manager of a farm, these modules will improve your chances of operating a successful business. If you are a farm management advisor, or an instructor, these modules are useful in reviewing and enhancing your understanding of management principles. They also provide an excellent resource of study materials, examples, and exercises for your students and clients.

Management is a process of gathering information, making decisions, and taking action. This module will help you take part in this process.

Leonard Bauer, PAg
Technical Editor

ACKNOWLEDGEMENTS

The authors acknowledge the contributions of many groups and individuals. The ideas portrayed in these modules were first developed as a tool for teaching introductory farm management. One individual in particular stands out for recognition; Alf Petersen has offered substance and encouragement to the preparation for many of the modules in the 'Managing the Modern Farm Business' series. Many students at the University of Alberta have provided a worthwhile testing ground for the subject matter and its presentation. Their candid contributions have been invaluable.

Staff members of the British Columbia Ministry of Agriculture, Fisheries, and Food have participated at risk management workshops and have provided useful suggestions for improvement. Their contributions and those of Howard Joynt and Mike Cowley of the British Columbia Ministry have provided practical insights invaluable to this set of modules. The insights of these individuals were incorporated into the first edition in 1993. We acknowledge funding of the first edition by the Province of British Columbia, Ministry of Agriculture, Fisheries and Food in cooperation with Agriculture Canada and the University of Alberta. Furthermore we acknowledge the contributions of Lois Hameister as copy editor, Melanie Eastley as graphic designer and Lu Ziola for electronic page composition.

The second edition, published in 1994, benefited from staff in Alberta Agriculture, most notably Ted Ford, Paul Gervais and Garry Bradshaw. We are grateful for their input and the input of others at an Alberta Agriculture Risk Management Workshop. The second edition was made possible through special funding provided by the Canada – Alberta Farm Business Management Initiative. This important contribution is hereby acknowledged. We acknowledge too the role Lois Hameister played as copy editor.

Alberta Agriculture, Food and Rural Development provided special funding for the considerable revisions undertaken in the third edition. We gratefully acknowledge this valuable contribution as well as the editorial and substantive contributions of Ted Darling and Dale Kaliel of that organization.

Whilst care has been taken to ensure accuracy of the material the authors freely accept responsibility for any errors remaining.

Table of Contents

INTRODUCTION

The Risk Management Modules

Discussing farm risk usually involves reference to poor yields, disastrous events, calamitous markets, and missed opportunities. There is no doubt that bad things happen on the farm. Good things can happen as well: high yields, bountiful markets, and avoided disasters are some examples. But even these good things can have a bad side for the operator who did not anticipate or plan for them and then was unable to realize on the opportunity.

A high price for barley coinciding with a bumper crop is a good thing for the grain farmer who planted barley. It would be a bad thing for the farmer who decided against planting barley. Similarly, a farmer who sprayed for insects would be protected in the case of an infestation; in a year of few insects, he will have spent money unnecessarily. Risk, then, has two major components: the probability of bad things happening, and the consequences of bad things that have happened.

Farm managers need to understand their attitude toward risk. They must develop methods to identify, measure, and control risk to reduce the losses that are a consequence of bad things happening. Effective management can help to improve the chances that good things happen, losses are avoided, and opportunities captured. These are the themes that are developed in each of the modules.

The first module, *Identifying Risk Attitudes*, examines the predisposition to risk of the manager. One must be able to recognize and allow for one's own risk attitude in selecting the "right" course of action. *Identifying Risk Sources* explores the compounding effect that financial risk has on business risk. *Measuring Degrees of Risk* presents methods that the manager can use to calculate risk exposure and make effective comparisons of alternate actions. *Designing Risk Management Strategies* outlines the ways that effective farm managers can reduce overall risk exposure.

Identifying Risk Sources

There are many sources of risk for farm managers to consider. There are sources that can be planned for but not controlled like the weather. Others can be more directly controlled such as production techniques or methods. There are categories like obsolescence that can be anticipated. Changes in government policies, programs, or regulations require a response. The key factors in business risk on the farm scene, however, are the production and marketing processes. In other words business risk involves yields and prices.

Yields can be expressed as pounds of pork gained, litres of milk produced, tonnes of silage per hectare, or some other measure. No matter how they are measured, they can be categorized as favourable or unfavourable, good or poor. Managers must allow for the eventualities of the unfavourable whilst being in position to take advantage of the favourable. That is the purpose of risk management.

Similarly the price obtained for the product can vary from one year to the next. Markets fluctuate according to the forces of supply and demand. Farm managers must allow and plan for poor prices. And at the same time, they must be strategically placed to take advantage of good prices. This is a major component of risk facing the business.

In this module you will learn how to:

- use financial reports (income statement and balance sheet) and production records to help identify sources of business risk
- measure the probability of adverse events
- calculate the consequence of business risk
- calculate the consequence of financial risk

To facilitate learning about business and financial risk we will use K&L Farms as an example of. By examining this case, you will see how to identify, calculate, and interpret your own risk situation.

It is by analyzing the underlying causes and impact of risk that strategies to cope with risk can be developed.

TWO CATEGORIES OF RISK

Two major categories of risk confront farm managers. They are business risk and financial risk. Managers make projections of income and then, when the year is tallied up discover that their projections were off. Earnings were less than what was expected because yields were down and so were prices. This disparity between what is expected and what is actually realized is due to risk.

Business Risk

Business risk refers to the variability of profit from one year to the next. Of course, a well-managed business will hit the target more closely and more often than a poorly managed one. Nevertheless, actual performance will usually deviate from that which is expected. This module will treat these conditions under the general heading of 'business risk'. Regardless of where the business is operating or its line of production, prices and production levels will vary from expectations. Business risk is always present.

Financial Risk

Business risk, however, is compounded by financial risk. In this case, if an adverse event, such as a poor yield is combined with a poor price, the heavily levered farm business is more highly exposed to financial risk and in a much more difficult position than one who has managed that risk more effectively.

To illustrate the point, consider the situation confronting two businesses. One is owned free and clear. The other operates with the aid of borrowed money. Otherwise they are in the same line of production, are of the same size and have equally competent managers. They also have the same variability in earnings. The variability in earnings, however, will have a magnified effect on the indebted operation. Lowered earnings means lowered returns to the owner of the business without debt. The indebted business suffers even lower returns in the same business condition because of the payment obligation on the debt. The variability in earnings arises due to business risk. The business risk becomes magnified into financial risk as the business operates with an increased debt load.

Asset Financing Alternatives

To set the stage for understanding the distinction between business risk and financial risk we must first look at financing alternatives. Business assets can be financed in one of two ways; either through equity investment or through borrowing. Public companies might issue common shares or they may float bonds. Common shares are a form of equity financing. Shareholders (share owners) are owners of the business and directly share in the success (or failure) of the operation. Bonds, however, are paid back at a future date regardless of the operating success of the business baring of course bankruptcy or default. Bondholders (bond owners) have made a loan to the operation. Bonds are a form of debt financing.

Farms are generally not of the size to attract equity capital from outside investors; consequently the owners provide the equity with additional capital requirements made up through borrowing. Equity in the farm accumulates when profits are retained in the

business as retained earnings or when contributions from outside employment or other sources are put into the operation.

Regardless of whether it is a farm business or a large public company, debt and equity holders anticipate a return on their investment. Otherwise they would not commit their funds into the business. Debt holders expect to be paid interest. Equity holders expect to gain a profit. For the modern farm manager business risk is the result of fluctuations in yields, prices and costs. Good crops, low weight gains, poor prices, good sales, good weather, disease outbreaks, energy cost spikes and pest infestations are some of the things that can happen, good and bad.

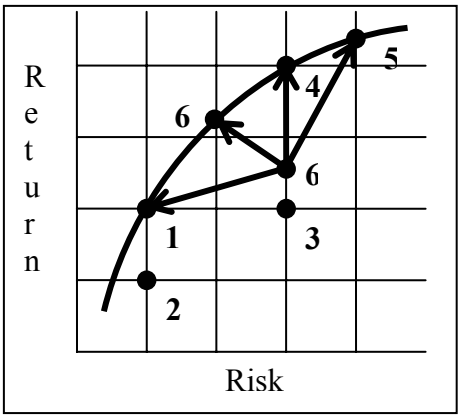
A FARM BUSINESS CASE STUDY

Kim and Lee are the owners, managers and operators of K&L Farms a cereal grain production operation. The return on their investment depends upon crop yield and price as well as on production costs. Fluctuations in prices and yields cause their profit to vary from year to year to a substantial degree. Unforeseen machinery breakdowns at critical times or the loss of a vital employee add a further dimension to their consideration of business risk as it is for all farmers. Although this is a specific case, the same analysis, calculations and comparisons apply to any enterprise.

