A COMPARISON OF RISK AND RETURN CHARACTERISTICS OF EFFICIENT CROP PORTFOLIOS FOR THE BROWN SOIL ZONES SASKATCHEWAN AND MECKLENBURG, GERMANY

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ABSTRACT

Two efficient farms are constructed for the brown soils of Saskatchewan, Canada and for Mecklenburg, Germany based on producer panels. Both farms feature highly integrated cropping systems which take advantage of cropping synergies. However, farm risk is inherently different between the two because differences in 1) climate that gives rise to very different yield risk and cost structure, and 2) EU programs which offer fixed cash payments and stable sugar beet prices. As expected, risk is much higher for the Saskatchewan case farm—it has a chance of a negative cash flow of approximately one year in five. In sharp contrast, the Mecklenburg has very little chance of generating a negative cash flow.

Hence, it is easy to understand why crop insurance and other risk reducing types of programs have long been popular in SaskatchewanBgrain and oilseed price and yield risk make for a very real possibility of cash shortfalls on even the most efficient farm with moderate debt. On the other hand, there is little need for such risk reducing programs by efficient German farms because risk remains relatively low unless he/she is financially imprudent. Moving to higher farmland rents associated with an equilibrated land market or removing government payments increases risk considerably, but still at levels well below those of the Saskatchewan case farm.

Key words: risk and return, EV model, Saskatchewan and German grain farms.

INTRODUCTION

The economic and climatic environment of the brown soils of Saskatchewan, Canada differs considerably from that of the Mecklenburg state in Germany. The Saskatchewan brown zone is located in a semiarid area where moisture is almost always a limiting factor and growing seasons are relatively short, making it one of the most variable wheat production regions in the North American. In sharp contrast, the Mecklenburg, Germany climate provides about 600 mm of precipitation which is evenly distributed throughout the year and features relatively moderate temperatures which allow the cropping season to span much of the year (Krumbiegel, D. 1991). These differences translate into very different production risk. Producers in these two countries also face much different price risk through differences in government agricultural policies. The EU Common Agricultural Policy (CAP) includes fixed acreage payments and cereal intervention prices and a highly regulated sugar beet program. These have dramatically increased German farm incomes while reducing overall risk.

The primary objective of this paper is to assess the relative risk and returns associated with case farms located in the brown soil zone of Saskatchewan and Mecklenburg, Germany. Because of evolving EU agricultural policy, a secondary objective is to review the impact of removing some government programs on risk and returns of the Mecklenburg, Germany

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farm. Note that all prices and costs are in Canadian dollars.

Crop Portfolio Analysis

Efficient crop portfolios of high-management, case farms located in each area are compared based on the expected income / variance of income (E-V) portfolio model developed by Markowitz. In the E-V crop portfolio model, the decision maker maximizes expected utility as a function of expected gross margins, a tradeoff parameter, λ , and the variance of gross margins:

$$Max E(U) = E(C)X + \lambda(X' Cov X)$$
$$st AX \leq b$$
$$TX \quad \leq 0$$
$$X \geq 0$$

where:

	E(U)	= expected utility,
	E(C)	= expected gross margin
	X	= vector of cropping acreage or hiring in drying and custom harvesting operations (Mecklenburg),
	A	= resource use coefficients,
	T	= vector of rotational 0/1/-1 coefficients,
	λ ,	= tradeoff scalar,
	Cov	= variance-covariance matrix of gross margins and
	b	= vector of resource endowments or limits.

The EV crop portfolio problem is relatively straight forward.[3] Farm cropping decisions are considered in a fashion similar to a stock portfolio. The amount of land devoted to fallow or to crop, X, is similar to the decision to invest in a particular stock.[4] Hence, the crop portfolio decision variables consist of the various cropping alternatives plus in the case of the Mecklenburg case farm, the ability to hire in custom drying and custom harvesting. The constraints are mostly land use restrictions with exception to the AT@ constraints. The AT@ constraints are accounting constraints associated with rotational restrictions such as not having the amount of crops on fallow exceed the amount of fallow. Because risk preferences are largely unknown, the efficient income-risk frontier is mapped over a range of expected gross margin values.

