COMPARISONS OF FARMING SYSTEMS YIELD MORE QUESTIONS THAN ANSWERS

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Abstract

Farming is a complex business where profit and sustainability affect management. Ideally, farm management tools should consider both profit and sustainability. Unfortunately, they do not. A novel whole-farm budget (FARM) is described that addresses both farm profitability and sustainability. FARM helps evaluate and compare farming systems by integrating enterprise budgets into a whole-farm budget. The costs of soil erosion, acidification, salinisation and soil structural decline are estimated. The user can specify the enterprise budgets and all of the cost, price and yield data, so FARM is very flexible. Much of the input data is specific to individual farms and farmers, and is subjective but relevant. Although the use of subjective input data can bias the results, this is considered preferable to using less relevant, but documented data. The uses of FARM are mostly open-ended, with constant juggling of input data and evaluation of results. Users can play with FARM. We discuss some benefits of p laying management games.

Keywords: farm, business, budget, sustainability, software, comparison, bias, game, learning

Farmers operate complex businesses. The complexity of the choices of enterprises and products and the farming systems required to successfully produce a range of products can make mixed farms difficult to manage. In southern Australia a "wheat- sheep" farm often produces multiple grain commodities, animals for meat and breeding, and wool. The grains are further segregated into quality classes that have substantial price differentials and may require special farming methods. Livestock and wool are also segregated and sold according to quality. Some farming systems in the northern grain belt are simpler, and have wheat as the sole crop, but the quantity and quality of the wheat produced nevertheless depends strongly on management.

Farmers also deal with land degradation, and this affects their business decision-making. Land and water are easily degraded or ruined by poor stewardship. But despite the importance of both profit and stewardship in farm decision-making, farm business economics has not usually linked profits with the economics of land and water stewardship. Some recent studies have gone as far as relating soil management and consequent changes in soil erosion to wheat gross margins (1). However, a more comprehensive approach linking profit and sustainability at a farm level would be a useful advance.

A major objective of many farmers, in broad terms, is to earn an adequate living and protect their resources.? But how? Having a good mix of suitable enterprises is an essential ingredient of productive, sustainable farming. Suitable enterprises ar e usually those with a good balance of profit and sustainability, and a good mix enhances the performance of the individual enterprises.? For example, pasture leys often have positive effects on the profitability and sustainability of wheat cropping systems.

So how do farmers choose suitable enterprises and a good mix of enterprises? In some areas there are benchmarks for production or quality. For example, maintaining 10% protein in wheat achieves Australian Standard White (ASW) prices and requires maintenance of available soil nitrogen. This usually involves legume leys in the south and fertiliser applications in the north. Other ways of selecting a farming system are to use trial and error (at least to fine-tune a system), or to mimic or make minor adaptions to systems that perform well.

While benchmarks, rules-of-thumb and mimicry may be useful, good management of individual farms is very specific (2). Analysis of the circumstances of individual farms may be a way of improving management. Budgeting has been useful, and activity budgets , whole-farm budgets, partial budgets, cash-flow budgets and sensitivity budgets have been developed and applied in farming (2). These are all relatively simple and powerful.? More complex analyses of inputs, outputs and enterprise mixes are also possible. These include mathematical programming (MP) methods used in the MIDAS (3) and PRISM (4) models, and other tools such as dynamic programming. Simplicity is a major advantage of budgets over complex tools like MP.

Activity budgets such as gross margins (GMs) are very popular. However, they are not helpful for deciding enterprise mix or choice because they do not allow for inter-activity benefits and costs, and these are often important in determining the best enterprise mix or rotations (3, 4). For example, GMs will allocate the benefits of legumes in rotations to later cereal crops because that is where the benefit is expressed in increased yield or price (for quality). Also, we usually calculate GMs on a per crop basis, and do not usually account for effects of crop frequency. For example, growing 2 crops with GMs of $100/ha each would be preferable to growing 1 crop in the same period with a GM of $150/ha. Whole-farm analysis also allows for reduced/diffe rent machinery, labour, *etc.* when looking at substantial changes, such as introducing ley pastures, irrigation, intensive crops, share-farming, *etc*. Malcolm (2) also considers a crude analysis at a whole-farm level to be preferable to a detailed analysis of a small part of the farming system.

A whole-farm budget that easily allowed the user to compare enterprise mixes and rotations (including the sustainability costs) would be a very useful management tool. All the better if it was generalised to work for the major farming systems of the Australian cropping zone.? And allows users to tailor the system to their particular needs. The main aim of this paper is to describe such a system. Other aims are to apply the system, evaluate the approach taken, and discuss a role for the system in learning and improving management skills.

