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Economics in Technical Models of Farm Systems - Better none than some

By

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Abstract

Models of technical parts of farm systems have proliferated over the past decade. In this paper, the difference between the decision-information deriving from the farm management economic analysis that is included in a technical systems model, and the results derived from analysing the technical information that comes out of the model using standard farm management tools, is demonstrated, using case studies. In essence the argument of this paper is that in much systems simulation work provides sound technical coefficients about the operation of a farming system, which can then form the basis of, and be used in, whole farm management analyses. It is sufficient, to provide these coefficients without the systems model itself linking to some half-baked 'economic' analysis. In technical systems models destined to be decision support tools it may well be the case of no economics is better than some!

1/ Introduction

Most decisions about management of dairy farms are made by the farm managers on the basis of their own and their advisors' knowledge. This knowledge comes from past experiences about responses to particular actions and judgements about what is most likely to happen if particular actions are taken. The traditional farm management methods of decision analysis, and related decision support systems, have been developed to assist these decision-making processes – although in practice these methods are not used in a complete manner if they are used, and more often are not used at all.

Generally, decision support systems are a development of technical systems models – models which may or may not have been built for purposes of decision analysis. Often technical models are built with the aims of scientific investigation in mind. The requirements of models for the purposes of science, and the requirements for the purposes of decision analysis, are different. Generally, in decision support systems models, relevant pieces of technical information, which emerge, are incorporated into some attempt at economic and financial analyses, usually with no distinction between these two types of analysis! Often the high standards of the technical systems simulation are not matched by the standard of the economic analysis.

The underlying idea in this paper is that good technical information accompanied by good economic analysis is more useful to decision-makers than good technical information accompanied by low standard economic analysis. This idea is explored in the specific context of a well–established and highly regarded dairy decision support model called UDDER, tested in some decision-making situations in dairy-farming in South-western Victoria. The issue investigated in this research is that, as good and valuable as UDDER is as a decision support tool, even more valuable results could emerge from its use if the technical information from the model was used in the context of the traditional suite of farm management decision tools – partial (steady state and discounted cash flow) budgets and whole farm economic budgets, risk analysis budgets, and financial analysis budgets. To explore this notion, using case studies, the decision information arising from using the technical and economic analysis of the UDDER model is compared with the decision information resulting from using the technical information from UDDER and the traditional farm management methods.

The rest of the paper is as follows:

- Part 2. The dairy farm systems model UDDER is described and explained.
- Part 3. A partial budget to analyse dairy-farm changes.
- Part 4. Case studies are investigated.
- Part 5. Concluding discussion.

2/ The Dairy Systems Model UDDER

A systems simulation model of dairying activity called UDDER has been built and is used with growing popularity in dairy advisory circles in Australia and New Zealand. The model UDDER can be calibrated to particular dairy farming operations and in this way can provide extremely valuable technical information about how that farm might perform after changes have been made. To calibrate UDDER to the farm in question a thorough understanding is required of the interactions occurring within the farming system. Information is required about the farm's milk production, milk composition, cow condition, pasture condition and detailed descriptions of the farm's management during the year. Usually the most difficult figures to obtain are related to the pastures such as pasture growth rates and digestibility.

To begin calibrating UDDER, the actual performance figures from the most recent past production year on the farm are compared with the UDDER simulation of the performance of the farm. Usually there are some inconsistencies with the information provided by the farmer such as number of cows actually being milked at any one time and the amount of grain being fed. These irregularities are usually easily identified when the farm is simulated and the results are compared to the actual performance measures. To fix these problems, input variables are slightly changed so that the UDDER simulation of the operation of the farm for the production year begins to fit the known values of the year's production.

Once a good simulation of the animal numbers and grain feeding levels has been established, the focus is on predicting the farm pasture growth. UDDER requires pasture growth rates to make prediction about milk production, body condition score changes and changes in pasture cover on the farm. Getting accurate predictions of pasture growth rates is time consuming and expensive. UDDER calculates the growth rates from either the average pasture cover or the pre-grazing mass during the year which are more readily available. Once a series of pasture growth rates have been established it is necessary to test that UDDER is predicting reliable body condition scores by varying the levels of supplementation, lengths of rotations and the amount of pasture being conserved to provide more or less feed into the system. When the pasture growth rates and body condition scores are close to what is expected from the actual farm system, the predictions for milk production must be checked. Once UDDER is simulating the past production year properly, comparisons are made between the UDDER simulation of the original farm situation and the UDDER simulation of the change in strategy.

The economic analysis contained in the UDDER model comprises essentially an attempt to estimate the extra costs and gains, focussing on changes in variable costs and milk income, with some confusion between the economic and finance aspects of the change involved. The economic information required by UDDER for the gross margin analysis is built into the costs and prices section of the model, as seen in Table 1.

Table 1. UDDER Costs and Prices

Costs Of Purchased Feed

GRAIN	$/T wet
HAY	$/T wet
SILAGE	$/T wet
Price of Nitrogen	$/T
Agistment at 3 Months	$/Day
Agistment at 12 Months	$/Day
Agistment for 2 years up	$/Day

Costs of Conserved Fodder

	Hay	Haylage	Silage
Sale Value	($/T DM)	($/T DM)	($/T DM)
Conservation Costs	($/T DM)	($/T DM)	($/T DM)

Marginal cost of running a cow	$/Year
Marginal cost of extra milking	$/Year

Milk Prices

Market Milk Prices

Month	% milk to Market	Market Price ¢/l
January	- %	- ¢
February	- %	- ¢
March	- %	- ¢
April	- %	- ¢
May	- %	- ¢
June	- %	- ¢
July	- %	- ¢
August	- %	- ¢
September	- %	- ¢
October	- %	- ¢
November	- %	- ¢
December	- %	- ¢
Annual Adjustment		(¢/l)

Levies on Total Milk

Levies on total volume	(¢/l)
Levies on total fat	(¢/kg)
Levies on total protein	(¢/kg)
Annual charges	($/year)

Manufacturing Milk Price

Month	¢/litre	¢/kg fat	¢/kg prot
January	- ¢	- ¢	- ¢
February	- ¢	- ¢	- ¢
March	- ¢	- ¢	- ¢
April	- ¢	- ¢	- ¢
May	- ¢	- ¢	- ¢
June	- ¢	- ¢	- ¢
July	- ¢	- ¢	- ¢
August	- ¢	- ¢	- ¢
September	- ¢	- ¢	- ¢
October	- ¢	- ¢	- ¢
November	- ¢	- ¢	- ¢
December	- ¢	- ¢	- ¢
Litre adjustment			(¢/l)
Fat adjustment			(¢/kg)
Protein adjustment			(¢/kg)

3/ Using UDDER Technical Output in a Partial Budget

The model UDDER attempts to evaluate the economic benefit of the management change by estimating, essentially, the change in activity gross margin using single values for key variables such as milk and grain prices. Wider considerations are involved in analysing a change in the operation of a farming system. For example, changes other than those in variable costs are usually relevant, while finance charges are not relevant at all to the economic analysis, but do come into the financial analysis - which is a distinct and separate question.