The Farm Business Described

K&L Farms began as K. J. Weeds Farm seven years ago with an investment of $100,000 in equipment and buildings. Kim got his start seven years ago when his Uncle Max willed him $100,000 on his death. Equity has grown to $225,000 through reinvestment of annual profits. Now, after several years of high prices and good yields, and a marriage, the operation has expanded to its present size. Kim and Lee continue in their respective professions. Kim is an accountant for a local manufacturing company. Lee is a high school mathematics teacher. Kim is able to take time off from his job during the seeding and harvest seasons. Lee has time available during the summer months. Management is a year round activity that they share.

Kim and Lee own 1280 acres, of which approximately 1143 acres (1142.8571 acres to be precise) are cultivable and in crop. They purchased 960 acres two years ago and purchased additional new machinery while expanding on-farm storage facilities. Their total investment is now $725,000 made up of $225,000 in equity and $500,000 debt.



Kim and Lee are concerned about the level of debt they are carrying. They are anxious to get their operation onto the risk-efficiency line that they learned about in the module "*Identifying Risk Attitudes*". In that lesson, they learned that the Risk Efficiency Line (shown by the curved line in the chart) represents the most desirable balance of return on investment for different levels of risk. They are anxious to know where their business lies relative to the efficiency line so they can explore alternatives to move them closer to the line

according to the level of risk they are comfortable with. In order to understand the level of risk they are exposed to and the return on their investment in K&L Farms, they need first to determine their business risk. To analyze business risk, they must examine the variation in prices and yields.

The risk and return that they experience as owners of K&L Farms can be determined by analyzing the financial statements. The Profit and Loss or Income Statement, and the Balance Sheet or Statement of Assets, Liabilities and Equity are especially useful to them in completing the analysis.

Income Statement for K&L Farms for the Year Ending December 31, 2xx7		
Income:		
Crop Revenue	200,000	
Gross Income		**$200,000**
Expenses:		
Crop Expenses	30,835	
Fuel and Repairs	20,000	
Term Interest	50,000	
Depreciation	34,000	
Total Expenses		**$134,835**
Net Income		**$65,165**

The income statement is for the year just ended. The balance sheet is an accounting of the business as it stood at the start of the year just ended.

Statement of Assets, Liabilities and Equity for K&L Farms as at December 31, 2xx6		
Assets:		
Cash	5,000	
Accounts Receivable	20,000	
Term Deposits	15,000	
Supply Inventory	10,000	
Product Inventory	50,000	
Total Current Assets		100,000
Land	400,000	
Buildings	50,000	
Machinery	175,000	
Total Fixed Assets		625,000
Total Assets		**$725,000**
Liabilities:		
Operating Loans		0
Total Current Liabilities		0
Term Loans	500,000	
Total Term Liabilities		500,000
Total Liabilities		**$500,000**
Equity:		
Total Equity		**$225,000**
Total Liabilities and Equity		**$725,000**

Return to the Asset Holder

Kim was quick to point out that the business entity called K&L Farms was actually the holder, or owner, of the business assets. The assets amount to $725,000 as shown on the balance sheet. The lender had a debt claim of $500,000 while Kim and Lee have a residual equity claim of $225,000.

In an unincorporated farming business, as is K&L Farms, net income is a reward to the business owners for the labour and management they provide as well as the equity capital they have invested in the operation. But what about their labour and management, what are they worth? Both Kim and Lee have off farm jobs, but they are able to take time off from those jobs at critical times of the year such as summer, seeding, and harvest time. Thus, they are part time workers but full time managers of K&L Farms. They value their time operating and managing the farm at $24,000 per year. Accordingly, they have withdrawn $2,000 per month as remuneration. In an incorporated business the operators would likely have paid themselves a salary rather than taken a withdrawal as is normal practice for a proprietorship.

So back to the question, how much did the assets earn? The question must be answered from the perspective of the business; we'll ask the same question from the perspectives of the debt holders and the equity holders in due course. In other words, return to the "owners" of the business is not the issue for the moment; it will be dealt with later.

Return to Assets Calculation		
	Crop Revenue	200,000
Equals	Gross Income	200,000

The only source of revenue earned by K&L Farm was from crops as shown on the income statement. In 2xx7, Crop Revenue was $200,000. This was the only income earned, so it is also the amount of the Gross Income.

The Net Income is the residual remaining after Expenses are subtracted from Gross Income on the Income Statement.

Return to Assets Calculation		
	Crop Revenue	200,000
Equals	Gross Income	200,000
Less	Expenses	134,835
Equals	Net Income	$65,165

Lee was able to subtract $134,835 from $200,000 in her head. "The Net Income is $65,165."

"Right," Kim said, pointing to the same figure on the Income Statement.

The first step in the analysis is to deduct the value of their labour from net income and then add back the interest they paid on their term debt. Kim explained that they are interested in the earnings of all the assets in the business, regardless of how they are financed.

Return to Assets Calculation		
	Crop Revenue	200,000
Equals	Gross Income	200,000
Less	Expenses	134,835
Equals	Net Income	65,165
Less	Personal Withdrawals	24,000
Plus	Term Debt Interest	50,000
Equals	Return to Assets	$91,165

During the year, they had taken $2,000 per month in withdrawals. At the same time, they had paid a total of $50,000 in interest on their Term Loan. As Kim wrote the numbers on the form, he entered them into his calculator.

"What does this $91,165 mean?" Lee asked.

"You are fast," Kim exclaimed as he checked his calculator. "The return to assets of $91,165 is what the assets earned," he explained.

In effect they deducted a net of $108,835, (134,835 expenses – 24000 labour allowance + 50,000 term interest payment), from gross income of $200,000 to arrive at the return to assets figure.

Per Cent Return on Assets

"Calculating the per cent return is quite a simple matter now," Lee suggested. "Let's just divide the earnings by the total value of assets."

"That's correct," said Kim as he entered 91,165 / 725,000 in his calculator. "On assets of $725,000 this is 12.57 %," he said.

"Looks about right," Lee said. She did not calculate the percentage in her head; instead she stated, "I'd like to analyze the return we got as equity holders."

"Before we do that let's look at the earnings of the lender," Kim suggested.

Return to Assets Calculation		
	Crop Revenue	200,000
Equals	Gross Income	200,000
Less	Expenses	134,835
Equals	Net Income	65,165
Less	Personal Withdrawals	24,000
Plus	Term Debt Interest	50,000
Equals	Return to Assets	$91,165
Equals	Per Cent Return to Assets	12.57 %

Return to the Debt Holders

Kim went on to explain, "When we borrowed the money for buying the 960 acres and extra machinery, we signed papers that promised to pay the credit agency 10.0 % annually on the outstanding balance. The lender expects this plus a payment on principal each and every year. A poor year on our part is not his concern."

"Well, we had a balance of $500,000 outstanding at the start of the year, so that's why we paid $50,000 in interest," Lee said.

Per Cent Return on Debt

The per cent return on debt is the rate of interest paid to the lender. This is the lender's return. Since the outstanding balance was $500,000 and $50,000 interest was paid, this amounts to 10.00 %. The per cent return on debt was therefore 10.00 %

Return to Equity Holders

Kim went on to explain, "Since the lender was paid $50,000 interest on the $500,000 debt owing as term liabilities it means we earned $41,165 as a return on our equity. The return to debt holders is fixed by contract while return to equity is a residual."

"In effect we get what is left over after the lender has been paid?" Lee queried.

"Right," Kim agreed. "Remember we signed the mortgage contract to pay 10.00 % per year on the outstanding balance, no matter what."

Lee wondered, "But what if things got real bad?"

"I suppose we could renegotiate," Kim replied, "but that would be a bit of a bother and could result in additional costs." Kim sighed, "You know, Lee, we're quite heavily leveraged!"

"What do you mean by 'leveraged'?" Lee inquired.

Leverage

"Leverage works like this," Kim stated. "When we combine debt capital with equity capital we are using the equivalent of a lever. Just like with a lever in the physical sense we can get more economic work done if we use our equity as a 'lever' when we combine it with borrowed funds. We are leveraging our equity money by using borrowed money."

"For this reason we'll calculate the leverage ratio which is also called the debt to equity ratio," Kim said. "We have $500,000 of borrowed funds to our equity of $225,000." "This means our leverage ratio is 2.2222," he entered the figures 500,000 / 225,000 = 2.2222 on his calculator.

"Isn't this kind of risky?" Lee enquired.

"Well," Kim answered "the bigger the leverage ratio, the more exposed we are to financial risk. Business risk becomes levered into financial risk. This will soon become clear; but let's first look at per cent return on equity."

"I hope so," Lee said doubtfully.

Dollar Return to Equity

The portion going to the equity holder is not a contractual amount, but a residual. That is, the equity holder is entitled to the remainder after all other claimants have been paid. The assets of K&L Farms earned $91,165.

