CREEP BUDGETING

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One of the side-effects of those developments which are presently transforming linear programming into a more useful technique is the encroachment of the " programming attitude " into methods of farm planning for use where a computer is unavailable. " Programming attitude " may be taken to mean that the enterprise combination problem is seen as one of expanding, in some way, unit scale enterprises with fixed gross margins until they are restrained by resource availability, or some other requirement. This attitude is epitomized in the " Swedish method of farm planning " which has been reported for English readers by McFarquhar[1].

In linear programming, starting with an initial feasible farm plan, one activity is substituted for another by choosing as a replacing activity one which always increases total gross margin (the value of the objective function). Ideally, the incoming activity would be the one which increased gross margin more than any other possible incoming activity. In practice, it is difficult to make this selection, and the compromise adopted is to choose as an incoming activity that one which gives the highest rate of (total) gross margin increase per unit scale of the activity, and this activity is then brought in at a level set by the most limiting resource or some other restraint.

The Swedish Method of Farm Planning

The Swedish method, whilst starting with basic data similar to an initial linear programming matrix, chooses, as an incoming activity, that activity which has the highest gross margin per unit requirement of resource X, where resource X is intuitively adjudged to be the " most limiting resource "[2]

The Swedish method continues by expanding this incoming activity to its limit, calculating residual resources and then selecting the second most efficient activity (with respect to resource X) as an incoming activity, and then the third etc. until the limiting resource is wholly utilized. At this stage, activities not requiring X are introduced in an order determined by their efficiency in using a " second most limiting " resource. This whole procedure is repeated to give plans for different levels and orderings of resources and the *optimum optimorum* is selected.

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[1] A. M. M. McFarquhar, " Research in Farm Management Planning Methods in Northern Europe ", *Journal of Agricultural Economics*, Vol. XV, No. 1 (May, 1962), pp. 78-100.

[2] The fact that this can get the planner away to a bad start can be illustrated by an extreme, standardized matrix:

Zo	10	10	10	10
Po	*P*1	*P*2	*P*3	*P*4
100	1	100	100	2
100	100	1	100	2
100	100	100	1	2

It is obvious that the solution to the implied problem consists in 50 units of *P*4. *P*4 however, is less efficient than one other activity in the use of each resource, considered separately. Bad starts are unimportant with linear programming and a computer.

The question to be answered is whether or not the Swedish method and its relatives (McFarquhar[3]) have a potential value for planning under Australian conditions. Whilst a properly formulated linear programme will give a more reliable and probably more profitable answer than any imperfect implementation of the programming attitude, there is still a need for farm planning methods which the adviser can work through in a day with the farmer by his side making intuitive judgements.

Possible Use in Australia

Methods of the Swedish type seem appropriate for a wide variety of European farm planning problems, but in considering their suitability for Australian conditions it is necessary to note certain common differences between European and Australian farming:

(i) there are usually a much larger number of potential and actual enterprises on European farms.

(ii) enterprise scale is usually smaller on European farms.

(iii) changes in size of livestock enterprises on European farms are more likely to yield proportional changes in returns.[4]

For planning purposes, one implication of a larger number of enterprises is that the average percentage contribution of each enterprise to European farm profit is smaller and hence the relative importance of resource misallocation within a particular enterprise is less than in Australia. The same conclusion in absolute terms is suggested by the differences in enterprise scale. Whilst Australian cropping enterprises show constant returns to acreage in an approximate fashion, a large part of the planning of livestock-pasture enterprises consists in predicting the results of altering acreages and stocking rates. These are the types of changes with which an Australian planning method should be able to cope. Constant returns to flock or herd size are more relevant in Europe where stock may be housed over winter and fed concentrates for production in the non-winter months.

Whilst an incomplete argument has been presented above, these comments do suggest that an Australian field planning method must allow for the possibilities of intra-enterprise modification, rather than assume constant returns to enterprise size. Assuming the appropriateness of this specification would appear to preclude methods based on the manipulation of a single matrix with one or a few activities representing each enterprise i.e. such methods as the Swedish method, programme planning etc.[5]

An Adapted Budgeting Technique

It would seem that we are forced back to partial budgeting of one type or another, preferably making all possible use of the programming attitude but additionally enabling the manipulation of gross margins and resource requirements within enterprises. Partial budgeting can conveniently be taken to mean budgeting which assumes fixity in the availability of peak working capital, land, improvements and machinery resources, and in

[3] A. M. M. McFarquhar, *ibid.*

[4] Size being measured by animal numbers.