Also, provision needs to be made for the price of feeds changing through the year. For example the price of grain is usually cheaper during the summer when many dairy farmers are feeding large amounts of grain. In reality different amounts of feeds are fed during different times of the year at different prices.

As well, every milk factory has a different pricing structure and the partial budget is set-up to try to accommodate all the different types of pricing strategies. There are different levies for market and manufacturing milk and not just one levy on all the milk produced. Most factories do not have one annual charge for the year, rather the farmers are charged per tanker stop at the farm. Many factories have quality incentives for the milk produced. These incentives are based on the farm being paid at different levels subject to the quality of the milk. The milk quality is graded by a series of tests for bulk cell count, total plate count, milk sediment, antibiotics, and freezing point. Some of the factories have seasonal and winter incentives, which are bonuses given during different months of the year.

A partial budget can be used to consider all the items of income and expense that might change once parts of the farm system changes. Shown in Table 2 is a skeletal model of a partial budget for analysing a change to a dairy farm system. As can be seen in the partial budget model, there is provision to evaluate the decision in terms of extra net return on extra capital involved by accounting for all extra costs and all extra returns resulting from a change in the operation of a dairy farming system. Extra income, extra variable costs, extra overheads, and extra tax are accounted for, allowing for price variation according to the time of year. As well, there is provision for financial analysis of the simulation in question, once it passes tests of economic soundness.

Table 2. The Partial Budget

Extra Income	**Annual**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**
Extra Milk Sales	-	-	-	-	-	-	-	-	-	-	-	-	-
Extra livestock sales	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Extra Income	-	-	-	-	-	-	-	-	-	-	-	-	-

Extra Variable Costs

Extra Feed Costs	**Annual**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**
Extra Grain Costs	-	-	-	-	-	-	-	-	-	-	-	-	-
Extra Fertiliser Costs	-	-	-	-	-	-	-	-	-	-	-	-	-
Extra Fodder Costs	-	-	-	-	-	-	-	-	-	-	-	-	-
Extra Lease & Agistment	-	-	-	-	-	-	-	-	-	-	-	-	-
Extra Feed Costs	-	-	-	-	-	-	-	-	-	-	-	-	-
Extra Shed Costs	-	-	-	-	-	-	-	-	-	-	-	-	-
Extra Herd Costs	-	-	-	-	-	-	-	-	-	-	-	-	-
Extra Casual Labour Costs	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Extra Variable Costs	-	-	-	-	-	-	-	-	-	-	-	-	-

Extra Overhead Costs	**Annual**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**
Extra Permanent Labour Costs	-	-	-	-	-	-	-	-	-	-	-	-	-
Extra Livestock Death & Depreciation	-	-	-	-	-	-	-	-	-	-	-	-	-
Extra Machinery Depreciation	-	-	-	-	-	-	-	-	-	-	-	-	-
Extra Machinery Repairs & Maintenance	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Extra Overhead Cost	-	-	-	-	-	-	-	-	-	-	-	-	-

Total Extra Expenditure	-	-	-	-	-	-	-	-	-	-	-	-	-

Extra Gains	**Annual**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**
Extra Monthly Gain	-	-	-	-	-	-	-	-	-	-	-	-	-
Cumulative Monthly Gain	-	-	-	-	-	-	-	-	-	-	-	-	-

Economic Analysis

Gain before Interest & Tax	-
Extra Return : Extra Cost Ratio before Interest & Tax	-
Return on Marginal Capital before Interest and Tax	-

Extra Capital Costs

Stock required (+) / Released (-)	-
Machinery required (+) / Released (-)	-
Net Capital Required (+) / Released (-)	-

Interest Schedule

Interest Rate	-
Extra Interest Received	-
Extra Interest on Borrowings	-
Gain after Interest and before Tax	-
Extra Return : Extra Cost Ratio after Interest and before Tax	-
Return on Marginal Capital after Interest and before Tax	-

Tax Schedule

Extra taxable income	-
Average Marginal Tax Rate	-
Gain after Interest & Tax	-
Extra Return : Extra Cost Ratio after Interest & Tax	-
Return on Marginal Capital after Interest & Tax	-

Financial Analysis

Gain after Interest and before Tax	-
Gain after Interest & Tax	-

4/ An example analysis of a dairy-farming question using UDDER and a Partial Budget

Farm Background and Current Situation

The case study to be examined is on a dairy farm near Terang in S/W Victoria during the 1996-1997 production year. The farm covers 113 ha and runs 200 milking cows. On this farm the cows start calving on June 1, with a mean calving date of June 18. Calving is usually finished within 10 weeks and the heifer calves remain at home for ten months after the start of calving. At the end of August the cows are joined for 12 weeks (9 weeks AI and 3 weeks Bull) The dry cows are grazed at home and in April the heifers leave the property for twelve months in an outpaddock.

Gain is fed throughout the year with a maximum of 5 kg. per day per cow being fed in August during joining. In a normal year 3 kg. per day per cow will be fed during the spring period but due to the short Spring break in the year in question the gain feeding levels only got down to 3.6 kg. per day per cow to try and conserve some of the limited pasture growth. During the 96/97 year a total of 274 tonnes of grain was fed to the milkers and calves, in comparison 1.27 tonnes of grain fed to each milking cow and 0.28 tonnes of grain fed to each calf. No fodder crops are grown on the farm. Hay and silage was cut on the farm during the month of November producing about 80 tonnes dry matter of hay and 50 tonnes dry matter of silage.

Two different types of fertilisers were used: 70 tonnes of Potash was applied in two applications of 35 tonnes in April and June and 11 tonnes of Urea was applied to the farm in two applications, half the farm was fertilised in late April and the other half fertilised in mid July.

In this case study two types of management change have been evaluated. First an increase in grain feeding during early and late lactation and second, the same increase in grain feeding with an increase in stocking rate from 200 to 220 milking cows.