Return to Equity Calculation		
	Crop Revenue	200,000
Equals	**Gross Income**	**$200,000**
Less	Expenses	134,835
Equals	**Net Income**	**$65,165**
Less	Personal Withdrawals	24,000
Plus	Term Debt Interest	50,000
Equals	**Return to Assets**	**$91,165**
Less	Term Debt Interest	50,000
Equals	**Return to Equity**	**$41,165**
Equals	**% Return on Equity**	**18.30 %**

"Now," Kim stated, "to find the return to equity, the term debt interest has to be deducted. The earnings of Kim and Lee, after deducting the payment of $50,000 in interest, are $41,165," he said as he wrote the figures onto the table.

"From what you've said Kim," Lee interjected, "our per cent return on equity is 18.30 %. We would simply divide the dollar amount of return by the amount of our equity."

Kim entered the figures 41,185 / 225,000 = 0.1830 on his calculator. "Right, but we could get that number in another way."

The per cent return on equity can be expressed in relation to the return on assets, the cost of debt, and the level of leverage. That is, the return on equity is composed of the return on assets on the 'owned' portion plus the margin of return on assets above the cost of debt on the 'borrowed' portion. There is a mathematical relationship between these different factors:

In the formula:

$$r_E = r_A + L(r_A - r_D)$$

(r_E) represents per cent return on equity,

(r_A) per cent return on assets,

(r_D) per cent return to debt holders or the rate of interest and

(L) the leverage ratio.

Sometimes analysts abbreviate per cent 'Return on Equity' as 'ROE'.

"Let me do this," Lee said. She used the formula and wrote 12.57 + 2.2222 x (12.57 - 10.00) on a piece of paper. "Ok," she said, "18.30%. The return on equity is identical to what was calculated directly. But how does this help?" she asked.

"The formula tells us that per cent return to equity is composed of two parts," Kim said. "The equity portion earned 12.57 % and the debt part, because of the leveraged margin, earned 2.57 %."

Exercise 1 - Return to Equity

Complete the missing calculations in the table. Then refer to the table to place the appropriate response in the statement.

		Return		**Share of ROE**
Source	**Amount x Per Cent =**	Dollar	Per Cent	Per Cent
Equity portion	225,000 x 12.57% =	**[_____]**	12.57%	**[_____]**
Debt portion	500,000 x 2.57% =	12,872	**[_____]**	31.27%
	Total	**[_____]**	**[_____]**	100.00%

Kim and Lee earned [_____] on the equity portion and $12,872 on the leveraged portion for the total of [_____]. The equity portion accounted for 12.57 percentage points whilst the debt portion added another [_____] percentage points for the total of [_____] percentage points. We can also deduce that [_____] of the return to equity was because of the equity portion and 31.27% was because of the borrowed portion, or levered portion.

Return to Equity – Answer

Compare your work to Kim and Lee's. Correct any errors.

		Return		Share of ROE
Source	**Amount x Per Cent =**	Dollar	Per Cent	Per Cent
Equity portion	225,000 x 12.57% =	**[28,293]**	12.57%	**[68.73%]**
Debt portion	500,000 x 2.57% =	12,872	**[5.72%]**	31.27%
	Total	**[$41,165]**	**[18.30%]**	100.00%

Kim and Lee earned [**$28,293]** on the equity portion and $12,872 on the leveraged portion for the total of [**$41,165]**. The equity portion accounted for 12.57 percentage points whilst the debt portion added another [**5.72]** percentage points for the total of [**18.30]** percentage points. We can also deduce that [**68.73%]** of the return to equity was because of the equity portion and 31.27% was because of the borrowed portion, or levered portion.

Give yourself one point for each correct answer. Enter your score in the table.

Exercise	Possible Score	Your Score
Chart	5 points	___ points
Statement	5 points	___ points
Total Score	10 points	___ points

If you have less than 8 of 10 correct (more than 2 incorrect) you may wish to review the information in this section.

COMPONENTS OF BUSINESS RISK

Business Risk has to do with the combination of amount produced and the price that the amount fetches in the marketplace. We will look at yield and price payoff to determine the probability of the yield and the probability of the price. These are the basic elements of business risk.

Yield and Price Payoff

Price Yield Payoff per acre		
Price		
Poor	Normal	Good

"What we need to do," Kim suggested, "is consider what our payoff will be in good and bad times. Let's build a table that will allow us to compare all the combinations of yield and price payoffs," he said as he set up the rows and columns on a sheet of paper. "First we put the poor, good, and normal prices in the table."

Price Yield Payoff per acre		
Price		
Poor	Normal	Good
($2.75)	($3.50)	($4.25)

Experience on K&L Farms suggests that Kim and Lee could receive poor, normal, or good prices for their grain crop. After examining the history of prices they assigned values of $2.75 per bushel for a poor price, $3.50 per bushel for a normal price and $4.25 per bushel for a good price.

"Now," he said, "we'll consider the yields." With their present farm practices, Kim and Lee feel that three yield levels are possible in any given year. Yields may be normal, as they were in the past year, at 50 bushels per acre. They may be poor at 25 bushels per acre. Or, yields may be good at 75 bushels per acre.

Price Yield Payoff per acre			
Yield	Price		
	Poor ($2.75)	Normal ($3.50)	Good ($4.25)
Poor (25 bus/ac)			
Normal (50 bus/ac)			
Good (75 bus/ac)			

"This table is often called a 'payoff matrix'," Lee pointed out to Kim. "It's just simple arithmetic to calculate the values of each from poor/poor to good/good."

They copied the figures into the cells from the calculator.

"Now we need to consider the probability of these things happening," Lee advised.

Price Yield Payoff per acre			
Yield	Price		
	Poor ($2.75)	Normal ($3.50)	Good ($4.25)
Poor (25 bus/ac)	68.75	87.50	106.25
Normal (50 bus/ac)	137.50	175.00	212.50
Good (75 bus/ac)	206.25	262.50	318.75

Probability of Yield

Over the past seven years of farming in this community Kim and Lee observed considerable variation in prices and yields. This experience, supplemented by conversations with the old timers in the community, has allowed them to develop a subjective feel for crop yields in the district and for K&L Farms.

Experience suggests that a normal yield is twice as likely as either a poor yield or good one. Furthermore, they estimate that the chances of either a good or poor yield are about equal. Kim drew more columns and labeled the headings.

"Ok," Lee said, "this is my area. To determine the probability of yields, we can assign a weight to each event. This will allow us to compare the probability of a poor, normal or good yield."

Event	Yield	Weight	Calculation	Probability
Poor	25 bus/acre	100	100 / 400	0.25
Normal	50 bus/acre	200	200 / 400	0.50
Good	75 bus/acre	100	100 / 400	0.25
Total		400		1.00

"I see," Kim replied, "let's give a poor yield a weight of 100. Then normal yields, which are twice as likely, have a value of 200. Because good yields are equally as likely as poor yields they also have a weight of 100."

"Good," Lee commented. "The weights associated with each of these events, poor, normal and good yields, add to 400. Now we can calculate the probabilities." They entered the results of their calculations into the table.

Exercise 2 - Calculate Probabilities

"Would it make any difference if the weight that we assigned to the events were different?" Kim asked. Lee gave a normal yield a weight of 100. Since a poor yield is half as likely as a normal yield so it receives a weight of 50. A good yield, which is just as likely as a poor one, also has a weight of 50.

Enter the information and complete the probability calculations in the table. Then refer to the table to complete the statement.

Event	Yield	Weight	Calculation	Probability
Poor	25 bus/acre	50	**[_____]**	**[_____]**
Normal	50 bus/acre	100	**[_____]**	**[_____]**
Good	75 bus/acre	50	**[_____]**	**[_____]**
Total		200		**[_____]**

The probabilities were **[less than/identical to/greater than]** those found for the previous situation. The weight for poor yields is now 50 but the probability of a poor yield **[goes up to/remains the same at/falls to] [25.0 %].** Similarly the probability of a normal yield **[goes up to/remains the same at/falls to]** 50.0 %, and for a good yield **[goes up to/remains the same at/falls to] [**25.0 %].

Calculate Probabilities – Answer

Compare your answers to Lee's calculations. Correct any errors. If you have more than two errors, you may wish to review the material in this section.

Event	Yield	Weight	Calculation	Probability
Poor	25 bus/acre	50	**[50 / 200]**	**[0.25]**
Normal	50 bus/acre	100	**100 / 200]**	**[0.50]**
Good	75 bus/acre	50	**50 / 200]**	**[0.25]**
Total		200		**[1.00]**

The probabilities were **[~~less than~~/identical to/~~greater than~~]** those found for the previous situation. The weight for poor yields is now 50 but the probability of a poor yield **[~~goes up to~~/remains the same at/~~falls to~~] [25.0 %]** (50 / 200= 0.25 or 25.0 %). Similarly the probability of a normal yield **[~~goes up to~~/remains the same at/~~falls to~~] [50.0 %]**, (100 / 200 = 0.50 or 50.0 %) and for a good yield **[~~goes up to~~/remains the same at/~~falls to~~]** [25.0 %]. (50 / 200 = 0.25 or 25.0 %).

