THE INFLUENCE OF WORKING CAPITAL ON FARM ORGANIZATION - HOW APPROPRIATE IS A LINEAR PROGRAMMING ANALYSIS?*

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Effective limitations on farm working capital are not easily identified but behaviour consistent with such limitations is observed. Using a linear programming analysis, the results of having limited working capital are shown. It is also shown that the value of the working capital resource is so high that farmers make every endeavour to keep it free from limitation.

The effects of a varying supply of working capital have been explored by linear programming studies of both English and New Zealand farm situations.[1] By using monthly capital restraints, it has been shown, in both cases, that considerable changes in organization with consequent reductions in income are induced by limitation of working capital. These changes are theoretical consequences of the formal conditions specified in the linear programming analysis. It has not been shown that they have real counterparts under farm conditions.

The obvious criticism of the use of linear programming for studying the problem of limited working capital is that a restraint in its mathematical formulation is absolute and inflexible. This characteristic is appropriate when representing, say, the acreage of land available, but it may not be so suitable for representing working capital limitations which are in reality more flexible. The flexibility is due to the variety of sources of working capital, which include not only lending institutions but also delayed payments of debts and reduced spending on family living. It might be argued that these can all be specified in a linear programme, but it is virtually impossible to say how much can be squeezed out of the non-institutional sources of capital. Hence the rigid specification of a linear programme may still be inappropriate.

In 1962 an exploratory survey was carried out in the North Western Slopes of New South Wales by D. A. Muir of the University of New England to seek evidence of the effects of working capital availability on farm organization.[2] Such effects were not observed as no scarcity of working capital was found, probably because farm incomes in this area happened to be high at the time. The evident prosperity of the region probably also meant liberal overdraft accommodation by bankers adhering to the practice of heaping an embarrassment of credit on those who do not need it.

[1] McFarquhar, A. M. M., "The Marginal Value Product of Circulating Capital in Farming; Implications of British and New Zealand Cases", *Farm Economist* 9: 574-95, 1961.

[2] Results of this exploratory survey have not been published.

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Not all areas, however, are so fortunate in the provision of credit, and it was thought that small to medium farms in the Tableland divisions of New South Wales were more likely to be adversely affected by seasonal shortages of money. The area chosen for this particular study was the Oberon district of the Central Tablelands. In order to collect data and obtain farmers' accounts of their own experience, 16 Oberon farms were selected. They do not comprise a random sample but were chosen for the variety of their circumstances.
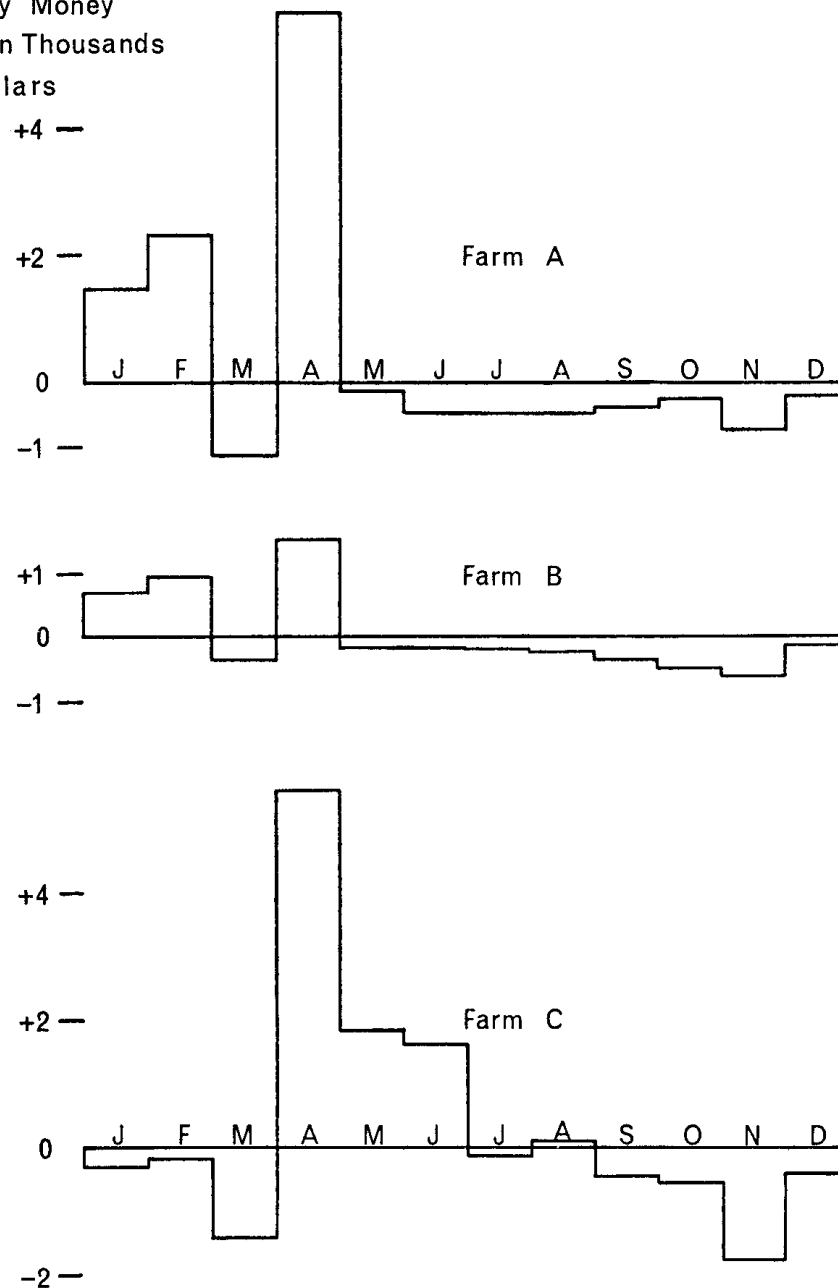