Change in Grain Feeding

The management change simulated with UDDER in this case study is an increase in grain feeding of the milkers during the early and late lactation periods.

Figures 1 and 2 show the change to grain feeding during the lactation. In the simulation, during June and July more than 6 kilograms was fed to each cow per day. In August the gain feeding levels returned to around the normal levels until December when the gain levels were increased to over 5 kg. per day per cow, reaching a peak grain feeding level of 6.8 kg. per cow per day during March. The feeding levels were then reduced steadily to 5 kg. per day per cow by the end of the lactation.

Figure 1. Milker Grain Feeding for 200 and 220 Cow Scenarios.

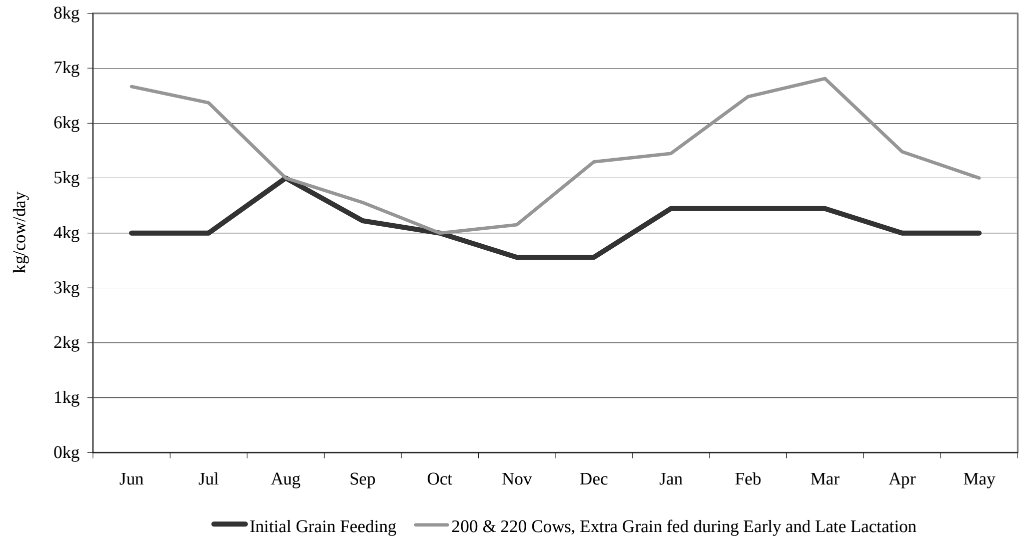
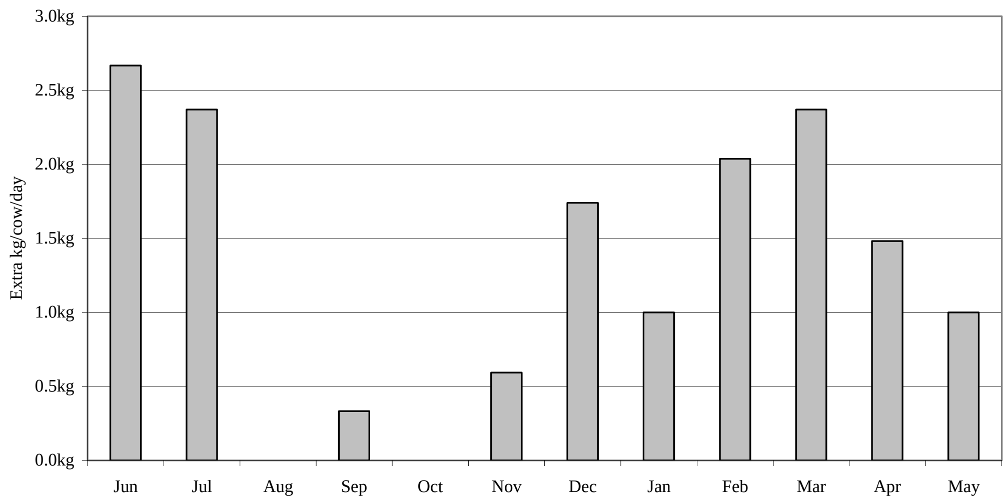


Figure 2. Extra Milker Grain Feeding for 200 and 220 Cow Scenarios.



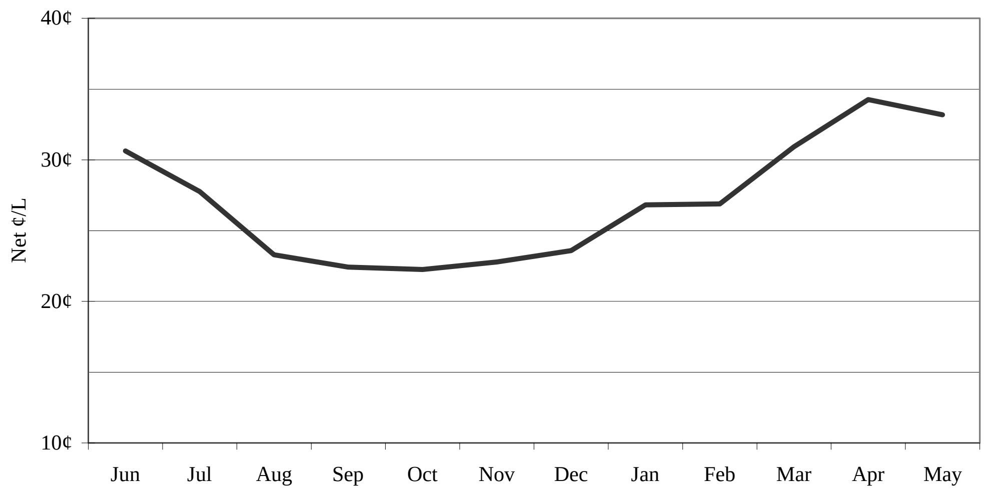
Change In Stocking Rate and Grain Feeding

The second management change that was simulated was to increase the milker numbers from 200 to 220. The new grain feeding regime was retained with the 220 cows to see whether the rise in grain feeding would be able to support an increase in cow numbers.

Milk Prices

In this simulation the extra grain was fed during the early stages of lactation to take advantage of the higher milk prices provided by the milk factory during June, July and August (Figure 3). Grain was fed during early lactation because the cows are able to provide a good milk response to concentrates. At this stage of lactation the cow's appetite is reduced and the animal is producing the greatest amount of milk. Due to this metabolic condition, the cows are in energy deficit and loosing weight, so when the their diet is supplemented with a high-energy feed such as grain, they are able to reduce the loss in body condition and produce a greater amount on milk.