Results

Development of FARM

The whole-farm budget was initially specified and developed as an Excel workbook by P. Ridge. Consultation with B. Robinson and P. Wylie lead to the development of a workbook with 6 spreadsheets, specifying land and machinery values and overhead costs, crop and pasture sequences, livestock production, crop gross margins (2 sheets - winter and summer crops), and results. Fig. 1 shows the key parts of the crop and pasture sequences sheet and Fig. 2 shows the main table of results. Users enter code d crop, pasture and fallow names in a sequence to specify cropping systems. Appropriate GMs are linked from separate spreadsheets.

	Summer		*Winter cereals*		*Winter others*		*Pastures*
sor	sorghum	whe	Wheat	pea	Field peas	P1	Lucerne
cot	Cotton	bam	Barley malt	lup	Lupins	P2	Clover/medic
cos	Cotton-skip	baf	Barley feed	chi	Chick peas	P3	Per. grass/legume
sun	Sunflower	oag	Oats grain	can	Canola	P4	Annual grass/legume
mai	Maize	oad	Oats dual	saf	Safflower	P5	User-defined #2
mun	Mungbean	tri	Triticale	len	Lentils		
-	Fallow 1	-	Fallow 1	fab	Faba beans		
				lin	Linola		

		Area	Year 1		2		3		4		5		
Soil type		(ha)	S	W	S	W	S	W	S	W	S	W	S
A	1	400	sor	-	sor	-	sor	whe	mun	-			
	2												
B	1	100	sor	-	sor	-	mun	-	P1	P1	P1	P1	
	2	100	-	whe	-	whe	-	chi					

Figure 1. Part of the crop and pasture sequence sheet. A sequence is represented by entering codes from left to right (for up to 9 years, 5 shown). In this example, summer and winter crops and pasture (lucerne) are grown, with 1 sequence on soil type A and 2 sequences on soil type B. The codes are used to access yield and economic information from the crop and pasture GM sheets. All of the codes and the GM information are user-definable (e.g. wheat could be coded 'w' or 'Hartog', GMs for durum wheat or tomatoes could be added).

Following the development of this part (Version 1), a workshop was convened (in Adelaide) to display and evaluate the budget and brainstorm the development of budgets for sustainability issues. Team members developed sections on issues that were important in their farming regions. Several sustainability issues were identified and methods of estimating their costs were devised. In each case the cost was estimated as either the on-farm cost of the factor (soil erosion, acidification and? structural decline) or the on-farm cost of ameliorating a problem that usually occurs off-farm (salinisation) (Fig. 3). Some important issues were considered too difficult to cost, such as pesticide hazards. As well as continuous review and consultation with the workshop participants, improvements leading to Version 2 were based on a workshop with consultants and scientists.

GM and profit (annual mean of rotation/sequence)		
GM from		
Cropping on soil A	$	88,000
Cropping on soil B	$	21,360
Permanent pastures	$	19,080
Pastures on soil A and B	$	2,480
Overheads		
Labour	$	25,000
Machinery replacement	$	34,420
Other overheads	$	-
Cost of working capital	$	10,521
Operating profit	$	60,979
Capital value ($ thousands)	$	1,450
Return on capital (% per annum)		4.2%

Figure 2. Part of the results sheet, indicating GMs, overheads, operating profit and return on capital (at full equity). These figures were for a large farm on the Darling Downs.

Sustainability Costs		
Water Erosion - Soil Loss		
Salinity – Loss of GM to Redress	$	2,839
Acidity – Cost to Redress with Lime	$	3,571
Wind Erosion Damage- Loss of GM	$	108
Structural Decline - Loss of GM	$	435
Total Sustainability Cost	$	6,953
Op. Profit after Sustainability	$	(2,936)
Return on Capital		
after Sustainability Costs (% pa)		-0.3%

Figure 3. Sustainability costs as shown on the results sheet. Each cost (water and wind erosion, acidification, salinisation and soil structural decline) is estimated on a separate sheet. These figures were for a small mixed farm in southern NSW.

Version 3 was developed from responses from further workshops in Dalby, Muresq, Horsham, Bendigo, Wagga Wagga and Adelaide. Responses to questionnaires at Dalby and Adelaide generally gave support to the system, and improvements suggested were generally able to be incorporated into the software.

FARM now has 13 Excel spreadsheets in a workbook of about 350 kB. Calculating the results takes a couple of seconds with a 80486 computer and under 1 second with a Pentium. The spreadsheets are similar to that used in Version 1 with the exceptions t hat; (i) Instead of 2 soil types with 2 sequences each (Fig. 1), there is provision for 6 crop and pasture sequences. These are not categorised by soil type, but may be used to represent differences in management, soils, location or other factors. (ii) The system of estimating pasture GMs has been simplified. They are estimated from livestock GMs ($/DSE) and stocking rates (DSE/ha). (iii) The spreadsheets for calculating sustainability costs have undergone substantial revisions during the review proc ess.