"Ok, I can see how this works for yields," Kim stated, "but what about prices?"

"Let's take a look," was Lee's answer.

Probability of Price

"We can approach the probability of good, normal and poor prices the same way," Lee stated. "Let's assign a weight of 100 for a normal price. Then because both a poor and a good price are half as likely as normal, they can each get a weight of 50." Kim made more columns and rows and entered the new figures in the cells.

They calculated the price probabilities just as they did for yields. They found the probability of a poor price is 0.25 or 25.0 %. For a normal price they estimate it to be 0.50 or 50.0 % and for a good price 0.25 or 25.0 %.

Event	Yield Price	Weight	Calculation	Probability
Poor	$2.75 / bu	50	50 / 200	0.25
Normal	$3.50 / bu	100	100 / 200	0.50
Good	$4.25 / bu	50	50 / 200	0.25
Total		200		1.00

"Looks good," Kim commented. "But what's the probability that a poor price and a poor yield will occur at the same time?"

The Joint Probability of Price and Yield

"We know from the rules of probability," Lee answered, "that if a poor yield has a probability of 25% and a poor price also 25%, then the probability of both a poor yield and poor price happening at the same time is 6.25%."

"OK," Kim stated, "I can see that you just multiplied them." (That is 0.25x0.25=0.0625 or 6.25%).

				Price		
				Poor	**Normal**	**Good**
Yield	**Poor**					
	Normal					
	Good					

Lee went on. "Two or more events occurring at the same time are called joint events. The probability of two or more events occurring at the same time is called a joint probability."

"We could build a chart and calculate the joint probabilities then," Kim enthused. He proceeded to draw out rows and columns. "First we'll list the price information, and then we'll put the possible yields alongside."

"The events are the same for both prices and yields – poor, normal and good," Lee stated as Kim wrote them in. "The price for the poor price event is $2.75," Lee quoted, "and then $3.50 and $4.25."

				Price		
				Poor	**Normal**	**Good**
				$2.75/bu	$3.50/bu	$4.25/bu
				25%	50%	25%
Yield	**Poor**	25 bu/acre	25%	6.25%		
	Normal	50 bu/acre	50%			
	Good	75 bu/acre	25%			

Kim added them to the table stating, "And poor, normal and good yields are 25, 50 and 75 bu/acre respectively."

"And the per cent probability are each 25, 50 and 25% respectively too," Lee pointed out. "Right," Kim agreed. "You had calculated the joint probability for the poor yield and poor price joint event at 6.25%."

Exercise 3 - Joint Probabilities of Occurrence

There are a total of nine possible combinations of crop, price, and yield. Complete the missing combinations.

				Price		
				Poor	**Normal**	**Good**
				$2.75/bu	$3.50/bu	$4.25/bu
				25%	50%	25%
Yield	**Poor**	25 bu/acre	25%	6.25%	12.50%	6.25%
	Normal	50 bu/acre	50%	12.50%	**[_____]**	12.50%
	Good	75 bu/acre	25%	**[_____]**	12.50%	**[_____]**

Joint Probabilities of Occurrence – Answer

Compare your work with Lee's. Correct any errors. If you have made a mistake, you may wish to review this section.

				Price		
				Poor	**Normal**	**Good**
				$2.75/bu	$3.50/bu	$4.25/bu
				25%	50%	25%
Yield	**Poor**	25 bu/acre	25%	6.25%	12.50%	6.25%
	Normal	50 bu/acre	50%	12.50%	**[25.00%]**	12.50%
	Good	75 bu/acre	25%	**[6.25%]**	12.50%	**[6.25%]**

Cumulative Probability

"We now have two tables containing information about crop production on our farm," Kim observed. "Isn't there some way we could combine the payoff matrix and the joint probability table? I have trouble keeping all this information clear in my mind."

"There certainly is," Lee responded. "Let's construct a cumulative probability table."

"Go for it, Lee," Kim said. "You draw up the columns and rows for this one."

"OK, first let's arrange the payoffs for each joint event as a column," Lee carried on.

"Wouldn't it make it easier if we arranged the payoffs from low to high as well," Kim suggested. Lee wrote the entries in the columns.

"Tell me the values from the other tables," Lee asked and then listed them in the table as Kim read them off.

Probability Payoff Table			
Joint Events		**Gross per Acre**	**Probability**
Yield	**Price**		
Poor	Poor	68.75	6.25%
Poor	Normal	87.50	12.50%
Poor	Good	106.25	6.25%
Normal	Poor	137.50	12.50%
Normal	Normal	175.00	25.00%
Good	Poor	206.25	6.25%
Normal	Good	212.50	12.50%
Good	Normal	262.50	12.50%
Good	Good	318.75	6.25%

"Ok, now we've combined the payoff table and the joint probability table onto one table," said Kim. "But what's 'cumulative' about it?"

"That's still to come," said Lee. "Cumulative, in this sense, means that we 'accumulate' the probabilities. We can determine what the probability is of achieving specific levels of gross income per acre. We just add another column to the table."

"The accumulation is carried out in a straight forward way," Lee explained. "The probability of getting a gross of $68.75 is 6.25 %," she pointed to the first line in the table "and the probability of getting $87.50 is 12.50 %. When we add the probability of getting $87.50 to the probability of getting $68.75 we have a probability of 18.75 % of getting either $68.75 or $87.50."

"I think I see," said Kim. "By adding 6.25 and 12.50 we get 18.75. So we can conclude that the probability of getting $87.50 or less is 18.75 %."

"You've got it," exclaimed Lee. "That's why it's called cumulative probability because it accumulates." They went ahead to complete the column.

Exercise 4 - Cumulative Probability

Complete the entries in the table and refer to the information to complete the statement.

Probability Payoff Table				
Joint Events		**Gross per Acre**	**Probability**	**Cumulative Probability**
Yield	**Price**			
Poor	Poor	68.75	6.25%	6.25%
Poor	Normal	87.50	12.50%	18.75%
Poor	Good	106.25	6.25%	**[_____]**
Normal	Poor	137.50	12.50%	**[_____]**
Normal	Normal	175.00	25.00%	**[_____]**
Good	Poor	206.25	6.25%	**[_____]**
Normal	Good	212.50	12.50%	**[_____]**
Good	Normal	262.50	12.50%	**[_____]**
Good	Good	318.75	6.25%	**[_____]**

The probability of K&L Farms having gross revenues per acre of $106.25 or less is **[_____]** per cent. Or, looking at it the other way, the probability of having [**less/more**] than $106.25 is 75.00 per cent. The probability of normal/normal events or revenues of $175.00 or less per acre is **[_____]** per cent.

Cumulative Probability – Answer

Compare your work to Kim and Lee's. Correct any errors. If you have less than 8 correct (more than 2 wrong) you may wish to review this section.

Probability Payoff Table				
Joint Events		**Gross per Acre**	**Probability**	**Cumulative Probability**
Yield	**Price**			
Poor	Poor	68.75	6.25%	6.25%
Poor	Normal	87.50	12.50%	18.75%
Poor	Good	106.25	6.25%	**[25.00%]**
Normal	Poor	137.50	12.50%	**[37.50%]**
Normal	Normal	175.00	25.00%	**[62.50%]**
Good	Poor	206.25	6.25%	**[68.75%]**
Normal	Good	212.50	12.50%	**[81.25%]**
Good	Normal	262.50	12.50%	**[93.75%]**
Good	Good	318.75	6.25%	**[100.00%]**

The probability of K&L Farms having gross revenues per acre of $106.25 or less is [25.00] per cent. Or, looking at it the other way, the probability of having [~~less~~/more] than $106.25 is 75.00 per cent. The probability of normal/normal events or revenues of $175.00 or less per acre is [62.5] per cent.

BUSINESS RISK

Now that Kim and Lee have established the probability of events occurring they turn their efforts to exploring the impact of these events and their probabilities on their business. Specifically they want to know the extent of their business risk. An important consideration in estimating business risk involves the return to assets for each of the nine joint events. They began with the gross revenue and then made the needed adjustments to arrive at the return to assets figures for each combination of prices and yield.

Gross Revenue

K&L Farms has approximately 1,143 acres, (1142.8571 acres to be precise), under cultivation and in crop. Kim noted that a joint event of a normal yield (50 bushels per acre) and a good price ($4.25 per bushel) provides gross revenue of $212.50 and a total of $242,857 (1142.8571 acres x 212.50 = $242,857). He added a column to the table. They proceeded to complete the calculations.

Exercise 5 - Crop Revenue

Complete the calculation of total crop revenue for each of the other possible combinations of yield and price. Kim's first calculation is listed for the normal yield good price joint event. Then complete the missing items in the statement.