Figure 3. Milk Prices



More grain was fed during late lactation after the spring to try to take advantage of the higher milk prices offered towards the end of the year (Figure 3). From the end of November to the end of February the levels of pasture growth are generally low so the extra grain fed also benefits the cows by providing a high-energy supplement and reducing the grazing pressure on the pastures. Even though the milk response of feeding extra grain during late lactation is not as great as during early lactation, a benefit can still be seen. The benefits are lower because they are in their third trimester of pregnancy and partitioning large amounts of energy to the foetus rather than to milk production.

Figure 4 shows the change in milk production due to the increase in grain feeding during early and late lactation with 200 and 220 cows when compared to the initial grain feeding regime with the original 200 cow herd size.

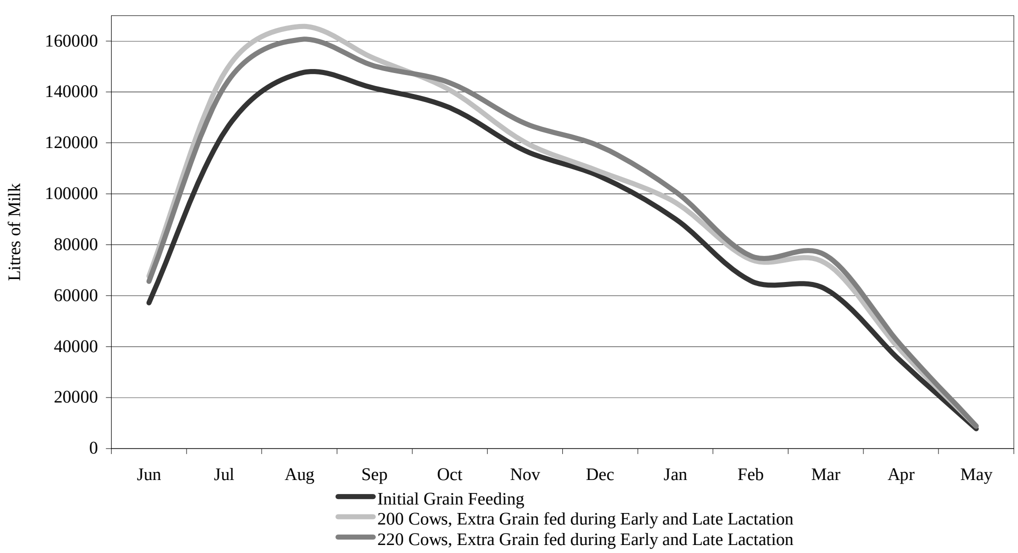
200 Cows fed more grain during early and late lactation.

In the simulation the extra 25.1 tonnes of grain fed to the herd produced an extra 109,481 litres of milk over the year. This means that over the whole lactation the cows gave an average response of over 1.43 litres of milk to every kilogram of grain fed. The cows produced an extra 547 litres each and had a slightly better condition score at the end of lactation with the extra grain feeding.

220 Cows fed more grain during early and late lactation.

In this simulation the extra 108.21 tonnes of grain fed to the herd produced an extra 125,172 litres of milk over the year. This means that during the whole lactation the cows gave an average response of over 1.14 litres of milk for every extra kilogram of grain fed. Even though the cows were being fed an extra 108 tonnes of grain, they only produced an extra 75 litres each as there were 20 extra cows in the herd and they finished the simulation with the same level of condition as in the original system.

Figure 4. Milk Production Change



Tables 3 and 4 show the farm production summary provided by UDDER with some limited economic information. The information is compared to the original farming system with the initial grain feeding regime and the original stocking rate of 200 cows. In Tables 3, 4, 5 and 6, Farm 1 is the original farming system and Farm 2 is the system with the changed farming system. The model UDDER generates a series of graphs depicting farm animal numbers, pasture production, supplements fed, animal intake, production and condition score and an annual gross margin.

Table 3. UDDER Production Summary. 200 Cows fed more grain during early and late lactation.

FARM PRODUCTION SUMMARY — Page 41

	WHOLE FARM		PER COW		PER HECTARE	
Strategy	1	2	1	2	1	2
Farm Area (ha) ...	113.0	113.0	0.5650	0.5650		
No of Cows	200	200			1.8	1.8
Fat Produced (kg).	44560	48164	222.8	240.8	394.3	426.2
Conc. Used (t)	274.00	347.33	1.370	1.737	2.425	3.074
Fod 1 Used (t)	105.73	105.73	0.529	0.529	0.936	0.936
Fod 2 Used (t)	70.83	70.83	0.354	0.354	0.627	0.627
Fod 3 Used (t)	0.00	0.00	0.000	0.000	0.000	0.000
Dry Matter Cut (t)	199.59	208.46	0.998	1.042	1.766	1.845
Nitrogen Used (t)	5.68	5.68	0.028	0.028	0.050	0.050
Milk Income......$	266032.59	294158.73	1330.16	1470.79	2354.27	2603.17
Price / kg fat ..$	5.97	6.11				
MILK INCOME .....$	266032.59	294158.73	1330.16	1470.79	2354.27	2603.17
FEED COSTS.......$	74134.32	88035.27	370.67	440.18	656.06	779.07
INCOME LESS FEED.$	191898.27	206123.45	959.49	1030.62	1698.21	1824.10
VARIABLE COSTS ..$	124134.32	138035.27	620.67	690.18	1098.53	1221.55
GROSS MARGIN.....$	141898.27	156123.45	709.49	780.62	1255.74	1381.62

Table 4. UDDER Production Summary. 220 Cows fed more grain during early and late lactation.

FARM PRODUCTION SUMMARY — Page 41

	WHOLE FARM		PER COW		PER HECTARE	
Strategy	1	2	1	2	1	2
Farm Area (ha) ...	113.0	113.0	0.5650	0.5136		
No of Cows	200	220			1.8	1.9
Fat Produced (kg).	44560	49833	222.8	226.5	394.3	441.0
Conc. Used (t)	274.00	382.21	1.370	1.737	2.425	3.382
Fod 1 Used (t)	105.73	116.32	0.529	0.529	0.936	1.029
Fod 2 Used (t)	70.83	77.91	0.354	0.354	0.627	0.689
Fod 3 Used (t)	0.00	0.00	0.000	0.000	0.000	0.000
Dry Matter Cut (t)	199.59	170.39	0.998	0.775	1.766	1.508
Nitrogen Used (t)	5.68	5.68	0.028	0.026	0.050	0.050
Milk Income......$	266032.59	297727.94	1330.16	1353.31	2354.27	2634.76
Price / kg fat ..$	5.97	5.97				
MILK INCOME .....$	266032.59	297727.94	1330.16	1353.31	2354.27	2634.76
FEED COSTS.......$	74134.32	100463.51	370.67	456.65	656.06	889.06
INCOME LESS FEED.$	191898.27	197264.43	959.49	896.66	1698.21	1745.70
VARIABLE COSTS ..$	124134.32	155463.51	620.67	706.65	1098.53	1375.78
GROSS MARGIN.....$	141898.27	142264.43	709.49	646.66	1255.74	1258.98

Tables 5 and 6 show a limited evaluation of the initial farm strategy (Farm 1) compared to the new strategies in question (Farm 2) with extra grain feeding during early and late lactation.