Example application of FARM

A topical issue in the northern grain belt is whether sorghum growers would be better off growing dryland cotton. The GMs for cotton crops are higher than sorghum, but cotton requires long fallows and the yields and costs are variable. Cotton is more intensively managed, needing extra labour, machinery and expertise.? This example is a synthesis of several analyses conducted in workshops in the northern grain-growing regions. The assumptions and crop GMs are shown in Table 1. The figures shown i n Table 1 are approximations only. For brevity, only the economic results are discussed below. The sustainability results are nevertheless important.

The average GM for the sorghum sequence is $308/ha/year, and $386/ha/year for the cotton sequence.? The high crop GM for the cotton sequence looked good, but the difference in the annual figures are not nearly as great. FARM highlights some less ob vious costs, such as the opportunity cost of the working capital that is invested in crops. Because the costs of cotton are high, the opportunity cost of its capital is $25/ha/year, while for sorghum it is only $14/ha/year (@ 10% p.a. with an investment period of 4 months for the variable costs).

FARM can calculate the effects of changes in other overhead costs. Taking the example above, a medium-sized farm (500 ha) may require extra casual labour ($5,000) and extra machinery ($50,000 for planter and sprayrig upgrades and a stubblebuster, replaced at 10% p.a.), so overhead costs could increase by $10,000.? After including these costs the operating profits of the cotton and sorghum sequences are $105,000 and $82,000 p.a. respectively. A smaller difference than one might think, given the cotton and sorghum crop GMs of $780/ha and $323/ha. This clearly shows the deficiency of comparing the GMs of dissimilar crops and enterprises.

FARM can be used to examine the effects of changing the assumptions, and can help work out the conditions where 2 systems are equal in profit or sustainability.? Take the example above, where the sorghum and cotton sequences have operating profits of $82,000 and $105,000 p.a. Changing the sorghum yield and observing the changes in profit lets the user find the yield necessary to match cotton. The results are; 4.5 t/ha = $82,000, 4.75 t/ha = $92,000, and 5 t/ha = $102,000 p.a.? So the sorghum system is as profitable as cotton if an average yield of 5 t/ha is achieved. This may be important information for a farmer comparing the 2 systems.? They may be able to achieve the higher yields and profit within their sorghum system with fewer management changes than if they changed to cotton. A similar analysis shows that a price change for sorghum from net $130/t to $145/t has the same effect on profit, highlighting the strong influence of price on relative profitability of the 2 systems.

These sensitivity analyses have been popular with farmers and consultants. Conducting the analyses in close consultation with farmers has had 2 important advantages; realistic scenarios are developed, and managers are able to rapidly evaluate results. Although FARM and similar management tools can be applied in isolation from data concerning particular farms and farmers, it is naive to believe that the results could then be applied on farms or be relevant and interesting to farmers. Farmers and their consultants have very different interests to scientists and operate under different environmental and economic conditions. Farmers can conduct highly relevant analyses with FARM because they use their own data. Although the input data may then be biassed (*ie.* wrong) and the biases may have complex origins (5), they are clearly and simply expressed in FARM in the yields, costs, prices and a few other factors. This is quite different to complex MP and simulation models that conceal biases in complex arithmetical and logical expressions. This visibility of the assumptions and biases in FARM gives it a substantial advantage over more complex "black box" farm management tools.

The various applications of FARM discussed above are all management games of one sort or another, and it is obvious that users "play" with FARM in workshops.? This playing is important - games are a well-accepted means of learning and experiencing management systems (6). Players in these games: (i) formulate a clear goal and strategies, (ii) learn to recognise opportunities and hazards, (iii) isolate the sensitive parts of the system, (iv) make many decisions, and (v) take the consequences o f their actions (after Longworth (7)). Interesting games present situations that require solutions and actions, and FARM combines this with real-world relevance.

Table 1. Yield and price assumptions, and gross margins for 2 sorghum and cotton farming sequences.

System	Sequence	Summer crop yield	Wheat yield	Crop gross margins
Sorghum	sorghum-winter fallow-sorghum-winter fallow-summer fallow-wheat	4.5 t/ha	3 t/ha	S=$323/ha* W=$382/ha*
Cotton	cotton-wheat-summer fallow-winter fallow	4.0 bales/ha	1 t/ha	C=$780/ha* W=$62/ha*

* sorghum price = $130/t, cotton price = $440/bale, wheat price = $170/t, fallow costs = $35/ha.

Conclusions

FARM calculates farm sustainability and profitability - a significant advance. It makes it possible to analyse many scenarios, leading to its other main strength - facilitating interaction with farmers and consultants.? Playing games with FARM and similar management tools may be a valuable path to learning.

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