Cumulative Probability of Gross Farm Revenue					
Joint Event		**Gross Revenue**		**Probability**	
Yield	**Price**	**Per Acre**	**Total**	**Of Event**	**Cumulative**
Poor	Poor	68.75	[_____]	6.25%	6.25%
Poor	Normal	87.50	[_____]	12.50%	18.75%
Poor	Good	106.25	[_____]	6.25%	25.00%
Normal	Poor	137.50	[_____]	12.50%	37.50%
Normal	Normal	175.00	[_____]	25.00%	62.50%
Good	Poor	206.25	[_____]	6.25%	68.75%
Normal	Good	212.50	242,857	12.50%	81.25%
Good	Normal	262.50	[_____]	12.50%	93.75%
Good	Good	318.75	[_____]	6.25%	100.00%

The probability of having a gross revenue of $100,000 or less is **[**_____**]** per cent. There is **[**_____**]** per cent probability of having **[**_____**]** or less. There is a **[**_____**]** per cent probability of having more than $300,000 gross revenue.

Crop Revenue – Answer

Compare your answers to Lee's and correct any errors.

Cumulative Probability of Gross Farm Revenue					
Joint Event		**Gross Revenue**		**Probability**	
Yield	**Price**	**Per Acre**	**Total**	**Of Event**	**Cumulative**
Poor	Poor	68.75	**[78,571]**	6.25%	6.25%
Poor	Normal	87.50	**[100,000]**	12.50%	18.75%
Poor	Good	106.25	**[121,429]**	6.25%	25.00%
Normal	Poor	137.50	**[157,143]**	12.50%	37.50%
Normal	Normal	175.00	**[200,000]**	25.00%	62.50%
Good	Poor	206.25	**[235,714]**	6.25%	68.75%
Normal	Good	212.50	242,857	12.50%	81.25%
Good	Normal	262.50	**[300,000]**	12.50%	93.75%
Good	Good	318.75	**[364,286]**	6.25%	100.00%

The probability of having gross revenue of $100,000 or less is [**18.75**] per cent. There is a [**62.50**] per cent probability of having [**$200,000**] or less. There is a [**6.25**] per cent probability of having more than $300,000 gross revenue.

Kim and Lee have now calculated the payoff for each of the nine joint events, an important step in measuring business risk.

Return to Assets

To understand business risk and its consequences, Kim and Lee need to know how the assets of the business performed. Analysis of the financial statements for K&L Farms in year 7 shows that they need to deduct $108,335 from gross income to arrive at the return to assets figure.

"Now," Kim stated, "if we were to experience that 'poor yields combined with poor prices' condition …"

"Which has a probability of 6.25%," Lee interjected.

"Right," Kim replied, "with a probability of 6.25%. But we would have the same expenses to cover. So we would have to deduct the same $108,335 in expenses from gross income to get the return to assets."

"Yes," Lee responded, "in a year where the joint event of poor yields and prices we calculated the gross income to be $78,571. From this we deduct $108,835 to arrive at the return to assets figure of a negative $30,264."

"I'll make a new column for the Return to Assets," Kim stated while entering the figures into his calculator. "$78,571 less $108,835 gives –$30,264 right you are Lee." He wrote the number in the table. This is the first entry in the table of return to asset figures.

> To refresh your memory on the process shown on page **6** of this module, Kim explained to Lee the steps of adjusting gross income to arrive at return to asset figures. 134,835 expenses – 24000 labour allowance + 50,000 term interest payment for a net deduction of $108,835 from gross income of $200,000 to arrive at the return to assets.

Exercise 6 - Return to Assets

Complete the table by calculating the remaining return to asset figures (Kim's first calculation is shown). Then refer to the table to complete the statement.

Cumulative Probability of Return to Assets					
Joint Event		**Returns**		**Probability**	
Yield	**Price**	**Gross**	**To Assets**	**Of Event**	**Cumulative**
Poor	Poor	78,571	-30,264	6.25%	6.25%
Poor	Normal	100,000	**[_____]**	12.50%	18.75%
Poor	Good	121,429	**[_____]**	6.25%	25.00%
Normal	Poor	157,143	**[_____]**	12.50%	37.50%
Normal	Normal	200,000	**[_____]**	25.00%	62.50%
Good	Poor	235,714	**[_____]**	6.25%	68.75%
Normal	Good	242,857	**[_____]**	12.50%	81.25%
Good	Normal	300,000	**[_____]**	12.50%	93.75%
Good	Good	364,286	**[_____]**	6.25%	100.00%

In a year of normal yields and prices gross revenue will be $200,000. The return to assets is **$[_____]** under these conditions. There is a **[_____]** per cent probability that this joint event will occur. Correspondingly there is a **[_____]** per cent probability that the return to assets will exceed this amount.

Return to Assets – Answer

Compare your answers to Kim and Lee's work. Correct any errors If you had more than 2 wrong (less than 9 out of 11 correct) you may wish to review this section.

Cumulative Probability of Return to Assets					
Joint Event		**Returns**		**Probability**	
Yield	**Price**	**Gross**	**To Assets**	**Of Event**	**Cumulative**
Poor	Poor	78,571	-30,264	6.25%	6.25%
Poor	Normal	100,000	**[-8,835]**	12.50%	18.75%
Poor	Good	121,429	**[12,594]**	6.25%	25.00%
Normal	Poor	157,143	**[48,308]**	12.50%	37.50%
Normal	Normal	200,000	**[91,165]**	25.00%	62.50%
Good	Poor	235,714	**[126,879]**	6.25%	68.75%
Normal	Good	242,857	**[134,022]**	12.50%	81.25%
Good	Normal	300,000	**[191,165]**	12.50%	93.75%
Good	Good	364,286	**[255,451]**	6.25%	100.00%

In a year of normal yields and prices gross revenue will be $200,000. The return to assets is [$**91,165**] under these conditions. There is a [**25**] per cent probability that this joint event will occur. Correspondingly there is a [**37.50**] per cent probability that the return to assets will exceed this amount.

Per Cent Return on Assets

"Even though there is only a 6.25% probability of that disastrous joint event occurring," Lee stated, "a negative return of $30,264 would have to come from somewhere!"

"Remember that this year's annual report for K&L Farms showed a return to assets of $91,165 and a per cent return on assets of 12.57%," Kim remarked pointing to the figures they had calculated.

"That percentage would be really different if both of those bad events happened at the same time," Lee stated as she did the calculations in her head, "a negative 4.17%."

To refresh your memory, on page **7** of this module, they calculated the per cent return by dividing the amount of the farm's earnings by the total value of the assets 91,165 / 725,000 = 0.1257 or 12.57 %.

"In the joint event of poor prices and poor yields," Kim said stated as his fingers flew over his calculator keys, "-30,264 / 725,000 = -0.0417. That's a negative 4.17 per cent return on assets."

"We can calculate all the other joint events; all the remaining price and yield combinations in the same way," Lee said.

"I'll add a column to the table," Kim stated.

Exercise 7 - Per Cent Return on Assets

Kim and Lee proceeded to calculate the per cent return on assets for each possible combination. Complete the missing calculations. Then refer to the table to complete the statement.

Cumulative Probability of Return to Assets					
Joint Event		Return to Assets		Probability	
Yield	Price	Dollars	Per Cent	Of Event	Cumulative
Poor	Poor	-30,264	-4.17%	6.25%	6.25%
Poor	Normal	-8,835	[_____]	12.50%	18.75%
Poor	Good	12,594	[_____]	6.25%	25.00%
Normal	Poor	48,308	[_____]	12.50%	37.50%
Normal	Normal	91,165	[_____]	25.00%	62.50%
Good	Poor	126,879	[_____]	6.25%	68.75%
Normal	Good	134,022	[_____]	12.50%	81.25%
Good	Normal	191,165	[_____]	12.50%	93.75%
Good	Good	255,451	[_____]	6.25%	100.00%

\

There is a **[_____]** per cent chance that per cent return on assets will be 17.50 per cent or less. There is a **[_____]** per cent chance that the per cent return will be greater than 12.57 per cent. The probability of having a negative per cent return is **[_____]** per cent.

Per Cent Return on Assets - Answer

Joint Event Yield	Price	Return to Assets Dollars	Per Cent	Probability Of Event	Cumulative
Poor	Poor	-30,264	-4.17%	6.25%	6.25%
Poor	Normal	-8,835	**[-1.22%]**	12.50%	18.75%
Poor	Good	12,594	**[1.74%]**	6.25%	25.00%
Normal	Poor	48,308	**[6.66%]**	12.50%	37.50%
Normal	Normal	91,165	**[12.57%]**	25.00%	62.50%
Good	Poor	126,879	**[17.50%]**	6.25%	68.75%
Normal	Good	134,022	**[18.49%]**	12.50%	81.25%
Good	Normal	191,165	**[26.37%]**	12.50%	93.75%
Good	Good	255,451	**[35.23%]**	6.25%	100.00%

Compare your work to Kim and Lee's calculations. Correct any errors. If you had more than 2 errors (less than 9 out of 11 correct) you may wish to review this section.