FIG. 1—Examples of seasonal money flows on farms in the Oberon district of N.S.W.

Development of the Linear Programme from the Capital Profile

If it is assumed that all sales and purchases are matched by simultaneous movements of money, it is possible, from information supplied by farmers, to draw up profile diagrams to represent the month by month movement of funds. Although the three examples in Figure 1 were selected to show a range of farm organizations, the one predominant pattern can be seen in all of them.[3] This is the result of the major incomes from and outlays on sheep.

A cursory examination of these profiles is sufficient to show that the extent of a farmer's liquidity problems will depend upon the amount that is carried forward from the heavy income period ending about April. It is from the surplus funds available at this time that repayments of debt and most investments are made. If too much money goes into these avenues, then the seven or eight deficit months which follow may cause serious difficulties. The deficit period is not so long if potatoes are grown, as can be seen in the case of Farm C in Figure 1.

In the linear programme, the working capital profile has been built in, activity by activity, with a set of fixed outlays added. The objective is a systematic study of the effect of carrying over varying amounts of liquid funds from the heavy income period mentioned above. Therefore the capital profile begins in May when revenue from sheep has virtually ceased. Outlays on investment, interest and debt retirement have not been specified. However, such payments cut heavily into the funds left at the end of April and so contribute to the limitation of working capital.

The programmed farm is hypothetical and consists of 350 acres of first class land, all suitable for sown pasture and crops. In addition, such a farm would usually have an appreciable area of uncleared land, virtually useless in its existing state, but a major outlet for investment funds.[4]

The computed plans in Table 1 show that, given the rigid conditions specified, working capital shortage would induce significant changes of plan. The income in plans 1 to 5 falls short of the income earned in plan 6 where working capital is unlimited.[5]

Flexibility of Working Capital Supplies

The first question to ask about these linear programming results is whether anything like the working capital restraint occurs in reality. Positive evidence of effective restraints on some farms in the area studied or any other would be sufficient to establish that the problem exists. However, it is not easy to establish positive evidence of an effective restraint. Certainly, it would not be effective if working capital supplies were sufficiently flexible to permit the revenue maximizing plan to be adopted in any year. Therefore, the flexibility of supplies is examined briefly.