Table 5. UDDER Margin Analysis. 200 Cows fed more grain during early and late lactation.

MARGIN ANALYSIS ($)			Page 44
Strategy	1	2	2 – 1
TOTAL MILK INCOME.	266032.59	294158.73	28126.14
Cow/Milking costs.	50000.00	50000.00	0.00
Concentrate Costs.	54252.59	68771.72	14519.12
Fodder Costs......	5080.32	4462.15	–618.17
Nitrogen Costs....	4541.60	4541.60	0.00
Agistment Costs...	10259.80	10259.80	0.00
Fodder crops......	0.00	0.00	0.00
FEED COSTS........	74134.32	88035.27	13900.95
VARIABLE COSTS....	124134.32	138035.27	13900.95
INCOME OVER FEED..	191898.27	206123.45	14225.19
MARGIN............	141898.27	156123.45	14225.19
MARGIN / cow......	709.49	780.62	71.13
MARGIN / ha.......	1255.74	1381.62	125.89
LITRES............	1084964	1194445	109481
FAT...............	44560	48164	3604
PROTEIN...........	35206	38786	3580

Table 6. UDDER Margin Analysis. 220 Cows fed more grain during early and late lactation.

MARGIN ANALYSIS ($)			Page 44
Strategy	1	2	2 – 1
TOTAL MILK INCOME.	266032.59	297727.94	31695.36
Cow/Milking costs.	50000.00	55000.00	5000.00
Concentrate Costs.	54252.59	75677.97	21425.38
Fodder Costs......	5080.32	8958.16	3877.84
Nitrogen Costs....	4541.60	4541.60	0.00
Agistment Costs...	10259.80	11285.78	1025.98
Fodder crops......	0.00	0.00	0.00
FEED COSTS........	74134.32	100463.51	26329.19
VARIABLE COSTS....	124134.32	155463.51	31329.19
INCOME OVER FEED..	191898.27	197264.43	5366.16
MARGIN............	141898.27	142264.43	366.16
MARGIN / cow......	709.49	646.66	–62.83
MARGIN / ha.......	1255.74	1258.98	3.24
LITRES............	1084964	1210136	125172
FAT...............	44560	49833	5273
PROTEIN...........	35206	39328	4122

In Tables 7 and 8 the results of a partial budget of the same case study are shown. The partial budget allows for changes other than changes in the variable costs and impacts of different milk prices from the original farming strategy. These partial budgets uses the technical information provided by UDDER but generates the milk prices, feed costs, shed costs and herd costs on a month by month basis using the monthly prices rather than annual average prices. There is also the provision for extra overheads, extra depreciation of a larger herds, extra opportunity cost of capital of a larger herd and extra income tax incurred due to the changed management regime.

200 Cows fed more grain during early and late lactation.

Using the partial budget (Table 7) the extra gain feeding extra grain during early and late lactation is $9,524 after interest and tax. With UDDER’s gross margin evaluation (Table 5) the extra gain is given as $14,225 before tax.

Table 7. Partial Budget. 200 Cows fed more grain during early and late lactation.

Extra Income	**Annual**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**
Number of Days	365	30	31	31	30	31	30	31	31	28	31	30	31
Extra Milk Sales	$26,574	$2,844	$5,689	$3,749	$2,457	$1,562	$781	$469	$1,741	$2,280	$3,191	$1,462	$351
Extra livestock sales	$0	$0											
Total Extra Income	$26,574	$2,844	$5,689	$3,749	$2,457	$1,562	$781	$469	$1,741	$2,280	$3,191	$1,462	$351

Extra Variable Costs													
Extra Feed Costs	**Annual**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**
Extra Grain Costs	$14,925	$1,722	$2,658	$0	$380	$0	$711	$2,159	$1,240	$2,167	$2,792	$948	$147
Extra Fertiliser Costs	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Extra Fodder Costs	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Extra Lease & Agistment	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Extra Feed Costs	$14,925	$1,722	$2,658	$0	$380	$0	$711	$2,159	$1,240	$2,167	$2,792	$948	$147
Extra Shed Costs	$445	$44	$97	$77	$49	$29	$14	$8	$27	$35	$43	$18	$4
Extra Herd Costs	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Extra Casual Labour Costs	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Extra Variable Costs	$15,370	$1,766	$2,755	$77	$429	$29	$725	$2,167	$1,267	$2,202	$2,835	$966	$151

Extra Overhead Costs	**Annual**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**
Extra Permanent Labour Costs	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Extra Livestock Death & Depreciation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Extra Machinery Depreciation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Extra Machinery Repairs & Maintenance	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Extra Overhead Cost	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Extra Expenditure	$15,370	$1,766	$2,755	$77	$429	$29	$725	$2,167	$1,267	$2,202	$2,835	$966	$151

Extra Gains	**Annual**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**
Extra Monthly Gain	$11,204	$1,078	$2,933	$3,671	$2,028	$1,533	$55	-$1,698	$474	$77	$356	$496	$199
Cumulative Monthly Gain	$11,204	$1,078	$4,011	$7,682	$9,711	$11,243	$11,299	$9,601	$10,075	$10,152	$10,508	$11,005	$11,204

Economic Analysis

Gain before Interest & Tax	$11,204
Extra Return : Extra Cost Ratio before Interest & Tax	1.73

Tax Schedule

Average Marginal Tax rate	15%
Gain after Interest & Tax	$9,524
Extra Return : Extra Cost Ratio after Interest & Tax	1.62

220 Cows fed more grain during early and late lactation.

The partial budget (Table 8) indicates that would be a gain after interest and tax of $3,648. UDDER's economic evaluation (Table 6) indicated that that there would be an extra gain before tax of $366. Importantly in this case, as extra capital is invested in cows, the partial budget indicates the expected return on marginal capital, which is 24 per cent after interest and tax.