There is a [**68.75**] per cent chance that per cent return on assets will be 17.50 per cent or less. There is a [**37.50**] per cent chance that the per cent return will be greater than 12.57 per cent. The probability of having a negative per cent return is [**18.75**] per cent.

Notice the rather wide range of per cent return on asset figures. Obviously a loss of 4.17%, which occurs with the worst possible event of poor price and poor yield, is substantial for K&L Farms. On the other hand, a return of 35.23 %, which coincides with the best possible event of good prices and good yields, would be welcome news. This variability, based on the joint events and probability of occurrence highlights the significance of business risk.

Summary of Business Risk

The business risk being faced by K&L Farms has now been described. As Kim and Lee discovered inadequate returns or out right losses can result from low prices and yields. The chance of losses or low returns depends directly upon the chances of experiencing poor prices and yields. On the other hand, good prices and good yields give good returns. The task of the manager is to identify the sources of risk and to capitalize on the opportunity presented.

We have pretended, for convenience, that there was no variability in the costs. Of course, costs are, like prices and yields are not totally predictable. True, the manager will usually know the cost of seed and fertilizer at the time of planting, but may be uncertain, at seeding time, about the amount and cost of pesticides that must be applied during the growing season. By the same token, the harvest costs are unknown at the start of the year because they depend both on the size of the crop to be harvested and harvesting input costs such as fuel and repairs.

Nevertheless, business risk refers to the variability in returns to assets. This variability results from the unpredictability and uncertainty of yields and prices, and of operating costs. This, then, is the essence of business risk. Because K&L Farms operates with a significant amount of borrowed funds we must now turn our attention to financial risk.

FINANCIAL RISK

To this point in the risk analysis, Kim and Lee have not considered debt. They have been considering business risk as they analyzed crop yield and price variations. They must now consider the financial risk involved. Financial risk concerns the probability that large losses on equity will occur. For K&L Farms, are there chances of large negative returns to equity? What is the chance that this will happen?

Per Cent Return on Equity

"A negative return to assets of $30,264 is bad enough," Lee mused. "But remember we signed the mortgage papers promising to repay our creditors. The interest cost alone amounts to $50,000. Just what are the implications?"

"We can get a better grip on the situation if we look at the per cent return on equity figures," said Kim.

In the formula that was explained on Page 9 (r_E) represents per cent return on equity, (r_A) per cent return on assets, (r_D) per cent return to debt holders or the rate of interest and (L) the leverage ratio. In this situation, leverage is 500,000 / 225,000 = 2.2222.

"That's right Kim," Lee suggested, "let's use the formula you brought up earlier."

$$r_E = r_A + L(r_A - r_D)$$

"Good idea Lee," Kim agreed. "We had calculated that our Leverage Ratio was 2.22222. If we consider the consequences of poor yields and prices we can find out the severity of such a bad thing happening."

"I'll do the calculation," Lee said taking over the calculator, "you make the new column in the table".

"Right," Kim passed the calculator to his wife.

"In the joint event of a crop failure coupled with a depressed price," Lee stated dramatically, "our return to equity is minus 35.67 per cent."

"Wow," whistled Kim as he wrote the information in the table. "We'd better do the calculations for all of the joint events."

"I'm on it," Lee replied.

Exercise 8 -Per Cent Return on Equity

Complete the calculations for the Returns on Equity for the remaining Joint Events. Then refer to the table to complete the statement. There may be differences in rounding which can cause variations in per cent return on equity.

Cumulative Probability of Return on Equity					
Joint Event		**% Return on**		**Probability**	
Yield	**Price**	**Assets**	**Equity**	**Of Event**	**Cumulative**
Poor	Poor	-4.17%	-35.67%	6.25%	6.25%
Poor	Normal	-1.22%	**[_____]**	12.50%	18.75%
Poor	Good	1.74%	**[_____]**	6.25%	25.00%
Normal	Poor	6.66%	**[_____]**	12.50%	37.50%
Normal	Normal	12.57%	**[_____]**	25.00%	62.50%
Good	Poor	17.50%	**[_____]**	6.25%	68.75%
Normal	Good	18.49%		12.50%	81.25%
Good	Normal	26.37%		12.50%	93.75%
Good	Good	35.23%		6.25%	100.00%

There is a **[_____]** per cent probability that K&L Farms will experience a negative per cent return on equity. There was only a **[_____]** per cent probability of a negative per cent return on assets. The range of per cent return to equity figures is from -35.67 per cent to 91.31 per cent which is considerably [**wider / narrower**] than the per cent return to assets range.

Per Cent Return on Equity – Answer

Compare your work to Kim and Lee's. Correct any errors. If you had more than 2 errors (less than 9 of 11 correct) you may wish to review this section.

Cumulative Probability of Return on Equity					
Joint Event		**% Return on**		**Probability**	
Yield	**Price**	**Assets**	**Equity**	**Of Event**	**Cumulative**
Poor	Poor	-4.17%	-35.67%	6.25%	6.25%
Poor	Normal	-1.22%	**[-26.15%]**	12.50%	18.75%
Poor	Good	1.74%	**[-16.63%]**	6.25%	25.00%
Normal	Poor	6.66%	**[-0.75%]**	12.50%	37.50%
Normal	Normal	12.57%	**[18.30%]**	25.00%	62.50%
Good	Poor	17.50%	**[34.17%]**	6.25%	68.75%
Normal	Good	18.49%	**[37.34%]**	12.50%	81.25%
Good	Normal	26.37%	**[62.74%]**	12.50%	93.75%
Good	Good	35.23%	**[91.31%]**	6.25%	100.00%

There is a **[37.50]** per cent probability that K&L Farms will experience a negative per cent return on equity. There was only a [**18.75**] per cent probability of a negative per cent return on assets. The range of per cent return to equity figures is from -35.67 per cent to 91.31 per cent that is considerably [**wider / ~~narrower~~**] than the per cent return to assets range.

"Well," Lee said, "that leverage surely changes the picture".

"Sure does," Kim agreed. "The range of possible levels of per cent return on equity is considerably wider than the range of possible levels of per cent return on assets."

"The worst per cent return on assets was a loss of 4.17% (-4.17%)," Lee noted. But the worst possible per cent return on equity was a loss of 35.67% (-35.67%)."

"True," Kim replied. "But do you see that the best possible asset return of 35.23% was in a situation of good yields and prices? In this 'good situation' the equity return would have been 91.31%."

"In every case," Lee noted, "the per cent probability of occurrence is unchanged but the impact on the business because of leverage is much more severe."

Impact of Financial Risk

"You know Lee," Kim stated, "if we take the per cent return to assets of 6.66 % earned in a year with normal yields but poor prices and look at the impact of leverage we would obtain a very interesting illustration about financial risk."

"Ok," said Lee, "the probability of that event was 12.50 per cent and our per cent return on equity was 0.75%. Why don't you put all this in a table?" she suggested.

"Good idea Lee," Kim began to prepare the table.

Source and Distribution of Equity Return				
Source	**Amount x Per Cent =**	**Return**		**Share**
		Dollar	**Per Cent**	**Per Cent**
Equity portion	225,000 x 6.66% =	14,992	6.66%	

"First, the equity portion," he said placing the figures in the row. "The $225,000 revenue by the 6.66 % gives…"

"We did that part," Lee interjected, "$14,992 isn't great but at least we're not in the hole."

"Not so fast," Kim replied. "Don't forget that the cost of debt is greater than those earnings." He proceeded to add another row to the table.

"That's right Kim, the interest rate is 10%," Lee replied.

"That means that the margin on borrowed funds is -3.34 %," Kim pointed out. "This is a negative amount showing that the cost of debt is greater than the earnings."

In the earlier explanation Kim and Lee calculated the share represented by each component, the equity and the debt portions. Since K&L lost money on the debt or leveraged portion, it is not possible to calculate the shares. The column remained in the table nonetheless.

Source and Distribution of Equity Return				
Source	**Amount x Per Cent =**	**Return**		**Share of ROE**
		Dollar	**Per Cent**	**Per Cent**
Equity portion	225,000 x 6.66% =	14,992	6.66%	n/a
Debt portion	500,000 x -3.34% =	-16,684	-7.42%	n/a

"Wow," said Lee. "As a result, the modest $14,992 earned on the owned portion is overshadowed by the borrowed portion of -$16,684."

"That's right Lee," Kim stated as he wrote the figures into the table. "The net would be a loss of $1,692 as a dollar return to equity or -0.75 % on a percentage basis."

This dramatically shows the downside of financial risk. The old adage 'leverage is a sword that cuts both ways' is borne out in this case.