[5] There is no reason why enterprises should not be represented by many activities in these hand methods but if this is done, formulation of the problem becomes more difficult, and the efficiency of the planning process, relative to the burden of calculation, may be of the same order as linear programming by hand.

rotational requirements. This is not to say that field methods of long-run planning are unwanted, but concentration on the short-run provides a convenient boundary for this paper.

Labour was not mentioned as a fixed resource above. Obviously it must be introduced in some way into the budgeting process. Quantitative labour data is generally unavailable in Australia but moderately experienced farmers appear to be able to judge intuitively whether or not they would be able to implement a proposed plan, or what changes would be necessary in a plan before they could implement it. There is plenty of room for error here, but for want of something better, it is suggested that the budgeting process could make use of this ability.

Whilst the availability of peak working capital, the maximum cash required during the year if a plan is to be implemented, is normally set by cash reserves and/or overdraft arrangements, it is frequently possible to attenuate the effects of this restraint by delayed payment of bills, credit purchases, hire purchase etc.

Apart from the idea of more-or-less invariate resources, which can be allocated between different enterprises, there are two further ideas which, in a slightly modified form, can be adopted from programming into a budgeting technique:

(i) the optimal enterprise combination lies on the boundary surface of the production possibility space. Unlike programming where this is a logically deducible implication of the assumptions of the method, this need not be so where enterprises may show falling profits in face of (imperfect) scale expansions and varying returns to imperfect scale. Frequently, in practice, this difficulty is not encountered, due to the emergence of one restraint or another.

(ii) the maximum marginal rate at which one enterprise can be substituted for one other enterprise, from points on this boundary surface will be limited at any point by one restraint only (there will be infrequent exceptions to this where one plus restraints will be equally limiting).

Interpreting these ideas as requirements for a budgeting technique suggests that the general method of budgeting will be to develop " full capacity " plans, plans in which no enterprise can be increased, and then substitute one enterprise for one other enterprise at the margin, in a systematic way, using profit charges as a criterion of the desirability of substitution.

An Example of the Method

A common combination of farming enterprises in Australia is sheep, beef and cereals. The method will be explained by showing how the most profitable combination of these three can be approximated within a partial budgeting framework. Before doing this, a few observations will be made on this particular budgeting problem. Under present prices, and in the better rainfall areas, the solution can frequently be obtained by a rule-of-thumb which says, " grow as much crop as possible, stack the sheep on the rest and toss out the beef ". The usual limitation on crop is the permissible cropping frequency or, occasionally, machine capacity. The stocking rate is frequently limited by caution to a level below that which, noting seasonal variation, is economically optimal. Sometimes the reasons are labour, difficulties with contractors, or hay availability (the problem of getting large numbers of sheep through the winter).

The difficulties in budgeting this combination come from:

(i) the joint use of pastures by cattle and sheep,

(ii) the joint consumption of hay by cattle and sheep,

(iii) the relationship between stubble acreage and the date at which autumn hand feeding commences, and

(iv) the dependence of maximum hay acreage on cropping area and stocking rate. (Hay making can be introduced into the budgeting problem as a separate residual enterprise, but this will not be done here.)

THE METHOD: STEP 1

It is first necessary to set out a " normalized " statement of current farm performance, as a guide to the result of re-implementing the current farm plan for another year. The figures to be quoted are more-or-less realistic for an 800-acre property.