[3] Farm A is specialized in wool and fat lamb production with some cattle and fodder cropping. Farm B is small and being developed; peas and potatoes are grown. Farm C runs both crossbred and merino sheep, and potato growing is a major activity; it also employs permanent labour.

[4] See Table 2.

[5] In McFarquhar's study, op. cit., plans were recomputed allowing a specified delay in payments. Such a procedure was not followed in the present study because such a modified programme still only explores the effect of rigid, although less restrictive, restraints.

TABLE 1

Optimal Plans for a Family Farm in the Oberon District with Varying Levels of Working Capital

	1	2	3	4	5	6
	$	$	$	$	$	$
Revenue (Z-C)	5,878	5,956	6,276	6,352	6,928	7,042
Working capital supply	2,510	2,540	2,686	2,724	3,018	3,180
Surplus available at end of April	1,972	2,050	2,370	2,446	3,022	3,136
Marginal return to $1 increase in working capital	2·86	2·57	2·18	2·06	1·96	0
Number of months working capital is limiting*	11	11	10	8	8	0
Crossbred ewes 1 (no.)		123	195	230	324	234
Crossbred ewes 2** (no.)	196				371	431
Merino wethers (no.)	906	1,003	1,049	1,005	405	380
Potatoes (acres)	32	33	28	27	18	13†
Peas (acres)						13†
Oats (acres)	32	32				13†
Swede turnips (acres)	6	5	8	8	13	5

* Beginning with May.
** "Crossbred ewes 2" calls for less careful husbandry than "Crossbred ewes 1".
† In this case potatoes, peas and oats occur in a rotation vector.

Credit from banks and government agencies was not found to be flexible in the short run. This was in contrast to the stock firms from which several farmers reported making variable drawings throughout the year, the limit being the anticipated value of the following season's wool clip. Borrowing from relatives was usually for the purchase of land or for large investments and was not reported to be a flexible source of finance.

There was some reluctance to discuss the use of merchant credit, due perhaps to the moral stigma attached to non-payment of bills. Also, some people may fail to realize the extent to which they can or do use delayed payments as a source of funds. Virtually all farmers run accounts and, except for those few who pay bills with clockwork regularity, all vary their supply of credit by varying the time lapse before payment. Despite the general tendency to be coy on this subject, some information was obtained indicating that anyone whose bills are paid-up should have little trouble in obtaining three months credit to cover virtually all expenditures. As long as his good standing is re-established by paying accounts up to date at some time in the year, a farmer can probably finance himself in this way for the leanest three months of every twelve.

An even less specifiable means of supplementing working capital is to cut down family consumption of purchased goods. In answer to a question on private expenditure, five farmers indicated that they could reduce it to a low figure if money were short. $1,000 per year was mentioned several times.

To sum up, there is obviously some limit to the working capital available to a particular farmer. This would be reached when his bank and stock firm would extend no further accommodation, merchants refused further credit, and family living expenses could be reduced no more.

However, virtually no one reaches this limit. As it is approached, the farmer faces increasing degrees of unpleasantness and embarrassment; how much of this an individual is prepared to tolerate cannot be anticipated. When there is pressure on liquidity, the decision to accept or resist a change of plan to one which falls short of the income maximizing plan will depend largely upon individual characteristics. Nevertheless it will be argued that the linear programme throws considerable light on the grounds for both types of decision.

Competition for Funds—Working Capital v. Investment Capital

There is in all plans an accumulation of funds at the end of the year, over and above the initial working capital. However, such surplus or "residual income" may be earmarked for large payments or investments not included in the programme. Thus, the $1,972 surplus at year's end in plan 1 of Table 1 might be scarcely enough to meet such commitments. These other demands for funds might then encroach on the pool of working capital which must remain intact if the computed farm plan is to be carried out each year. To indicate whether the end-of-year surplus would be adequate for normal investment, interest and debt retirement, the following summary deals with the magnitude of these payments in actual experience.