Case Farms

The data requirements present a particular challenge in that a consistent data set of gross margins does not exist for all cropping possibilities. Expected gross margins for each case farm are based on producer panel data and their associated risk characteristics are based on the statistical characteristics of area yields, price trends and their yield-price correlations. The case farms are constructed by IFCN producer panels set up in each area in the summer of 2000 (Tables 1a and 1b).[5] The Saskatchewan Brown Soil (SBSZ) farm is a 2,428 hectare (6,000 acres) grain and oilseed farm. A total of 14 cropping activities are delineated by the panel, con-

[3]The assumptions underlying the EV model are well known and a source of many problems For a brief review of the problems and their management implications refer to Hardaker, Huirne and Anderson, p 187.
[4]Note that unlike financial securities, the variance of a farm income portfolio is more complicated in that it consists not only of price variability but also yield variability.
[5]IFCN (International Farm Comparison Network) is a world-wide association of agricultural scientists, advisors and top management farmers. The network is designed to provide information on the various features of international competitiveness of agricultural production including COP analysis. The core database is derived from a range of panel farms, each consisting of five top farm managers as well as local advisors and agricultural scientists. For more information, refer to the web site http://WWW.ifcnnetwork.org/.

sisting of chick pea, lentil , CWRS (Canadian Western Red Spring) wheat, CWAD (Canadian Western Amber Durum) wheat on fallow and on previous wheat, canola, chick pea and lentil cropped land (Table 1a). Crops are differentiated by their preceding crop because the preceding crop impacts on the following crop yield and quality and alters the production system through different tillage and chemical practices. Costs are based on actual 2000 prices but commodity prices are based on those expected to prevail for the next several years.

The Mecklenburg-Vorpommern (M-V), Germany, case farm is based on a 1,500 hectare (3,706 acre) grain and oilseed farm situated near Mecklenburg.[6] A total of nine cropping activities are delineated based on sugar beet, barley, wheat and rapeseed crops with some distinctions made for the effects of previous crops (Table 1b). With the exception of sugar beets, gross margins are based on expected 2000 world prices.[7] Currency exchange rates are based on the 2000 production year.[8] Direct government payments are an important component of German farm income: if producers participate in the government program they receive $CAN 470 / h for set aside acres and eligible crops; sugar beets are not eligible.[9] In order to receive compensatory payments, farmers must set aside a minimum of 10% of the land in program crops. Set aside land may be idled with a cover crop or used for bio-diesel crops such as non-food rapeseed. Sugar beet prices are maintained at a relatively high, fixed level through a quota system. In the following analysis, program payments and sugar beet prices are treated as non stochastic. In addition to the cropping activities, there are four activities which permit custom harvesting and custom drying to be hired during the two fall work periods.

Price and Yield Risk

It is assumed that commodity price and yield variability are the sole sources of income variability. Hence, key to the analysis are price and yield variability and the correlations between the various price and yield components (Tables 2a and 2b). Saskatchewan short term price variability is based on the estimated 1990-2000 variability in local farmgate prices around the long term trend. The long term trend is estimated based on real 1960-2000 prices. In the case of Germany, price variability is based on 1990-2000 variability in world prices around their corresponding long term trend.[10] It is assumed that EU intervention prices would not set an effective floor in the future.[11]

Yield variability is also based on variability about a trend. In the case of the SBSZ farm, yield variability is based on detrended Saskatchewan Crop Insurance Corporation (SCIC) yield data for the brown soil zone. In the case of Germany, yield variability is based on detrended, Herzogtum-Lauenburg, area yields.[12] While both the SCIC and Herzogtum-Lauenburg data provide a good measure of yield dispersion, they also represent lower expected yields than