Table 8. Partial Budget. 220 Cows fed more grain during early and late lactation.

Extra Income	**Annual**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**
Number of Days	365	30	31	31	30	31	30	31	31	28	31	30	31
Extra Milk Sales	$32,741	$2,601	$5,011	$3,154	$2,021	$2,232	$2,521	$2,863	$2,899	$2,671	$4,187	$2,198	$384
Extra livestock sales	$1,834	$1,834											
Total Extra Income	$34,575	$4,435	$5,011	$3,154	$2,021	$2,232	$2,521	$2,863	$2,899	$2,671	$4,187	$2,198	$384

Extra Variable Costs													
Extra Feed Costs	**Annual**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**
Extra Grain Costs	$21,831	$2,159	$3,376	$671	$979	$496	$1,209	$2,815	$1,973	$2,935	$3,682	$1,299	$236
Extra Fertiliser Costs	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Extra Fodder Costs	$612	$2	$0	$0	$0	$0	$0	$0	$0	$0	$604	$2	$4
Extra Lease & Agistment	$2,400	$200	$200	$200	$200	$200	$200	$200	$200	$200	$200	$200	$200
Extra Feed Costs	$24,843	$2,361	$3,577	$871	$1,179	$696	$1,409	$3,015	$2,173	$3,135	$4,486	$1,501	$440
Extra Shed Costs	$811	$51	$102	$86	$67	$71	$75	$79	$75	$70	$85	$43	$9
Extra Herd Costs	$1,575	$58	$74	$161	$359	$279	$79	$79	$137	$155	$164	$23	$7
Extra Casual Labour Costs	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Extra Variable Costs	$27,230	$2,471	$3,752	$1,118	$1,605	$1,046	$1,563	$3,174	$2,385	$3,360	$4,734	$1,567	$455

Extra Overhead Costs	**Annual**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**
Extra Permanent Labour Costs	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Extra Livestock Death & Depreciation	$1,553	$129	$129	$129	$129	$129	$129	$129	$129	$129	$129	$129	$129
Extra Machinery Depreciation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Extra Machinery Repairs & Maintenance	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Extra Overhead Cost	$1,553	$129	$129	$129	$129	$129	$129	$129	$129	$129	$129	$129	$129
Total Extra Expenditure	$28,784	$2,600	$3,882	$1,248	$1,734	$1,175	$1,692	$3,303	$2,514	$3,490	$4,863	$1,697	$585

Extra Gains	**Annual**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**
Extra Monthly Gain	$5,791	$1,834	$1,129	$1,906	$286	$1,057	$828	-$440	$385	-$819	-$676	$501	-$201
Cumulative Monthly Gain	$5,791	$1,834	$2,963	$4,870	$5,156	$6,213	$7,041	$6,602	$6,986	$6,168	$5,491	$5,992	$5,791

Economic Analysis

Gain before Interest & Tax	$5,791
Extra Return : Extra Cost Ratio before Interest & Tax	1.20
Return on Marginal Capital before Interest and Tax	39%

Extra Capital Costs

Stock required(+) / Released(-)	+15000
Machinery required(+) / Released(-)	0
Net Capital Required(+) / Released(-)	+15000

Interest Schedule

Stock required	$15,000
Interest Rate	10%
Extra Interest on Borrowings	$1,500
Gain after Interest and before Tax	$4,291
Extra Return : Extra Cost Ratio after Interest and before Tax	1.15
Return on Marginal Capital after Interest and before Tax	29%

Tax Schedule

Average Marginal Tax rate	15%
Gain after Interest & Tax	$3,648
Extra Return : Extra Cost Ratio after Interest & Tax	1.13
Return on Marginal Capital after Interest & Tax	24%

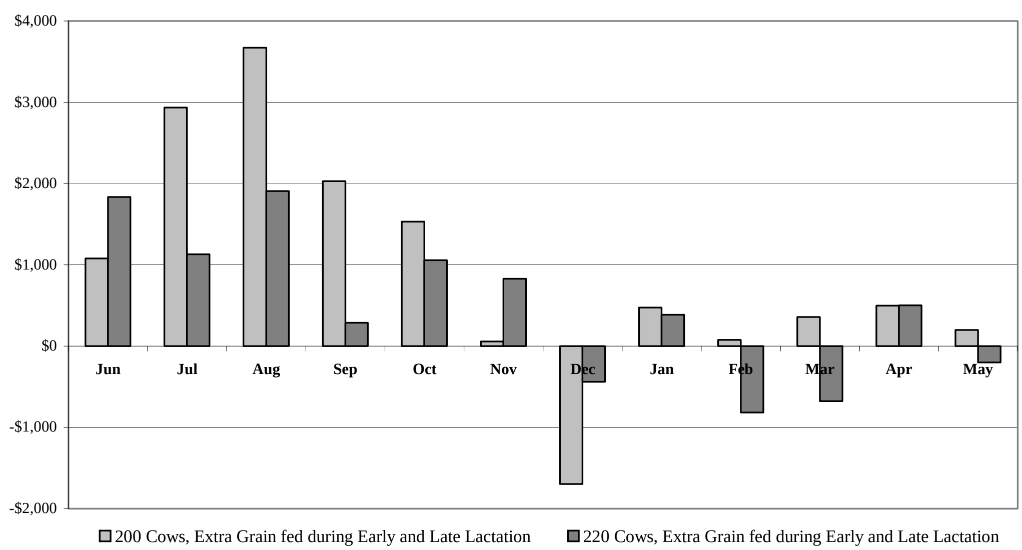
Financial Analysis

Gain after Interest and before Tax	$4,291
Gain after Interest & Tax	$3,648

The differences in results in this case using the UDDER economic analysis and the partial budget can be attributed to UDDER not being able to calculate the monthly milk and grain prices as accurately and the fuller treatment of capital and tax aspects using the partial budget. The model UDDER uses only one-grain price for the whole year rather than a monthly price, as is done in the partial budget. The model UDDER does not make provision for all the different pricing strategies of all the different milk factories around Victoria. The partial budget has valued the grain and the milk more precisely throughout the year. An account has also be made of the other extra feed costs, shed costs, herd costs, depreciation costs and livestock sales that have not been as accurately accounted for in UDDER as in the partial budget case. As it is set up, the partial budget provides an evaluation of the extra gains or losses incurred for each month so that the farmer can see during what months he or she is losing or gaining from the management change.