	£	£
(i) *Costs*		
(*a*) " Fixed " Costs		
Permanent labour	900	
Rates, land tax	200	
Depreciation of fixed assets	400	
Repairs to fixed assets	200	
Insurance of fixed assets	100	
Business expenses	200	
Interest	400	
Loan repayments	200	
Living expenses	1,400	
		4,000
(*b*) Proposed Capital Expenditure		500
(*c*) Variable Costs—		
Sheep (servicing costs per head plus feed costs per head) by flock size. (0·75 + 0·5) 1,000	1,250	
Beef (servicing costs per head plus feed costs per head) by herd size (2·0 + 5·0) 50	350	
Crop (variable costs per acre by crop acreage). (3·0 × 200)	600	
Beef plus sheep (pasture maintenance costs per acre by pasture acreage) plus joint hay costs. (1·0 × 600) + 200	800	
		3,000
Total Costs		7,500

(ii) *Returns*—

Sheep (cut per head by wool price by flock size).	
(10·0 × 0·25 × 1,000)	2,500
Beef (price per head by turnoff (80%))	
25 × 40 (= 80% of 50 head)	1,000
Crop (yield by price by acreage)	
45 × 0·75 × 200	6,750
Total Returns	10,250
(iii) *Total Returns Less Total Costs*	2,950
(vi) *Gross Margin (Total Returns less Variable Costs)*	7,250
(v) *Peak Working Capital (Feasible, Non-restricting)*	3,000
(vi) *Labour Adequate*?	Yes

The above is a simplification of reality, necessitated by space limitations. The present farm organization can be called Plan 1 and is the starting point for budgeting. The following points are worth noting:—

Fixed Costs, Proposed Capital Expenditure

These are readily estimated by the farmer, or from his books or cheque butts.

Variable Costs, Sheep

Parametric expression is convenient here. $Vs = (Ss + Fs)Ns$

where Vs = total " sheep-only " variable costs.

Ss = servicing costs per head; approximately constant over a wide range of stocking rates and flock sizes. With mixed flocks it may be convenient to use a " ewe-unit " base, i.e. one ewe plus associated sheep. Depreciation could be included in this entity.

Ns = flock size.

Fs = supplementary feed costs per head, sheep only. When budgeting, it is necessary to pre-determine a sheep feeding policy, e.g. forward-store maintenance over winter, oats for ewes before lambing.

Variable Costs, Beef

$V_B = (S_B + F_B)N_B$

where V_B = total " beef-only " variable costs.

S_B = servicing costs per head; again, approximately constant.

F_B = supplementary feed costs per head, beef only. As with sheep, a cow unit may be a convenient base for calculations, i.e. a beef mother plus followers.

Gross Margin

From here onwards we will be concerned with the maximization of gross margin rather than the difference between total returns and total costs.

Peak Working Capital Requirement

Assuming that the farmer has no cash reserves, this will be the peak overdraft for the year. A method of approximating this for any plan is given in the appendix.

Labour Adequacy

A subjective judgement by the farmer.

STEP 2 (*a*)

State the extra crop, extra beef or extra sheep which the farmer would be willing and able to grow or run in addition to his present commitments. Consider each of these expansions separately, i.e. as exclusive alternatives. State the restraint limiting each expansion.

For Example:

Extra crop—50 acres restrained by machine capacity (say).

Extra sheep—400 head, restrained by labour availability (say).

Extra beef—10 head, restrained by dislike of beef (say).

Peak working capital is likely to be the only restraint which the farmer cannot check " off-the-cuff ". This can be verified by the method in the Appendix or, if it is limiting, feasible expansion can be determined as in the Appendix.

STEP 2 (*b*)

Set out the returns and variable costs for each of these exclusive alternatives

(*a*) Plan 1 plus 50 acres of crop.

(*b*) Plan 1 plus 400 sheep.

(*c*) Plan 1 plus 10 beef.

In setting out these figures it will be necessary to take account of reactions within the expanded enterprise and on other enterprises e.g. when extra sheep are run, returns per sheep may be depressed, feed costs per sheep may rise but also, beef may get more joint hay and less pasture. These reactions have to be intuitively quantified by the farmer and the adviser.