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[6]*The state of Mecklenburg belongs to the ANew Lander@ in east Germany and constitutes the north east of Germany.*
[7]*The 1992 CAP reform switched from market price support towards a system of price support and product specific area payments accompanied by a variable mandatory set-aside. Under the 1992 reform, producers received product specific payments. The support price was cut in a two step process by 33 % and reached its lowest level in 1996. The Agenda 2000 Agreement on Agriculture (BMVEL) calls for support prices cuts which are partially offset by a uniform, direct acreage payments for eligible crops to start in 2002/2003. However, it is assumed that these are already in place.*
[8] *A Canada-Germany exchange rate of 1.4291DM per $CAN and a US-Canada exchange rate of 1.4855 $CAN per $US are used based on the calendar year and rates published US Federal Reserve Board of Governors.*
[9]*After 2002, payments are the same for all program crops, except for pulses which receive somewhat higher payments.*
[10]*The same downwards trend in real prices is used for both Canada and world prices. World prices are based on US HRW , fob Gulf; rapeseed, fob Rotterdam: and EU barley, fob North Sea. Prices are based on International Grains Council and ISTA Mielke Oil World reports. The long-run, downwards annual trend is estimated at 0.026, 0.024 and 0.018, respectively, for wheat, barley and rapeseed.*

those of the most technically efficient farms of the same region. It is assumed that both case farms face the same relative variation as their corresponding underlying area data but because they have higher yield expectations they also have higher standard deviations.

Constraints

The SBSZ farm has nine constraints. The first constraint limits total land use. In addition, there are five "T" accounting type of constraints which limit the amount of crop grown on fallow, wheat, canola, chick peas or lentil to the number of hectares made available by the other fallow, wheat, canola or lentil activities. Another "T" constraint prevents CWAD wheat from being grown two years in a row. The last three constraints limit the total acreage CWAD wheat, canola, pulses (chick pea and lentil) to be less than 25%, 25% and 20%, respectively, of total acreage (Table 3). The CWAD wheat constraint is imposed based on panel experience as to the time critical nature of CWAD wheat production: durum must be seeded early so that it is sufficiently mature at harvest time resulting in a narrow seeding-harvesting window which imposes a maximum acreage restriction. Acreage constraints are also imposed on canola and pulses in order to prevent disease buildup problems.

Land set aside constraints are imposed due to government programs for the M-V case farm, Table 3). In order to participate in government programs, German producers must set aside 10% of program acres (which does not include sugar beets) in eligible crops such as non- food rapeseed or non-marketed or non-grazed cover crops (idle land). In addition, the IFCN panel members indicated that they would place 2.0% of their poorest land in a permanent or long-term set aside, which is part of the 10%. Other constraints include maximums for government set aside acres, sugar beet quota and rapeseed, broad leaf and cereals. The latter constraints are imposed by disease build up. Finally, two harvesting period constraints are imposed for harvesting and drying capacity. The first harvesting period constraint reflects the window available for barley and rapeseed harvesting. These crops are generally harvested earlier than wheat. The second harvesting window reflects wheat harvesting and drying capacity. However, additional harvesting and drying capacity can be hired.

Annual Cash Flows

For many farmers, risk is best assessed through the probabilistic ability to meet cash flows. In order to calculate cash flows, the fixed cash commitments must be first specified. Fixed cash commitments include general farm overhead costs, cash land rents, debt service and family living withdrawals. The SBSZ farm fixed cash commitments are based on 60% of the land cash rented and the remaining amount is assumed to be owned. Family living withdrawals are based on unpaid wages and are set at $45,000. Debt service is based on a debt- asset ratio of 0.1. The total annual fixed cash commitment is $140,810. M-V fixed cash commitments are based on

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[11] *The estimated variability was checked to determine the probability that cereal prices would fall below the German intervention price less the mean basis. The mean basis was derived as the difference between the intervention price and market 1998-2000 price for the months where the market price was or less than the intervention price. Historical German producer and intervention prices are derived from ZMP reports. Using the study expected prices and standard deviations, it is estimated that there is a 6.2% chance that wheat prices will fall below the effective intervention price but there is a 24.9% chance that barley prices will fall below the effective intervention price. Hence, in the case of wheat the assumption that the government will not intervene is not much problem in estimating variability but in the case of barley, this more of a problem. The assumption of no government intervention causes risk to be overstated and the expected value to be underestimated.*

[12] *There are insufficient yield data under current technology for Mecklenburg, Germany, so that a comparable area, Herzogtum-Lauenburg is used. Data are derived from the Statistisches Bundesamt data. The long-run downwards annual trend is estimated at 0.021, 0.020, 0.013, respectively for wheat, barley and rapeseed. In the case of Saskatchewan, there is no statistically discernable yield trend for crops on fallow.*

85% rented land and the remainder is owned. Family living withdrawals are based on unpaid wages and are set at $104,962. Debt service is based on a mix of loans typical of these farms and is set at $159,181. Annual fixed cash commitments total $531,798.