Source and Distribution of Equity Return				
Source	**Amount x Per Cent =**	**Return**		**Share of ROE**
		Dollar	**Per Cent**	**Per Cent**
Equity portion	225,000 x 6.66% =	14,992	6.66%	n/a
Debt portion	500,000 x -3.34% =	-16,684	-7.42%	n/a
	Total	-1,692	-0.75%	n/a

Sensitivity to Leverage Rates

"Just how sensitive is per cent return on equity to changes in the leverage ratio," Lee asked. "We should do some sensitivity analysis".

"Good idea," Kim enthused. "We can build a table."

"How did I know you were going to make another table," Lee smiled.

"We'll start with the joint events and the percentages," he said as he drew up the rows.

"We should include other leverage ratios besides ours," Lee suggested. "How about including 1 through 4?"

"Good idea," Kim replied as he prepared the table, "1, 2, 3, and 4 as well as our 2.2222 will give a good spread of figures to compare."

Exercise 9 - Impact of Leverage on Financial Risk

Complete the calculations in the table then refer to the table to complete the statement.

Impact of Leverage on Financial Risk								
Joint Event		Cumulative	% Return	**% Return on Equity for Selected Leverage Ratios**				
Yield	Price	Probability	on Assets	1.0	2.0	2.2222	3.0	4.0
Poor	Poor	6.25%	-4.17%	-18.35%	-32.52%	-35.67%	-46.70%	-60.87%
Poor	Normal	18.75%	-1.22%	-12.44%	-23.66%	-26.15%	-34.87%	-46.09%
Poor	Good	25.00%	1.74%	-6.53%	-14.79%	-16.62%	-23.05%	-31.31%
Normal	Poor	37.50%	6.66%	3.33%	-0.01%	-0.75%	-3.35%	-6.68%
Normal	Normal	62.50%	12.57%	**[_____]**	**[_____]**	**[_____]**	**[_____]**	**[_____]**
Good	Poor	68.75%	17.50%	25.00%	32.50%	34.17%	40.00%	47.50%
Normal	Good	81.25%	18.49%	26.97%	35.46%	37.34%	43.94%	52.43%
Good	Normal	93.75%	26.37%	42.74%	59.10%	62.74%	75.47%	91.84%
Good	Good	100.00%	35.23%	60.47%	85.70%	91.31%	110.94%	136.17%

From the table they conclude that as leverage increases, the extremes of per cent return are [reduced/magnified/stay the same]. Good years become even better. Bad years become worse. If they were completely debt free leverage is zero and the per cent return on equity would be [lower/identical/higher] to the per cent return on assets. There would be no leverage effect and financial risk would be the [same as / different from] business risk. For example, at zero leverage for the normal price and yield joint event the per cent return to equity and assets were both equal to **[_____]** per cent. With leverage at 1.0, per cent return on equity rises to **[_____]** per cent. At 2.0 it is **[_____]** per cent.

Impact of Leverage on Financial Risk - Answer

Compare your answers to Kim and Lee's work. Correct any errors.

Impact of Leverage on Financial Risk								
Joint Event		Cumulative	% Return	% Return on Equity for Selected Leverage Ratios				
Yield	Price	Probability	on Assets	1.0	2.0	2.2222	3.0	4.0
Poor	Poor	6.25%	-4.17%	-18.35%	-32.52%	-35.67%	-46.70%	-60.87%
Poor	Normal	18.75%	-1.22%	-12.44%	-23.66%	-26.15%	-34.87%	-46.09%
Poor	Good	25.00%	1.74%	-6.53%	-14.79%	-16.62%	-23.05%	-31.31%
Normal	Poor	37.50%	6.66%	3.33%	-0.01%	-0.75%	-3.35%	-6.68%
Normal	Normal	62.50%	12.57%	**15.15%**	**17.72%**	**18.30%**	**20.30%**	**22.87%**
Good	Poor	68.75%	17.50%	25.00%	32.50%	34.17%	40.00%	47.50%
Normal	Good	81.25%	18.49%	26.97%	35.46%	37.34%	43.94%	52.43%
Good	Normal	93.75%	26.37%	42.74%	59.10%	62.74%	75.47%	91.84%
Good	Good	100.00%	35.23%	60.47%	85.70%	91.31%	110.94%	136.17%

From the table they conclude that as leverage increases, the extremes of per cent return are [~~reduced~~/**magnified**/~~stay the same~~]. Good years become even better. Bad years become worse. If they were completely debt free leverage is zero and the per cent return on equity would be [~~lower~~/**identical**/~~higher~~] to the per cent return on assets. There would be no leverage effect and financial risk would be the [**same as** / ~~different from~~] business risk. For example, at zero leverage for the normal price and yield joint event the per cent return to equity and assets were both equal to [**12.57**] per cent. With leverage at 1.0, per cent return on equity rises to [**15.15**] per cent. At 2.0 it is [**17.72**] per cent.

"Wow," Kim and Lee said in unison, "as leverage increases so does our financial risk."

"You know," exclaimed Kim, "I'm glad we locked in the interest rate at 10.00 %. You remember we had the choice of a floating rate at the time?"

"That's right," Kim agreed. "We can generate enough cash from the farm to make our mortgage payments at 10.00 % in most years, but I don't know what we would have done at a higher interest rate."

"That's for sure Kim," Lee speculated. "I guess we were interested in protecting ourselves against higher rates."

"That's true Lee," Kim replied. "Our strategy for managing financial risk was to lock in the rate."

"I see," said Lee. "We're protecting ourselves against the risk of rising interest rates and we're willing to accept the risk of falling rates."

"Right," Kim agreed. "If rates fall and we're locked in we don't get the benefit."

Sensitivity to Interest Rates

Kim suggested "To see what would happen, let's build a table with different interest rates at the different business risk levels and leverage rates."

"Ok," Lee responded. "That would mean at interest rates lower than 10.00 % we would enjoy the benefit."

"Just as if we had picked the floating rate option," Kim pointed out while preparing the table. "Let's use 5 per cent and 7.5 per cent."

"OK Kim, but we should also do rates higher too," Lee suggested, "so we can see both sides of the option."

"Right again Lee," Kim agreed with his wife. "I'll put in 12.5 and 15 per cent to make the comparison."

Exercise 10 - Impact of Interest Rates

Complete the calculations in the table then refer to the table to complete the statement.

Impact of Interest Rates on Financial Risk (Leverage at 2.2222)								
Joint Event		**Cumulative**	**% Return**	**Per Cent Return on Equity for Selected Interest Rates**				
Yield	**Price**	**Probability**	**on Assets**	**5.00 %**	**7.50 %**	**10.00 %**	**12.50 %**	**15.00 %**
Poor	Poor	6.25 %	-4.17%	**[_____]**	-30.12%	-35.67%	-41.23%	-46.78%
Poor	Normal	18.75 %	-1.22%	**[_____]**	-20.59%	-26.15%	**[_____]**	-37.26%
Poor	Good	25.00 %	1.74%	-5.51%	**[_____]**	-16.62%	-22.18%	**[_____]**
Normal	Poor	37.50 %	6.66%	10.36%	**[_____]**	-0.75%	-6.31%	-11.86%
Normal	Normal	62.50 %	12.57%	29.41%	23.85%	18.30%	**[_____]**	7.18%
Good	Poor	68.75 %	17.50%	45.28%	39.72%	34.17%	**[_____]**	23.06%
Normal	Good	81.25 %	18.49%	48.45%	42.90%	37.34%	31.79%	**[_____]**
Good	Normal	93.75 %	26.37%	73.85%	**[_____]**	62.74%	57.18%	**[_____]**
Good	Good	100.00 %	35.23%	**[_____]**	96.87%	91.31%	85.76%	80.20%

As the interest paid on debt increases the per cent return on equity [**increases/decreases**]. For example, in a poor yield, normal price situation at a 5.0% interest rate the per cent return on equity is **[_____]** per cent. The per cent return figure [**drops/rises**] to **[_____]** per cent at a 15.0% interest rate. This illustrates that floating interest rates would [**increase/decrease**] the severity of financial risk.

Impact of Interest Rates - Answer

Compare your work to Kim and Lee's. Correct any errors. If you have more than 3 errors (less than 14 out of 17 correct) you may wish to review this section.