TABLE 2

Net Cash Investments and Physical Changes Resulting from Investment—Average for Eleven Oberon Farms

	1957/58	1958/59	1959/60	1960/61	1961/62
	$	$	$	$	$
New fences or improvements to fences	400	72	248	282	168
New buildings and yards	490	450	200	256	1,244
New plant and machinery	372	962	930	966	1,620
Clearing and dams	300	426	1,488	1,034	454
Total new investment	1,562	1,910	2,866	2,538	3,486
	acres	acres	acres	acres	acres
Average farm size	794	805	805	805	828
Cleared area	399	429	473	521	572
Increase in cleared area	n.a.	30	44	48	51
Sown pasture	360	391	418	563	490
Increase in sown pasture	n.a.	31	27	45	27

Eleven of the sixteen survey farmers were able to provide records of cash investments for five years and these are summarized in Table 2. As only cash investment is shown, the very large inputs of permanent labour for clearing and fencing have not been taken into account. Also, it was not possible to estimate the cash investment in pasture, but Table 2 gives some indication of the extent of this type of investment by showing increases in sown pasture. Investment in additional livestock averaged about $380 per year over the period studied.

Information on interest and debt reduction was only obtained for the year 1961-62 and there is no way of knowing how typical a year it was. These payments are even more variable from farm to farm than investment expenditures. Average figures for the same eleven farms were as follows:

Reduction of debt incurred through purchase of land: $508
Interest paid to trading banks, livestock firms, Development Bank, Rural Industries Agency, and hire-purchase companies: $234

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Total: $742
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The average cleared area of these farms (572 acres in 1961-62) was appreciably more than the 350 acres specified in the linear programme. If the total figure for new investment, interest and debt reduction is scaled in proportion to cleared area, the scaled figure for the hypothetical farm is close to $2,800. For these outlays to continue on the same scale, the "surplus available" in any of the plans shown in Table 1 (row 3) must exceed $2,800. Where it does not, there will be competition for funds and either the investment and related outlays will be curtailed or the required pool of working capital diminished. Income tax payments will put added pressure on the supply of working capital..

As investment in fences, clearing and pasture improvement is often carried out according to a long-term programme, rigid adherence to such a programme might limit the pool of working capital.[6] The question therefore arises: If capital were restricted, would investment plans be adhered to at the expense of routine farm plans? This is one of the questions which must be answered if we are to assess the relevance of the theoretical result to real conditions.

Individual Experience of Liquidity Problems

In addition to the information already reviewed, the 16 farmers gave the answers summarized below to a series of questions designed to provide information on the restriction of working capital and its consequences.

I: *"Has the availability of working capital affected your activities?"*

Yes: Retards improvement (i.e., investment in clearing, fences and yards, pasture, etc.):   8
Retards improvement and prevents purchase of cheap hay in summer for winter feeding: 1
Retards improvement and prevents employment of a man: 1

No: No further comment: 3
Improvements can be made rapidly enough out of profits: 1
Can employ two men without any seasonal liquidity problem: 1
Has been able to borrow all he dares for development programme: 1

II: *"Is your investment influenced by (a) not wanting to operate with a large overdraft, (b) banks refusing to give credit, or (c) neither of these?"*

[6] Investment outlay is here being treated as if it all occurs in May whereas much of it can be spread through the winter. However, improvement work must be completed by spring when normal operations require full attention. As spring is the period when working capital is most limiting, the spreading of investment in winter will do little to ease the problem.

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Investment is not influenced by either: 2

Has raised as much as can use (property being improved as fast as possible): 1

Do not want to go too far into debt: 5

Refrained from borrowing in the past—now think that should have borrowed more heavily for rapid improvement: 2

Large initial overdraft for purchase of property makes unwilling to borrow for investment: 3