E-V Efficient Crop Portfolios

The efficient EV crop frontier is mapped by first identifying the profit maximizing point and then decrementing the required gross margin and minimizing risk for the base scenario (Tables 4a and b). In the case of the SBSZ farm (Table 4a), the profit maximizing (PMAX) rotation generates a gross margin of $373,464 with a standard deviation of $266,377 and a corresponding coefficient of variation of 71.3% which results in a PMAX net cash flow of $232,654. Assuming that cash commitments are truly fixed, the portfolio standard deviation can also be used to represent cash flow variability. Accordingly, there is a 19.6% chance, or a one year in 5.1, of having a negative cash flow at the PMAX solution. The SBSZ farm PMAX portfolio consists of 485.7 hectares of chick pea (Table 5a). This result is not too surprising as chick pea is the most profitable crop. However, total pulses are limited by a 20% land use constraint and so production shifts to 607.1 hectares of the next most profitable stubble crop, CWAD wheat. Additional crops include 485.7 hectares of both canola on fallow and fallow and 364.2 hectares of CWRS wheat on stubble. As the required expected return target is decreased, the risk-minimizing crop portfolio shifts out of relatively high risk-to-return crops to more fallow: as the target income decreases, progressively more fallow is introduced until it reaches a maximum of 38.96% of total acreage. The area in chick pea and CWAD wheat remains relatively constant over much of the frontier because of their high profitability to risk ratio; it is only in the middle of the E-V frontier where the decision maker becomes very risk averse that their acreage substantially decreases. At expected incomes below $298,464, risk is reduced by taking land out of production but the crop mix of the remaining land remains constant and the relative risk as measured by the CV remains around 61%. Note that if the producer objective is to minimize the probability of a negative cash flow, then the PMAX solution is only slightly more risky than the best alternative of $358,464 with an estimated 18.3% probability of having negative cash flows.

The M-V PMAX portfolio (Table 4b) generates an annual gross margin of $1,512,508 with a standard deviation of $350,666 and a corresponding CV of 23.2%. This combined with low yield variability and relatively high incomes means that this case farm faces far less risk than its SBSZ counterpart: it has virtually no chance of having a negative cash flow. The M-V farm PMAX portfolio consists of 30 hectares of mandated (by the producer) set aside and 114 hectares of non-food rapeseed (which qualify as set aside); 60 hectares of sugar beets (the quota limit); 316 hectares of food rape, 577 hectares of wheat and 403 hectares of barley (Table 5b). As the required expected gross margin decreases, the portfolio shifts out of wheat into barley and into either more non-food rapeseed or set aside land.

Impact of No Economic Profits and No Government Payments to German Producers

Both case farms generate excess economic profits under the base scenario. In the case of SBSZ farm, this is largely due to chick pea and CWAD wheat. Whether this will persist in the long run is doubtful; either chick pea and CWAD wheat prices will drop or farmland values will adjust accordingly. The same problem exists for the M-V farm, considerable excess economic profits are generated by government payments and sugar beets. Accordingly two alternative scenarios are identified. The first alternative scenario is based on zero economic profits. In order to drive excess profits to zero, farmland rents are increased by 39.9% and 151.5%, respectively, for SBSZ and M-V farms. The probability of cash shortfalls is recalculated. In the case of the SBSZ farm, the probability of cash shortfalls increases slightly to about 23.2%. However, in the case of M-V farm, the chance of a cash shortfall increases from virtually no chance to about 5.8%. While the riskiness of the M-V farm has increased substantially, the SBSZ case farm still has a five-fold greater chance of negative cash flows.