Impact of Interest Rates on Financial Risk (Leverage at 2.2222)								
Joint Event		**Cumulative**	**% Return**	**Per Cent Return on Equity for Selected Interest Rates**				
Yield	**Price**	**Probability**	**on Assets**	**5.00 %**	**7.50 %**	**10.00 %**	**12.50 %**	**15.00 %**
Poor	Poor	6.25 %	-4.17%	**-24.56%**	-30.12%	-35.67%	-41.23%	-46.78%
Poor	Normal	18.75 %	-1.22%	**-15.04%**	-20.59%	-26.15%	**-31.70%**	-37.26%
Poor	Good	25.00 %	1.74%	-5.51%	**-11.07%**	-16.62%	-22.18%	**-27.74%**
Normal	Poor	37.50 %	6.66%	10.36%	**4.80%**	-0.75%	-6.31%	-11.86%
Normal	Normal	62.50 %	12.57%	29.41%	23.85%	18.30%	12.74%	7.18%
Good	Poor	68.75 %	17.50%	45.28%	39.72%	34.17%	**28.61%**	23.06%
Normal	Good	81.25 %	18.49%	48.45%	42.90%	37.34%	**31.79%**	26.23%
Good	Normal	93.75 %	26.37%	73.85%	**68.30%**	62.74%	57.18%	**51.63%**
Good	Good	100.00 %	35.23%	**102.42%**	96.87%	91.31%	85.76%	**80.20%**

As the interest paid on debt increases the per cent return on equity [~~increases~~ / **decreases**. For example, in a poor yield, normal price situation at a 5.0% interest rate the per cent return on equity is **[-15.04**] per cent. The per cent return figure [**drops** / ~~rises~~] to [**-37.26**] per cent at a 15.0% interest rate. This illustrates that floating interest rates would [**increase** / ~~decrease~~] the severity of financial risk.

"We can certainly see the effect of varying interest rates on equity returns," they noted in unison.

Summary of Financial Risk

Kim and Lee now understand the impact of the various price-yield events on business risk and the magnifying effect on financial risk. They realize that they are sufficiently levered so that they need to pay special attention to their financial risk. They also know that by managing the business risk they will also mitigate some of the impact of the financial risk they face. They will need to consider strategies to help them through the situation. They will be doing this in the module *Designing Risk Management Strategies*.

CONCLUSION

In this module, we discovered that the variations in returns from year to year result from variations in product yields and in prices received for the products. This resulting business risk is magnified through leverage into financial risk. Understanding the underlying causes of risk and knowing the extent of it are important factors in developing strategies to cope with it.

Now, having identified the sources for risk in a business operation and understanding the compounding effect of financial risk, you are ready to proceed with the measurement of different degrees of risk in order to be able to select or devise appropriate strategies for managing risk successfully.

An opportunity to learn techniques for financial analysis and record keeping is provided in the series of modules on The Accounting System. Alternatives for improving earning performance and business strength are contained in the Managing the Production Process series. The modules in the Decision Making for the Farm Business provide an opportunity to consider long- and medium-range plans.

When you are ready to test your ability to apply the knowledge, skills, and processes in this module, go ahead to the self-check that follows.

SELF-CHECK

Per Cent Cost Of Debt	
Interest Rate	8.00%

% Return on Assets	
Poor	4.00%
Normal	12.00%
Good	20.00%

There are two farms identical as to size of business and performance; only differing in their respective debt loads. Farm A and Farm B each have assets of $300,000. Farm A has liabilities of $100,000 whereas Farm B has liabilities of $200,000. Farm A and Farm B each have identical per cent return figures on assets as shown in the table. The per cent return figures are associated with poor, normal and good profit years. Complete the calculations and answer the questions for each section below.

The equity of the owners on Farm A is **[_____]** and for Farm B is **[_____]**. The leverage ratio for A is **[_____]** and B is **[_____]**. The holders of debt obtained **[_____]** as a per cent return on their stake in the business. Farm A paid **[_____]** in interest while Farm B paid **[_____]**.

Balance Sheet		
	Farm A	**Farm B**
Assets	300,000	300,000
Liabilities	100,000	200,000
Equity		
Leverage		

Farmer A and Farmer B agree on the relative occurrence of the three kinds of years. A normal yield occurs two and one half times as often as a poor one. A good year happens only half as often as a poor year. Use this information to construct a subjective probability table. Also calculate the cumulative probability column.

Subjective Probabilities			
Event	**Weights**	**Probability**	**Cumulative**
Poor			
Normal			
Good			
Total			

Calculate the per cent return on equity figures for Farm A for each of the possible years and complete the statement.

There is a **[_____]** probability that Farmer A will have a negative per cent return on equity and a **[_____]** probability of a return on equity exceeding 14.00 %.

Farm A Per Cent Return on Assets	on Equity	Cumulative Probability
4.00%		0.250
12.00%		0.875
20.00%		1.000

Now do the same for Farm B.

There is a **[_____]** probability that Farmer B will have a negative per cent return on equity and a **[_____]** probability of exceeding 20.00 % return on equity.

Farm B Per Cent Return on Assets	on Equity	Cumulative Probability
4.00%		0.250
12.00%		0.875
20.00%		1.000

The business risk of Farm A is **[greater than/identical to/less than]** Farm B. The financial risk for Farm B is **[greater than/identical to/less than]** Farm A.

ANSWERS TO SELF CHECK

Balance Sheet		
	Farm A	**Farm B**
Assets	300,000	300,000
Liabilities	100,000	200,000
Equity	**[200,000]**	**[100,000]**
Leverage	**[0.50]**	**[2.00]**

The equity of the owners on Farm A is [**200,000**] and for Farm B is [**100,000**]. The leverage ratio for A is [**0.50**] and B is [**2.00**]. The holders of debt obtained [**8.00%**] as a per cent return on their stake in the business. Farm A paid [$**8,000**] in interest while Farm B paid [$**16,000**].

Subjective Probabilities			
Event	**Weights**	**Probability**	**Cumulative**
Poor	**[100]**	**[0.250]**	**[0.250]**
Normal	**[250]**	**[0.625]**	**[0.875]**
Good	**[50]**	**[0.125]**	**[1.000]**
Total	**[400]**	**[1.000]**	

Farm A Per Cent Return on Assets	on Equity	Cumulative Probability
4.00%	**[2.00%]**	0.250
12.00%	**[14.00%]**	0.875
20.00%	**[26.00%]**	1.000

There is a **[0.00 %]** probability that Farmer A will have a negative per cent return on equity and a **[12.5 %]** [1.00 – 0.875 = 0.125] probability of a return on equity exceeding 14.00 %.

Farm B Per Cent Return on Assets	on Equity	Cumulative Probability
4.00%	**[-4.00%]**	0.250
12.00%	**[20.00%]**	0.875
20.00%	**[44.00%]**	1.000

There is a **[0.25 or 25%]** probability that Farmer B will have a negative per cent return on his equity and a [**12.5%** (1.00 – 0.875 = 0.125)] probability of exceeding 20.00 % return on equity.

The business risk of Farm A is [**identical to**] Farm B. The financial risk for Farm B is [**greater than**] Farm A.

Calculating the per cent return on assets is the measure of business risk. If you have problems in this section of the Self-Check you should review the first section of this module. Interpreting the results of the calculation of asset returns is detailed in this section.

The calculation of per cent return on equity is explained in the Financial Risk section. If you have problems or questions here, you should refer to the second part of the module. Interpreting these results is explained in this section as well.

About the Authors

Leonard Bauer

Len Bauer is Professor Emeritus of Agricultural Business Management in the Department of Rural Economy at the University of Alberta. He joined the faculty in 1977 to assume research and teaching duties in agricultural business management, finance, and production economics. He has served as advisor and consultant to provincial and federal government departments and institutions and to private agencies on matters concerning production, finance, and risk management in agriculture.

He was instrumental in creating the Agricultural Business Management Program at the University and was its first director. Prior to joining the University, he was employed by the Province of Alberta as an extension officer and by the Government of Canada as project leader in the design and implementation of the CANFARM information systems for farm businesses.

He was guest professor at the University of Hohenheim in West Germany and guest lecturer at FINAFRICA in Milan, Italy, and at Curtin University of Technology in Perth, Australia. In 1995 he was workshop leader for agricultural instructors in Ukraine.

Although retired since 1996 Len, together with Don Bushe, continues to develop instructional materials in Agricultural Business Management.

Don Bushe

Don is a consultant, writer, teacher, and designer of interactive instructional materials. His products and publications have received national and international recognition from the European Broadcasting Union, Ohio State Awards of Excellence, National Educational Broadcasters' Association, and the Japan Prize Competitions. His more than 200 broadcast and non-broadcast radio and television productions range from ‘The Parent Puzzle’ series on parenting skills to ‘Listen to the Prairies,’ a radio series for elementary school science.

Don's experiences developing interactive learning materials have ranged from the preparation of video-disc based paramedical emergency services training to CD-ROM and computer delivered training systems for liquids and gas pipeline operators in Argentina, Brazil, Colombia, as well as individual companies in the USA and Canada.

The interactive DVD productions and systems he designed are featured in museums and information systems from the Royal Tyrrell Museum in Alberta to the Visitor Interpretive Center in Arviat (formerly Eskimo Point) in Nunavut. He brought an innovative and unique approach when assisting college instructors and university faculty in Ukraine as they struggled to re-define their economics curriculum in the post-soviet era.

Don and Len have collaborated to develop a number of self-instruction modules in farm management modules for the University of Alberta, Faculty of Extension and the British Columbia, Ministry of Agriculture, Fisheries and Food. Together, they prepared what has the become basis for the standard textbook for agricultural economics in Ukraine.