FIRST POSSIBILITY, PLAN 2 (plan 1 plus 50 acres of crop)

	£
(i) *Variable costs*—	
sheep (0·75 + 0·52) 1,000	1,270
beef (2·0 + 5·0) 50	350
crop (3·0 × 250)	750
beef plus sheep (1·0 × 550 + 200)	750
	3,120
(ii) *Returns*—	
sheep (9·8 × 0·25 × 1,000)	2,450
beef (25 × 40)	1,000
crop (45 × 0·75 × 250)	8,437
	11,887
(iii) *Gross Margin*	8,767
(iv) *Peak Working Capital* (*Feasible, Non-restricting*)	3,200
(v) *Labour adequate*?	Yes

SECOND POSSIBILITY, PLAN 2 (plan 1 plus 400 sheep)

	£
(i) *Variable costs*—	
sheep (0·75 + 0·65) 1,400	1,960
beef (2·0 + 5·0) 50	350
crop (3·0 × 200)	600
beef plus sheep (1·0 × 600 + 200)	800
	3,710
(ii) *Returns*—	
sheep (9·5 × 0·25 × 1,400)	3,325
beef (22 × 40)	880
crop (45 × 0·75 × 200)	6,750
	10,955
(iii) *Gross Margin*	7,245
(iv) *Peak Working Capital* (*Feasible, Non-restricting*)	3,800
(v) *Labour Adequate*?	Yes

THIRD POSSIBILITY, PLAN 2 (plan 1 plus 10 beef)

(i) *Variable costs*—	
sheep (0·75 + 0·55) 1,000	1,300
beef (2·0 + 5·0) 60	420
crop (3·0 × 200)	600
beef plus sheep (1·0 × 600 + 200)	800
	3,120
(ii) *Returns*—	
sheep (9·9 × 0·25 × 1,000)	2,475
beef (22 × 48)	1,056
crop (45 × 0·75 × 200)	6,750
	10,281
(iii) *Gross Margin*	7,161
(iv) *Peak Working Capital* (*Feasible, Non-restricting*)	3,700
(v) *Labour Adequate*?	Yes

STEP 2 (*c*)

Select the first possibility (Plan 1 plus extra crop) as Plan 2. This should increase gross margin from £7,250 to £8,767. Either of the other expansions would decrease gross margin.

STEP 3 (*a*)

Given Plan 2, state the extra sheep which the farmer would be willing and able to run. For simplicity we will assume that labour availability precludes any sheep expansion. Beef can be expanded by eight head before being restricted by capital availability (£3,900).

ONLY POSSIBILITY, PLAN 3 (plan 2 plus 8 beef)

	£
(i) *Variable Costs*—	
Sheep (0·75 + 0·57) 1,000	1,320
Beef (2·0 + 5·0) 58	406
Crop (3·0 × 250)	750
Beef plus sheep (1·0 × 550 + 200)	750
	3,226
(ii) *Returns*—	
Sheep (9·9 × 0·25 × 1,000)	2,475
Beef (23 × 47)	1,081
Crop (45 × 0·75 × 250)	8,437
	11,993
(iii) *Gross Margin*	8,767
(iv) *Peak Working Capital (just adequate)*	3,900
(v) *Labour Adequate*?	Yes

It might be thought impossible that beef can be introduced even though sheep cannot be introduced, because labour is considered limiting. Beef, however, require little labour and this need not clash with labour peaks for crop and sheep. It will be noticed that gross margin is not lifted (or depressed) with the introduction of eight beef. Nevertheless, Plan 3 becomes Plan 2 plus extra beef. This is a full capacity plan in which no enterprise can be expanded. Working capital is stopping expansion in all enterprises. Additionally, machine capacity and labour is limiting crop; labour is limiting sheep, and possibly is limiting beef.

STEP 4 (*a*)

Having developed a full capacity plan, we move onto the next stage—testing the feasibility and profitability of substituting one enterprise for one other enterprise at the margin. At first sight there are six possible substitutions:—

(i) crop for beef;
(ii) crop for sheep;
(iii) sheep for crop;
(iv) sheep for beef;
(v) beef for crop;
(vi) beef for sheep.

Because machine capacity is limiting crop acreage, crop cannot be substituted for beef or sheep. Intuitively we can eliminate the possibility of replacing crop with beef or sheep because we know that a large number of crop acres will have to be withdrawn to provide the working capital for a few livestock. In practice, these possibilities may still be tested but we will not do that here. We are left with " sheep for beef " and " beef for sheep ".