Government payments and sugar beets generate approximately 52% of the M-V PMAX gross margin and the continuation of payments is a major concern. Accordingly, a second scenario is based on discontinuing German government program payments and set aside programs but retaining sugar beet quota. Under this scenario, the M-V farm PMAX gross margins fall by 43.1% and an economic loss of ($218,624) is generated. If land rents are again adjusted to absorb economic profits or losses (Table 4), net cash flow falls by $358,464 and the associated risk of cash shortfalls is increased to 8.7% or one year in 11.6.

Implications, Conclusions and Limitation

Two efficient farms are constructed for Saskatchewan, Canada and Mecklenburg, Germany based on producer panels. Both farms feature highly integrated cropping systems which take advantage of cropping synergies. However, farm risk is inherently different between the two because differences in 1) climate that gives rise to very different yield risk and cost structure, and 2) EU programs which offer fixed cash payments and stable sugar beet prices. As expected, risk is much higher for the Saskatchewan case farm—it has a chance of a negative cash flow of approximately one year in five. In sharp contrast, the Mecklenburg has very little chance of generating a negative cash flow. Hence, it is easy to understand why crop insurance and other risk reducing types of programs have long been popular in SaskatchewanBgrain and oilseed price and yield risk make for the possibility of cash shortfalls very real on even the most efficient farm with moderate debt. On the other hand, there is little need for such risk reducing programs by efficient German farms because risk remains relatively low unless he/she is financially imprudent. Moving to higher farmland rents associated with an equilibrated land market or removing government payments increases risk considerably, but still at levels well below those of the Saskatchewan case farm.

Note that the impact of Canadian programs such as crop insurance and NISA was not analyzed and these would tend to reduce risk. Also note that less efficient or higher debt farms would face much higher risk levels. Finally, the simplifying assumptions which permit the use of the EV model, preclude the analysis of programs like crop insurance and NISA. While the impact of these programs is to primarily reduce risk, the assessment of these programs is beyond the scope of this paper.

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Table 1a: Activity Crop Yields, Prices and Margins, Brown Soil Zone, Saskatchewan, Canada

Cropping Activities	Commodity Price ($CAN/t)	Yield (t/h)	Covar (P,Y)	Gross Return ($CAN/h)	Variable Cost ($CAN/h)	Gross Margin ($CAN/h)
Fallow					$ 46.67	$ (46.67)
CWRS on Fallow	$ 146.26	$ 2.36	$ (3.66)	$ 342.01	$ 109.88	$ 232.13
CWRS on Wheat	$ 142.37	$ 1.56	$ 0.38	$ 222.53	$ 138.68	$ 83.85
CWRS on Canola	$ 148.21	$ 1.82	$ 0.46	$ 269.59	$ 124.44	$ 145.15
CWRS on Chick pea	$ 152.85	$ 1.95	$ 0.51	$ 298.63	$ 117.92	$ 180.72
CWRS on Lentil	$ 152.85	$ 2.02	$ 0.53	$ 308.93	$ 117.94	$ 190.99
CWAD on Fallow	$ 175.42	$ 2.36	$ (4.79)	$ 409.79	$ 115.03	$ 294.76
CWAD on Wheat	$ 171.85	$ 1.56	$ 1.62	$ 269.76	$ 143.82	$ 125.94
CWAD on Canola	$ 176.72	$ 1.82	$ 1.94	$ 322.86	$ 129.59	$ 193.27
CWAD on Chick pea	$ 179.60	$ 1.95	$ 2.12	$ 352.42	$ 123.07	$ 229.36
CWAD on Lentil	$ 179.60	$ 2.02	$ 2.19	$ 364.58	$ 123.09	$ 241.49
Canola on Fallow	$ 304.17	$ 1.35	$ (8.33)	$ 400.79	$ 161.04	$ 239.75
Lentil on Stubble	$ 344.13	$ 1.21	$ 7.38	$ 423.99	$ 283.35	$ 140.64
Chick Pea on Stubble	$ 414.50	$ 1.28	$ (13.98)	$ 515.70	$ 326.32	$ 189.38

Source: Yields, and costs-IFCN Data, 2001; Commodity prices are expected prices. Covar is the covariance term between market price and yields.