Banks refuse further credit: 2

Banks refuse further credit until legal complications settled: 1

III: *"Have you ever been asked to reduce your indebtedness?"*

No: No further comment: 8·

Yes: Mild request to reduce overdraft: 4

Agreed to regular annual reductions: 3

Mild request having no effect: 1

IV.   *"Have you ever grown a crop or changed your plans so as to obtain money at a time when it might be short?"*

No: No further comment:[7] 12

Would like to but cannot do anything about it: 1

Just aimed for maximum income: 1

Yes: Once grew a large acreage of peas to bring in a lot of cash: 1

Occasionally go woolclassing to bring in money when it is short: 1

V.   *"Do you plan to get an even distribution of income over the year?"*

No: No further comment: 9

Would like to but cannot do anything about it: 3

Yes: However, little can be achieved in this direction: 1

To a certain extent by growing potatoes: 2

By growing potatoes and doing contract carrying: 1

In summary, the farmers' responses to the problem of seasonal liquidity can be grouped as follows:

Apparently not affected: 9

Have felt the problem of seasonal liquidity but consider that they are unable to do anything about it: 3

Do off-farm work to relieve seasonal shortage of money: 2

Grow potatoes to spread income through winter:[8] 3

Before Question I was asked an attempt was made to explain the concept of working capital, but the answers show that few farmers distinguished it from investment capital. However, a general tendency to consider the availability of working and investment capital as one problem is not surprising. Anyone engaged in an investment programme cannot be expected to dissociate these outlays from the other seasonal money flows.

An obvious comment on the answers to Question II is that anyone not wanting to go too far into debt may know that an application for further credit would be refused. Also it is possible that, in the answers to Ques-

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[7] A number of these farmers indicated that the general objective of maximizing income ruled out the possibility of changing plans.

[8] One of these has also been counted under "off-farm work".

tion III, the extent of bank pressure has been understated. A farmer hates to admit that his bank manager has had him "on the mat".

In their answers to Question V, three farmers indicated that they felt the problem but were unable to do anything about it. This could be interpreted to mean that they would only accept as a solution a change which would ease the seasonal shortage of working capital but not reduce annual income. If this is not feasible they may resist the pressure to change plans and survive seasonal shortages by the methods suggested earlier.

Discussion

We are now in a position to make some assessment of the question: Do effective restraints on working capital occur? Pressures on liquidity have been shown to exist but these are not necessarily translated into restraints which effectively influence farm plans. However, if liquidity pressures are known to exist, farm plans which tend to ease these pressures are evidence that the causal relationship simulated by the linear programme may be at work.[9]

Our first example arises from the theoretical conclusion that increased potato acreage will result from limited working capital. This appears to be reflected in the plans and behaviour of several farmers. It will be recalled that in answer to Question V, three farmers reported that they plan to obtain a more even flow of income by growing potatoes. It does not necessarily follow that they would not grow them if seasonal distribution of income were of no interest. However, the corroborative evidence of the programme supports the view that liquidity difficulties are, for some farmers, the major reason for growing this crop.

The role of potatoes in relation to working capital is also consistent with the observation that as farmers become better established, their incomes larger, and their pool of working capital greater, they tend to give up potatoes. Farm G of Table 3, which lists some observed farm plans, is a good example of one which has passed through this process.[10]

Another consequence of limited working capital in the computed plans is a high proportion of wethers in the sheep flock as evidenced in Table 1. This is a result of the high labour requirements of potatoes. In Table 3 the relationship is seen in the plans of Farm D and to a lesser extent in Farm H and the first plan of Farm E. The latter two farms have been subject to liquidity difficulties and so tend to support the conclusion drawn from the linear programme that a shortage of working capital leads to a high proportion of wethers.

The owner of Farm D in Table 3 showed no concern with the liquidity problem but it can be argued that this is due to the adoption of a plan which very successfully overcomes the problem. Because this farm employs permanent labour there are fixed cash outlays of considerable size throughout the year. This feature corresponds to the fixed outlays specified in the hypothetical programme. Therefore, in view of the large acreage of potatoes, it is reasonable to conclude that the plan is in part

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[9] The significance of this type of evidence has been the subject of considerable discussion in recent years. See, e.g. Nagel, E., "Assumptions in Economic Theory", *American Economic Review* 53: 211-19, 1963.