In Figure 5 a month by month evaluation of the two management changes is shown. It can be seen that the general trend for both changes was to register large gains during early and mid-lactation and then minor gains and losses toward the end of lactation. Even though large gains were not made during late lactation with extra grain feeding, it still helps the herd stay in good condition during the time of the year when there is not a lot of quality pasture available, thus putting the animals in good condition for the next season. In the simulation, if the grain is taken out of the system during the late lactation, the animals lose condition, milk production suffers and the quantity of pasture available to the cows declines. Figure 5 indicates exactly when positive and negative impacts on the overall net gain from the extra grain feeding occurring during the year.

Figure 5. Extra Monthly Gain before Tax



200 Cows fed more grain during early and late lactation.

The first five months showed good returns for the extra grain being fed but in December there was an $1,698 loss. This loss was recouped by the end of the year. If the extra grain being fed during December was removed the cows struggled with production for the rest of the year and did not recoup the earlier loss.

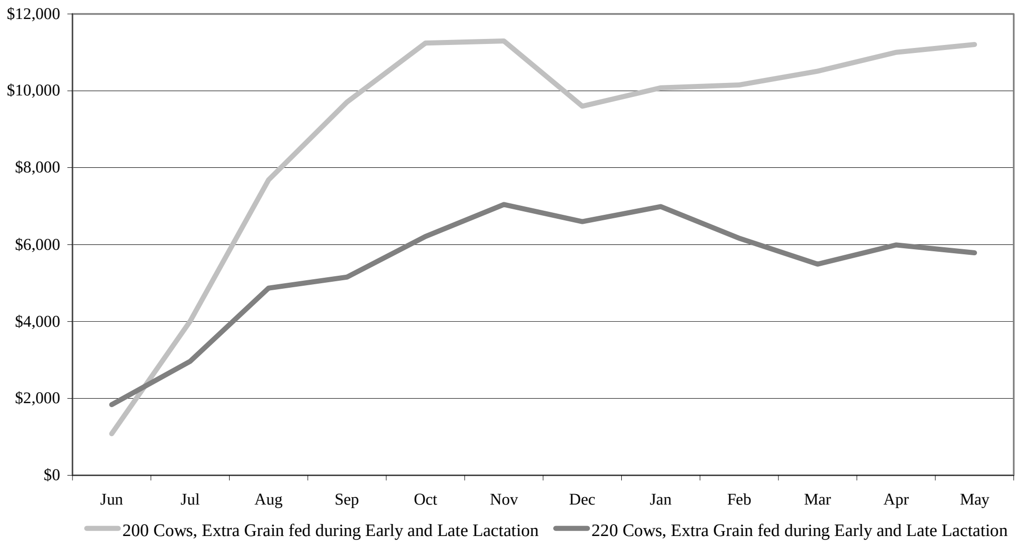
220 Cows fed more grain during early and late lactation.

Strong benefits were displayed during the first six months of the simulation. Only small gains and losses were incurred during late lactation. If the extra grain feeding was removed from the simulation the cows rapidly lost condition and milk production dropped, putting the herd and pastures in a poor position for the next season.

Even though the gains from extra grain feeding during late lactation are not immediately evident there are carry-over effects occurring into the next years production. Without the extra feeding during late lactation, the cows were not able to carry the increased production into the next year and their condition dropped and pasture production reduced due the pressure placed on the cows during late lactation.

Figure 6 shows the monthly extra cumulative gains from the change in grain feeding and stocking rate during the whole of the lactation for the two herd sizes. This graph indicates how the monthly gains and losses accumulate during the year to provide an annual gain or loss.

Figure 6. Cumulative Extra Monthly Gain before Tax



Another benefit of the partial budget is the ease of scenario analysis, which is not easily done using UDDER. Tables 9 and 10 show a simple scenario analysis of the gain after tax and the return:cost ratio after tax which has been generated from the partial budget using a computer spreadsheet. Three different grain prices have been evaluated: original grain price; a 10 per cent increase in grain price; and a 10 per cent decrease in grain price. Also Four milk price step-up regimes have been assessed: original regime ($0.75/kg BF equivalent); $0.4/kg BF equivalent; $0.6/kg BF equivalent; and $0.8/kg BF equivalent.

200 Cows fed more grain during early and late lactation.

The scenario analysis in Table 9 indicates that the increase in grain feeding to the 200 cows during early and late lactation would be beneficial under most price changes, except if the worst step-ups of $0.4/kg BF equivalent occurred.

Table 9. Scenario Analysis. 200 Cows fed more grain during early and late lactation.

Grain Price Scenarios	Altered Stepup Regime Scenarios	200 Cows, More Grain during Early & Late Lactation			
		Gain before Tax	Return:Cost before Tax	Gain after Tax	Return:Cost after Tax
Grain Price increase of 10%	Original Regime ($0.75/kg BF Equivalent)	$9,712	1.58	$8,255	1.49
	$0.4/kg BF Equivalent	-$6,361	0.62	-$6,361	0.62
	$0.6/kg BF Equivalent	$2,771	1.16	$2,356	1.14
	$0.8/kg BF Equivalent	$11,995	1.71	$10,196	1.60
Original Grain Price	Original Regime ($0.75/kg BF Equivalent)	$11,204	1.73	$9,524	1.62
	$0.4/kg BF Equivalent	-$4,868	0.68	-$4,868	0.68
	$0.6/kg BF Equivalent	$4,264	1.28	$3,624	1.24
	$0.8/kg BF Equivalent	$13,487	1.88	$11,464	1.75
Grain Price decrease of 10%	Original Regime ($0.75/kg BF Equivalent)	$12,697	1.91	$10,792	1.78
	$0.4/kg BF Equivalent	-$3,376	0.76	-$3,376	0.76
	$0.6/kg BF Equivalent	$5,756	1.41	$4,893	1.35
	$0.8/kg BF Equivalent	$14,980	2.08	$12,733	1.92
UDDER Result (Original Prices)		$14,225			

220 Cows fed more grain during early and late lactation.

The scenario analysis in Table 10 indicates that the increase in grain feeding of the 220 cows during early and late lactation would only be viable if the relatively high milk prices persisted. With the original step-up ($0.75/kg BF equivalent) and $0.8/kg BF equivalent step-up the increase in grain feeding was still profitable after a grain price increase of 10 per cent. The lower step-up regimes of $0.4/kg BF equivalent and $0.6/kg BF equivalent would not be viable even if the grain price dropped by 10 per cent. When milk price falls to the lower levels of $0.6/kg BF equivalent and $0.4/kg BF equivalent the extra grain feeding offers no gain.