Table 1b: Activity Crop Yields, Prices and Margins, Mecklenburg, Germany

Cropping Activities	Commodity Price ($CAN/t)	Yield (t/h)	Government Payments ($CAN/h)	Covar (P,Y)	Gross Return ($CAN/h)	Variable Cost ($CAN/h)	Gross Margin ($CAN/h)
Long-Term Set Aside			$ 470.23	$ -	$ 470.23	$ 37.05	$ 433.18
Set Aside			$ 470.23	$ -	$ 470.23	$ 37.05	$ 433.18
Sugar Beets	$ 55.98	53.7	$ -	$ -	$ 3,006.12	$ 1,154.32	$ 1,851.80
Non-Food Rape on Barley	$ 265.90	4.1	$ 469.90	$ (5.18)	$ 1,552.71	$ 703.73	$ 848.98
Food Rape on Barley	$ 283.40	4.1	$ 469.90	$ (5.52)	$ 1,623.95	$ 703.73	$ 920.22
Non-Food Rape on Wheat	$ 265.90	4.1	$ 469.90	$ (5.18)	$ 1,552.71	$ 737.78	$ 814.93
Food Rape on Wheat	$ 283.40	4.1	$ 469.90	$ (5.52)	$ 1,623.95	$ 737.78	$ 886.17
Wheat on Rape	$ 167.94	8.7	$ 469.90	$ (3.78)	$ 1,925.58	$ 692.40	$ 1,233.19
Wheat on Beets	$ 167.94	7.8	$ 469.90	$ (2.10)	$ 1,776.83	$ 698.87	$ 1,077.95
Wheat on Wheat	$ 157.44	7.3	$ 469.90	$ (1.85)	$ 1,616.60	$ 760.03	$ 856.57
Barley on Wheat	$ 132.95	7.8	$ 469.90	$ 0.75	$ 1,508.00	$ 683.48	$ 824.52

Source: Yields, and costs-IFCN Data, 2001; government payments-BMVEL, 2000. Commodity prices are expected prices; Covar is the covariance term between market price and yields.

Table 2a: Correlation Matrix and CV by Crop and Price, Brown Soil Zone, Saskatchewan, Canada

Crop Price or Yield		Price					Yield						
		Wheat	Durum	Canola	Lentil	Pea	Wheat on Fallow	Wheat on Stubble	Durum on Fallow	Durum on Stubble	Canola on Fallow	Lentil on Stubble	Chick Pea on Stubble
Price	Wheat	1.000	0.837	0.703	0.575	0.453	-0.176	0.022	-0.065	0.127	-0.498	-0.048	-0.012
	Durum	0.837	1.000	0.823	0.224	0.450	-0.288	-0.036	-0.144	0.058	-0.502	-0.160	-0.044
	Canola	0.703	0.823	1.000	0.117	0.665	-0.301	-0.210	-0.165	-0.081	-0.452	-0.100	-0.069
	Lentil	0.575	0.224	0.117	1.000	-0.047	0.011	0.303	-0.006	0.261	-0.276	0.387	0.275
	Pea	0.453	0.450	0.665	-0.047	1.000	-0.046	-0.192	-0.079	-0.165	-0.381	-0.016	-0.120
Yield	Wheat on Fallow	-0.176	-0.288	-0.301	0.011	-0.046	1.000	0.671	0.859	0.516	0.384	0.388	0.255
	Wheat on Stubble	0.022	-0.036	-0.210	0.303	-0.192	0.671	1.000	0.734	0.894	0.334	0.695	0.493
	Durum on Fallow	-0.065	-0.144	-0.165	-0.006	-0.079	0.859	0.734	1.000	0.755	0.430	0.512	0.334
	Durum on Stubble	0.127	0.058	-0.081	0.261	-0.165	0.516	0.894	0.755	1.000	0.263	0.673	0.470
	Canola on Fallow	-0.498	-0.502	-0.452	-0.276	-0.381	0.384	0.334	0.430	0.263	1.000	0.441	0.144
	Lentil	-0.012	-0.044	-0.069	0.275	-0.120	0.388	0.695	0.512	0.673	0.441	1.000	0.341
	Pea	-0.140	-0.278	-0.324	0.285	-0.379	0.255	0.493	0.334	0.470	0.144	0.463	1.000
CV		0.227	0.284	0.142	0.171	0.199	0.265	0.345	0.283	0.367	0.317	0.377	0.350