Substituting Beef for Sheep

The maximum number of beef which the farmer wishes to run is 60. Thus the substitution will be feasible if two beef are introduced and sheep are dropped, by an amount such that (*a*) peak working capital is not exceeded—say 30 sheep; (*b*) the labour load remains acceptable—say 10 sheep.

The requirement that peak working capital should not be exceeded is limiting the rate at which beef can be substituted for sheep. Plan 4, first possibility, is Plan 3 plus 2 beef less 30 sheep.

Plan 4, First Possibility

	£
(i) *Variable Costs*—	
Sheep (0·75 + 0·57) 970	1,280
Beef (2·0 + 5·0) 60	420
Crop (3·0 × 250)	750
Beef plus sheep (1·0 × 550 + 200)	750
	3,200
(ii) *Returns*—	
Sheep (9·9 × 0·25 × 970)	2,406
Beef (23 × 48)	1,104
Crop (45 × 0·75 × 250)	8,437
	11,947
(iii) *Gross Margin*	8,747
(iv) *Peak Working Capital*	3,900
(v) *Labour Adequate*?	Yes

Thus this substitution appears to decrease the gross margin.

Plan 4, Second Possibility

If sheep are substituted for beef, the work load must remain acceptable and peak working capital must not exceed the limit. If another 100 sheep are run, the farmer would want to cut out beef altogether (suppose) for the reason that he would not be prepared to do the work.

	£
(i) *Variable Costs*—	
Sheep (0·75 + 0·6) 1,100	1,485
Crop (3·0 × 250)	750
Pasture (1·0 × 550)	550
	2,785

(ii) *Returns*—	
Sheep (10·1 × 0·25 × 1,100)	2,778
Crop (45 × 0·75 × 250)	8,437
	11,215
(iii) *Gross Margin*	8,430
(iv) *Peak Working Capital*	2,500
(v) *Labour Adequate*?	Yes

Thus the second possible substitution is also unprofitable. If it had been profitable, the substitution would be made.

STEP 4 (*b*)

Given Plan 3, it only remains to check that a small reduction in any enterprise will not increase profits. For space reasons this will not be done here. Provided that the reduction does not increase profits the budgeting process is complete. If substitution had been profitable in the full capacity plan, then it could have been continued, creeping from one enterprise to another until

(i) gross margin increases, relative to confidence in the data, were considered insignificant;

(ii) substitution, whilst feasible, did not increase gross margin;

(iii) substitution became infeasible.

Discussion

The broad purpose of creep budgeting is to provide a framework within which organizational changes can be explored systematically. Whilst this outline does not discuss all the possible situations which can arise in applying the method enough has been said to enable the adviser to extrapolate to his own situation.

Marginal thinking is useful for quantifying the parametric expressions for costs. These have been presented as averages but such things as the change in feed costs per head can be more readily estimated by thinking through the effect of extra sheep rather than thinking through the average requirement of a flock of the new size.

Methodologically, the technique has two stages:

(i) from the present organization you budget onto the production possibility surface,

(ii) from there you creep from one plan to another by testing the profitability of making small moves in different directions. These moves are always in a " plane parallel to two axes ",

i.e. one enterprise is substituted for one other enterprise. You stop when creeping is no longer possible or profitable.

Theoretically the creeping process implies the possibility of being trapped on a localized bump in the production possibility surface. This is unlikely in practice but the possibility has to be accepted with field methods.

Generally, labour and capital are the resources most likely to be restricting for more than one enterprise simultaneously. They are treated as being non-homogeneous in this method. This is quite possible in programming but is seldom done.

One virtue of the method is that it can be checked for feasibility with the farmer at each stage. This means that the adviser is unlikely to contract " programmer's delight ", a syndrome which erupts in programmers when they return to the farmer with their results and find that their programmes were not adequately restrained.

APPENDIX

Peak Working Capital

The peak working capital required to implement a farm plan may be defined as the maximum amount of money which the farmer will require (borrowed or otherwise) if he is to put the plan into practice.