Table 10. Scenario Analysis. 220 Cows fed more grain during early and late lactation.

Grain Price Scenarios	Altered Stepup Regime Scenarios	220 Cows, More Grain during Early & Late Lactation					
		Gain before Interest and Tax	Return:Cost before Interest and Tax	Return before Interest and Tax	Gain after Interest and Tax	Return:Cost after Interest and Tax	Return after Interest and Tax
Grain Price increase of 10%	Original Regime ($0.75/kg BF Equivalent)	$3,570	1.12	24%	$1,759	1.06	12%
	$0.4/kg BF Equivalent	-$12,856	0.59	-86%	-$14,356	0.54	-96%
	$0.6/kg BF Equivalent	-$3,506	0.89	-23%	-$5,006	0.84	-33%
	$0.8/kg BF Equivalent	$5,907	1.19	39%	$3,746	1.12	25%
Original Grain Price	Original Regime ($0.75/kg BF Equivalent)	$5,791	1.20	39%	$3,648	1.13	24%
	$0.4/kg BF Equivalent	-$10,634	0.63	-71%	-$12,134	0.58	-81%
	$0.6/kg BF Equivalent	-$1,284	0.96	-9%	-$2,784	0.90	-19%
	$0.8/kg BF Equivalent	$8,129	1.28	54%	$5,635	1.20	38%
Grain Price decrease of 10%	Original Regime ($0.75/kg BF Equivalent)	$8,013	1.30	53%	$5,536	1.21	37%
	$0.4/kg BF Equivalent	-$8,413	0.68	-56%	-$9,913	0.63	-66%
	$0.6/kg BF Equivalent	$938	1.04	6%	-$562	0.98	-4%
	$0.8/kg BF Equivalent	$10,351	1.39	69%	$7,523	1.28	50%
UDDER Result (Original Prices)		$366					

This farming system seems to be more sensitive to a change in step-up price rather than a change in grain price as indicated by the rather small effect a change in grain price has when compared to a change in milk price. A 10 per cent change in grain price seems to either make the situation even better or even worse, but it does not appear to change the viability of the changed grain feeding regime which is being investigated.

To sum up, a limitation of UDDER is that the model estimates a herd gross margin which does not capture fully the gains and costs associated with management changes. Further the method of the gross margin calculation is a little odd from the viewpoint of farm management economics. Overall, UDDER is able to technically simulate what happens on a dairy farm very well, providing reliable detailed information is available about the particular farm in question. It can provide a good representation of how the animals, supplements and pasture interact to produce milk, which is useful information.

5/ Concluding Discussion: Technical Systems Models and Farm Management Analysis

Nowadays there is an abundance of computer models for simulating technical aspects of agricultural production processes. Such models often evolve from scientific inquiries where a detailed computer representation of a part of the production process facilitates exploration of the part of the production process that is of interest, in lieu of experimentation. Often the builders of such technical models of parts of agricultural production systems then seem to think 'I'd better put 'some economics' in this, usually 'at the end somewhere' – without apparent awareness that the economic considerations are involved throughout the operation of production systems, from setting the agenda onwards.

Further, the attempted economic analysis added to technical systems models usually takes the form of some activity gross margins, or occasionally financial cash flow budgets, neither of which are economic in the sense of telling the worth of the change to the production system (extra return on extra capital). 'The economics' is usually automatically linked with the technical data and formulas, which occur within the technical systems model, in order to eventually come up with 'a number' which is 'the answer'. This is where the technical systems modelers can go astray; especially if there is a belief that there is a generic 'answer', as in the real world there are no generic answers for individual farm businesses. In the real world, every case is different. The particular technique of economic analysis to use varies with each situation – the nature of the problem and the perspective determines the method of analysis.

The technical information which makes up a technical systems model of a particular farm situation is a necessary part of economic analysis of that farm case, but as to which farm management analytical techniques are appropriate to analyse a particular farm management question depends on what question is being asked.

Building the economic and financial analytical methods into the technical model means the model determines the analytical method, when the method(s) has/have to be determined by the questions and the details of the case at hand. Often, a partial development budget is needed, or a steady state partial budget – changes in activity gross margins budgets are rarely a relevant technique. Generally, activity gross margins budgets only have a role as part of a more comprehensive analytical technique such as partial, whole farm, and risk budgets.

Thus, the argument presented in this paper is that because the appropriate approach to analysing a problem depends on the nature of the problem, the farm management analysis is more useful if it remains outside the operation of the technical systems model. The technical information which is output from the systems model is simply input to the whole farm analysis, along with human, economic, financial, risk, institutional and other technical information which makes up farm management analysis. Partial, whole farm and risk budgets on the computer spreadsheet are powerful tools, enabling comprehensive evaluation of the changes that are expected to occur on the farm due to a change in the way the system is managed. Due to their simplicity, it is possible to analyse a short term or long term plan, making sure that all the income and expense changes are accounted for from year to year.

The problem of the technical systems models getting the economics wrong may stem from the inadequately held whole-farm views of technologists, as well as from a lack of appreciation for the multi-faceted nature of farm problems. Also, there can be simply a lack of understanding of how to use the useful farm management decision budgets. There is a whole suite of well-developed tools of farm management analysis - all that is missing usually is the relevant technical coefficients for particular changes in the operation of part of a farm system.

The technical expert systems, if built in an appropriately skeletal manner can be useful in providing sound technical output relevant to particular farm cases, which is then input into the whole farm, partial, development and break-even budgets which are the cornerstones of farm management analyses. Importantly, the process of doing the whole farm analysis itself is enlightening and a critical part of the process of forming judgements and reaching decisions.

A related question arises as to the degree of technical detail that is necessary in order to make a sound farm management decision. In farm management decision analysis and decision-making, just enough information is needed for the decision-maker to reach a decision – and how much is enough depends on each situation. However, the argument here is that what is enough information for the purposes of scientific analysis might not be the same amount as would be enough for many farm management decision situations. For sound farm management decisions it is not necessary to know everything about everything- enough about enough will do.

In essence the argument of this paper is that in much systems simulation work two things are not well recognized; (i) providing sound technical coefficients about the operation of a farming system which can then form the basis of, and be used in, whole farm management analyses is sufficient, without the systems model itself linking to some half-baked 'economic' analysis. Relatedly, (ii) the marked difference between the technical information required for scientific analytical purposes and the amount of information needed to make a sensible decision about farm management. In technical systems models destined to be decision support tools it may well be the case of no economics is better than some!

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