Table 2.b: Estimated Correlation Matrix and CV, Mecklenburg, Germany

Crop Price or Yield		Price			Yield		
		Wheat	Barley	Rapeseed	Wheat	Barley	Rapeseed
Price	Wheat	1.000	0.916	0.821	-0.161	-0.034	-0.340
	Barley	0.916	1.000	0.721	-0.178	0.069	-0.306
	Rapeseed	0.821	0.721	1.000	-0.189	-0.232	-0.316
Yield	Wheat	-0.161	-0.178	-0.189	1.000	0.344	0.446
	Barley	-0.034	0.069	-0.232	0.344	1.000	0.625
	Rapeseed	-0.340	-0.306	-0.316	0.446	0.625	1.000
CV		0.189	0.144	0.177	0.075	0.104	0.121

Source: Prices-International Grains Council and Oil World; Crops-IFCN data 2001.

Table 4a: Efficient Crop Portfolio and the Probability of a Negative Cash Flow, Brown Soils of Saskatchewan

Gross Margin ($CAN)			Base Scenario			Equilibrium Cash Rent Scenario		
Mean	St Dev	CV	Expected Net Cash Flow ($CAN)	Probability of a Negative Cash Flow	A Negative Cash Flow Will Be Experienced 1 Year in	Expected Net Cash Flow ($CAN)	Probability of a Negative Cash Flow	A Negative Cash Flow Will Be Experienced 1 Year in
$ 253,464	$ 155,831	61.5%	$ 112,654	23.9%	4.2	$ 86,799	29.2%	3.4
$ 268,464	$ 162,807	60.6%	$ 127,654	22.1%	4.5	$ 101,799	26.9%	3.7
$ 283,464	$ 171,903	60.6%	$ 142,654	20.8%	4.8	$ 116,799	25.2%	4.0
$ 298,464	$ 181,405	60.8%	$ 157,654	19.8%	5.1	$ 131,799	23.8%	4.2
$ 313,464	$ 192,649	61.5%	$ 172,654	19.0%	5.3	$ 146,799	22.7%	4.4
$ 328,464	$ 205,472	62.6%	$ 187,654	18.6%	5.4	$ 161,799	22.0%	4.5
$ 343,464	$ 219,646	64.0%	$ 202,654	18.4%	5.4	$ 176,799	21.5%	4.6
$ 358,464	$ 235,483	65.7%	$ 217,654	18.3%	5.5	$ 191,799	21.2%	4.7
$ 373,464	$ 266,377	71.3%	$ 232,654	19.6%	5.1	$ 206,799	22.3%	4.5

Probability statistics are based on a t distribution and 20 degrees of freedom

Table 4b: Efficient Crop Portfolio and the Probability of a Negative Cash Flow, Germany

Gross Margin ($CAN)			Base Scenario			Equilibrium Cash Rent Scenario			No Government Payments		
Mean	St Dev	CV	Expected Net Cash Flow ($CAN)	Probability of a Negative Cash Flow	A Negative Cash Flow Will Be Experienced 1 Year in	Expected Net Cash Flow ($CAN)	Probability of a Negative Cash Flow	A Negative Cash Flow Will Be Experienced 1 Year in	Expected Net Cash Flow ($CAN)	Probability of a Negative Cash Flow	A Negative Cash Flow Will Be Experienced 1 Year in
$ 1,372,558	$ 285,041	20.8%	$ 840,761	0.4%	252.4	$ 435,365	7.1%	14.1	$ 430,430	9.6%	10.4
$ 1,390,052	$ 292,993	21.1%	$ 858,255	0.4%	241.2	$ 452,859	6.9%	14.5	$ 440,926	9.4%	10.6
$ 1,407,546	$ 300,947	21.4%	$ 875,748	0.4%	231.0	$ 470,352	6.7%	15.0	$ 451,423	9.3%	10.8
$ 1,425,040	$ 308,902	21.7%	$ 893,242	0.5%	221.7	$ 487,846	6.5%	15.4	$ 461,919	9.1%	11.0
$ 1,442,533	$ 316,885	22.0%	$ 910,736	0.5%	213.2	$ 505,340	6.3%	15.8	$ 472,415	9.0%	11.2
$ 1,460,027	$ 325,073	22.3%	$ 928,229	0.5%	204.5	$ 522,833	6.2%	16.2	$ 482,911	8.8%	11.4
$ 1,477,521	$ 333,398	22.6%	$ 945,723	0.5%	196.2	$ 540,327	6.0%	16.6	$ 493,408	8.7%	11.5
$ 1,495,015	$ 341,751	22.9%	$ 963,217	0.5%	188.4	$ 557,821	5.9%	16.9	$ 503,904	8.6%	11.7
$ 1,512,508	$ 350,666	23.2%	$ 980,711	0.6%	179.6	$ 575,315	5.8%	17.2	$ 514,400	8.7%	11.6