[10] It was found that potatoes are often given up completely whereas the optimum plan with no restriction of working capital (plan 6, Table 1) still includes potatoes. The avoidance of an apparently profitable crop is probably due to the high variability of potato returns and the feeling that potatoes are a nuisance.

designed to cope with the heavy drain on working capital. Farms of this kind employing permanent labour, but having limited funds, probably provide the best practical illustrations of the type of consequence deduced by the linear programme.

TABLE 3

*Examples of Observed Farm Plans—Oberon District**

	Farm D		Farm E		Farm F	Farm G	Farm H
Crossbred ewes (no.)		610	450	750	450	2,000	1,500
Merino ewes (no.)	400	650					
Wethers and cattle** (no.)	400	720	440	220	50		950
Potatoes (acres)	21	42	15		3		10
Peas (acres)	15	40	25		30		35
Oats (acres)	60	60	20	20	30		35
Swede turnips (acres)		40				20	6

* Where two plans are shown for one farm, the first is four years prior to the second. The farms vary in size from a little smaller than the one programmed (see Table 1) to about twice its size.
** To facilitate comparison with the programming results, cattle have been counted with wethers at the rate of 7 wethers for 1 beast of any age.

Valuations—A Key to Observed Behaviour

Seemingly negative evidence is provided by those farmers who feel the seasonal liquidity problem but do not change their plans as a result. Evidence was found that the spread between the level of funds at which some shortage will be felt and the absolute limit to working capital is often sufficiently wide for a tenacious farmer to persevere with his plan despite liquidity difficulties. No farmer knows precisely how far he can go in supplementing this resource until he tries.

Although, in one sense, it appears to negate the programming solutions of the allocation problem, this tenacity of farmers in adhering to their plans is readily explained by the valuations computed in the programme. It can be seen in Table 1 that the marginal value product of working capital is very high until, with unlimited working capital, the income maximizing plan is achieved. By persevering with the best plan, a farmer indicates his awareness that the high marginal productivity of this resource, when there is any deviation from the income maximizing plan, makes it worthwhile to suffer trouble and embarrassment to obtain additional supplies.

Thus the linear programme has given, in theoretical form, a reason for farmers persevering with their routine organization, and we can answer the question raised earlier: Will investment plans be adhered to at the expense of farm operating plans or vice versa? The formal answer is that if the present value of a sum of investment capital exceeds the value of that sum as working capital, then the investment plans should prevail. Without delving into the question of a farmer's time preference, it seems likely that any substantial deviation from the best farm plan due to shortage of working capital (e.g. from plan 6 to plan 4 of Table 1) would give this type of capital a value greater than would generally be ascribed even to farm investment capital. Thus ten farmers indicated in reply to Question I that the effect on their activities of restricted "working capital" was to retard improvement. In other words, when money available for work-

ing capital and investment was reduced, it was investment that was normally curtailed. This implies agreement with the relative valuations suggested above.

Summary and Conclusions

It was demonstrated that a series of farm plans can be generated by varying the supply of working capital in a linear programme which represents a typical farm in the area under study. It was also shown that the heavy investment programme often adopted could theoretically lead to such changes of plan.

When the hypothetical results were assessed in relation to farmers' experience the following conclusions were reached:

In the computed plans, large areas of cash crop (potatoes) and a high proportion of wethers result from limitation of working capital. Some farmers were found to adopt similar plans apparently for the same reason. Although the linear programming results are thus mirrored in some cases, they are not in others where similar restrictions prevail.

When money is short, farmers employing permanent labour, and thus having fixed cash outlays throughout the year, are most likely to adopt plans of the type computed for limited working capital conditions.

Farmers who suffer liquidity difficulties but refuse to make the changes indicated by the programme appear to deny the relevance of the linear programming approach. However, the working capital valuations generated by the programme offer an explanation of this behaviour. Were these farmers to regard their working capital as fixed at levels such as those presented in row 2, plans 1 to 5 of Table 1, they would be sacrificing the high marginal returns to additional temporary supplies that could be obtained with but little trouble. Similarly, they will not as a rule allow investment plans to reduce working capital because, judged by the valuations, the latter is the most productive use of available funds.