The maximum amount of money required will be the maximum difference between cumulative cash outlays and cumulative cash returns over the year. Assume that cash outlays and returns are zero at the start of the year, and zero cash reserve. The main elements to be considered are:

(i) Normalized " fixed " cash costs and proposed (cash) capital expenditure on fixed assets.

(ii) Expected returns from production in previous years, e.g., wheat payments.

(iii) Variable cash costs for each enterprise.

(iv) Returns from each enterprise during the budget year.

(v) Bank interest should be considered but frequently, for budgeting purposes, it can be ignored.

The peak working capital requirement for Plan 1 (the present organization) can be obtained by:

(*a*) Allocating each of the above cash items to a month of the year.

(*b*) Finding the " running " cash position for each month, i.e., the difference between cumulative cash outlays and returns up to the end of each month in the year.

(*c*) Noting the difference between cash outlays and returns for each month and observing the maximum.

This is a " base " profile. In order to find the change in peak working capital with a change in plan, it is necessary to determine a " unit profile " for each enterprise, e.g., the monthly cash costs and budget year returns for one beef, including the capital cost of the animal. When developing a full capacity plan the unit profile is multiplied by the number of additional units and the " base " profile is modified—each cumulative figure in it is corrected by a factor of (unit profile figure times additional units of the incoming enterprise).

Strictly, the unit profile for each enterprise should be re-written before each change in plan but usually the changes in the unit profile are relatively small and it may be acceptable to retain the same unit profiles throughout budgeting.

When substituting one enterprise for another the modified base profile has to be corrected twice; once for the incoming enterprise and once for the outgoing enterprise. In the situation where peak working capital is one of the possible restraints limiting the rate at which one enterprise can be substituted for another, the key figures are:

(*a*) the working capital profile prior to the substitution;

(*b*) the amounts by which working capital rises in each month for an m-unit increase in the incoming activity where m is the number of units by which the incoming enterprise is to be increased at the margin (five-ten per cent).

(*c*) The amounts by which working capital falls in each month for a one-unit decrease in the outgoing enterprise.

(*d*) The limit value of peak working capital.

The rate of substitution, or number of units of the outgoing enterprise which have to be withdrawn to enable an *m*-unit increase in the incoming activity is obtained by:

(i) adding the profile prior to substitution to the profile for an *m*-unit increase in the incoming activity;

(ii) subtracting the working capital limit from each monthly figure in the aggregated profile which is greater than the working capital limit;

(iii) dividing each of the figures so obtained by the corresponding monthly figures for a one unit decrease in the outgoing activity;

(iv) the number of units of outgoing activity which have to be withdrawn to enable an *m*-unit increase in the incoming activity is the largest of these dividends.

EXAMPLE

(*a*) *Profile Prior to Substitution—Three Critical Months Only—*

Oct.	*Nov.*	*Dec.*
3,000	3,500	4,000 (limit)

(*b*) *Profile for an m-unit Increase in Activity A*

Oct.	*Nov.*	*Dec.*
300	600	200

(*c*) *Profile for a One-Unit Decrease in Activity B*

Oct.	*Nov.*	*Dec.*
—20	—10	—25

(*d*) *Aggregation of Profiles* (*a*) *and* (*b*)

Oct.	*Nov.*	*Dec.*
3,300	4,100	4,200

(*e*) *Profile* (*d*) *less Peak Working Capital Limit*

Oct.	*Nov.*	*Dec.*
—	100	200

(*f*) *Dividends when the Elements in Profile* (*d*) *are Divided by the Corresponding Elements in Profile* (*c*)

Oct.	*Nov.*	*Dec.*
—	—10	— 8

Thus, ten units of activity B have to be withdrawn to keep the peak working capital within the £4,000 limit. The rate of substitution of enterprise A for enterprise B at the margin is $m/10$ with respect to peak working capital. It may of course be higher or lower with respect to labour, and it is the lower of these two values which determines the maximum rate at which substitution can be made.

Note that in making the above substitution, the peak working capital moves from December to November. It is because of such possibilities that calculations should be done for the working capital profile for the whole year and not just one (assumed) critical month. Experience may modify this requirement.