Probability statistics are based on a t distribution and 20 degrees of freedom

Table 5a: Efficient EV Frontier, Brown Soils, Saskatchewan

Expected Gross Margin ($CAN)	Cropping Activity (h)											Total Area (h)
	Fallow	CWRS on Fallow	CWRS on Canola	CWRS on Chick pea	CWAD on Fallow	CWAD on Canola	CWAD on Chick pea	CWAD on Lentil	Canola on Fallow	Lentil on Stubble	Chick Pea on Stubble	
$ 253,464	705.7	227.5	186.8	90.8	182.5	108.9	38.6	28.8	295.7	28.8	129.4	2,023.3
$ 268,464	878.9	352.2	80.4	84.0	155.4	70.8	62.4	27.0	371.3	27.0	146.4	2,255.9
$ 283,464	928.0	371.8	85.1	88.8	164.0	74.8	65.8	28.5	392.1	28.5	154.6	2,382.0
$ 298,464	900.2	342.1	90.9	95.0	169.5	96.9	84.1	40.9	388.6	40.9	179.2	2,428.3
$ 313,464	827.6	283.6	98.1	102.2	173.1	129.2	111.0	59.6	370.9	59.6	213.2	2,428.3
$ 328,464	755.1	225.2	105.2	109.4	176.8	161.7	137.9	78.2	353.2	78.2	247.3	2,428.3
$ 343,464	673.0	166.3	127.6	130.7	168.4	184.1	157.7	96.9	338.3	96.9	288.3	2,428.3
$ 358,464	579.5	103.9	156.9	178.3	139.7	179.0	167.3	121.0	335.9	121.0	345.6	2,428.3
$ 373,464	485.7	-	364.2	0.1	-	121.5	485.6	-	485.7	0.0	485.7	2,428.3

Table 5b: Efficient EV Frontier, Meckleberg, Germany

Expected Gross Margin ($CAN)	Cropping Activity (h)										Total Area (h)
	Long-Term Set Aside	Set Aside	Sugar Beets	Non-Food Rape on Barley	Food Rape on Barley	Non-Food Rape on Wheat	Wheat on Rape	Wheat on Beets	Wheat on Wheat	Barley on Wheat	
$ 1,372,558	30.0	233.6	60.0	132.8	226.8	34.5	334.1	60.0	28.6	359.6	1,500
$ 1,390,052	30.0	201.3	60.0	136.3	233.1	34.8	344.2	60.0	30.9	369.4	1,500
$ 1,407,546	30.0	169.6	60.0	140.1	239.4	35.4	354.9	60.0	31.1	379.5	1,500
$ 1,425,040	30.0	137.6	60.0	143.7	245.7	35.9	365.3	60.0	32.5	389.4	1,500
$ 1,442,533	30.0	101.6	60.0	148.0	254.8	27.2	370.0	60.0	45.6	402.8	1,500
$ 1,460,027	30.0	67.2	60.0	139.4	255.2	35.5	378.5	60.0	71.4	403.0	1,500
$ 1,477,521	30.0	35.5	60.0	135.5	256.9	37.6	390.7	60.0	80.8	413.1	1,500
$ 1,495,015	30.0	5.0	60.0	135.3	261.0	33.7	403.6	60.0	86.1	425.4	1,500
$ 1,512,508	30.0	-	60.0	87.0	316.0	27.0	430.0	60.0	87.0	403.0	1,500