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# CHANGES IN FARM PRODUCTION UNDER INTENSIVE FARM MANAGEMENT ADVICE\*

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**This investigation examines the impact of intensive farm management advice on levels and productivities of resource use on samples of farms. A total of 60 members of 13 farm management advisory services and 60 non-members, matched by locality, were studied in two farming regions of Western Australia. A production model has been formulated and analysed which discriminates between effects of differences and changes in resource use and productivity over time and between members and non-members. Major differences between members and non-members over time have been rates of growth of inputs and outputs rather than systematic changes of production relationships.**

## *Introduction*

Intensive farm management advice in Australia and New Zealand began in the 1930s, when A. H. Flay initiated a management service in conjunction with Lincoln College. In 1952, a group of farmers in the Franklin district of New Zealand co-operated to employ their own extension officer. This basic pattern foreshadowed the development in New Zealand of 35 Farm Improvement Clubs by 1968, employing 63 advisers and servicing over 3,000 farmers.<sup>1</sup>

The first farm management club in Australia was formed in the Bombala district of New South Wales in 1955, followed by one in the Brunswick district of Western Australia in 1958.<sup>2</sup> There followed a period of rapid growth of co-operative management advisory clubs in Western Australia, which were seen as 'yet another self-help movement by Australian farmers' that would enable them to purchase technical and managerial advice to enhance the business value of technical advice by combining it with economic considerations.<sup>3</sup>

Thirteen clubs had been formed in Western Australia by 1962, and this number had increased to 53 by 1966. These clubs consisted of up to 50 farmers, who were 'legally bound to one another to jointly employ a professional adviser whose job it is to help the individual members of the club to increase their net farm income through better decision-making'.<sup>4</sup> Though each club was administered by a committee, the consultant was free to exercise his professional judgment without inter-

\* Financial support of the Rural Credits Development Fund of the Reserve Bank, which made this study possible, is gratefully acknowledged.

<sup>1</sup> See Rose, E. G., Role of farm improvement clubs, *Jour. N.Z. Inst. Agr. Sci.*, 2: 118-120, 1968.

<sup>2</sup> See Shaw, H.E.B., The Bombala District Rural Advisory Service, *Jour. Aust. Inst. Agr. Sci.*, 25: 327, 328, 1959, and Schapper, H.P., Farm management clubs for Australia, *Jour. Austr. Inst. Agr. Sci.*, 25: 23-30, 1959.

<sup>3</sup> Schapper, H. P., *ibid.*

<sup>4</sup> Schapper, H. P., *ibid.*

ference from the committee. Since 1964 there has been a tendency for some consultants to operate privately, usually servicing former club members and accepting additional clients. Another modification has been to retain the club structure, and to encourage the consultant to take on additional clients. Hence, whereas prior to 1964 it was appropriate to talk in terms of farm management clubs, since then it has been more appropriate to talk in terms of farm management advisory services.

Before the advent of intensive farm management advisory services, all farmers in Western Australia had access to extensive governmental advice, and this is still open to farmers who do not employ consultants. That some farmers have continued to pay for advice is evidence that they believe that there are benefits from doing so. It was the general purpose of the investigation from which this study is drawn to examine the nature of these benefits.<sup>5</sup> It is the specific purpose of this study to analyse, over time, the technical and economic performance of farmers who have employed consultants with those who have not.

### *The Samples and the Data*

Two samples, each of 60 farmers, were interviewed in 1967. Farmers in the first sample, referred to as 'members', were drawn at random from all farmers who belonged in 1967 to one or other of the original 13 farm management clubs in Western Australia, and had done so for four or more years. Farmers in the second sample, referred to as 'non-members', did not belong to a management club, but had farmed in the same localities during the same period. The sample of non-members was stratified to have the same number of farmers from each shire as the sample of members. Non-members from each shire were selected at random.<sup>6</sup> The samples are assumed to represent two populations. The localities sampled covered two well defined types of farming, and are referred to as 'south-west' and 'sheep-cereal' regions respectively, corresponding to the south-west and agricultural statistical divisions of Western Australia.

Sixty-eight of the farmers were from the south-west region where dairying for both whole-milk and butterfat predominates, together with the grazing of cattle and sheep for meat, pig raising, some orcharding, and potato growing. Thirty-four farmers were members of seven advisory groups, and 34 were non-members. Exposure to an intensive advisory service ranged from four to eight years, with an average for the sample of 5.2 years.

The remaining 52 farmers were from the sheep-cereal region, where cereals and sheep for wool predominate, together with some cattle, sheep for fat lambs, and pigs. Twenty-six farmers were members of six advisory groups, and 26 were non-members. Exposure to an intensive

<sup>5</sup> Southcombe, F. J., *An Evaluation of Intensive Farm Management Advice in Western Australia*, Unpublished Ph.D. thesis, University of Western Australia, Nedlands, 1969. Some descriptive comparisons of technical and economic performance of members and non-members of farm management advisory services are given in Southcombe, F. J. The impact of intensive farm management advice, *Farm Policy*, 8: 9-15, 1968.

<sup>6</sup> Two restrictions observed in drawing the sample of non-members were (i) the exclusion of farmers who had been in residence on their farms for less than five years, and (ii) the exclusion of properties of less than minimal cleared areas (which varied with locality) to exclude part-time farmers.

advisory service ranged from four to six years, with an average for the sample of 4.5 years.

Among the categories of information gathered about each farm were physical and financial histories as documented in annual taxation returns (and other financial statements) and in annual returns of agricultural, dairying, and pastoral statistics. The taxation year immediately prior to the advent of intensive management advice in a locality was taken as the base year for these histories, and the terminal year (which was the same for all farmers) was the taxation year 1966/67. The aggregates upon which subsequent analyses are based have been constructed from these sources. These aggregates are defined in the Appendix. All values are in 1967 dollars.

Input and output data from one year prior to the advent of an advisory service to from four to eight years after were available for 33 members and 29 non-members in the south-west region, and for 26 members and 23 non-members in the sheep-cereal region. Observations were not available in some years for particular farms. Over the seven years 1960/61 to 1966/67, 271 complete sets of observations were obtained for south-west farms and 234 complete sets for sheep-cereal farms. These were approximately equally distributed between members and non-members in each year.

#### *A Model of Production*

A separate production function is assumed for each group of farmers (members and non-members) for each year after the advent of a management advisory service in a district. The Cobb-Douglas form

$$Y = \alpha \prod_i X_i^{\beta_i} \text{ (for all } i \text{ resources)}$$

is used, or

$$Y' = \alpha' + \sum_i \beta_i X_i'$$

where primes represent logarithmic transformations.

To analyse the impact of membership of advisory services, it is necessary to discriminate in the production relationships between levels of resources used, membership or non-membership over the period during which advice has been available, and year-to-year variation which is independent of these foregoing factors. The following generalized production function discriminates in these ways;

$$Y' = \alpha_j' + \alpha_1' U_1 + \alpha_2' U_2 + \alpha_3' U_1 U_2 + \sum_i (\beta_i + \gamma_i U_1 + \delta_i U_2 + \varepsilon_i U_1 U_2) X_i',$$

where  $U_1$  is the number of years since the advent of advice

$U_2$  is 0 for non-members and 1 for members.

The effect  $\alpha_j$  is due to the particular year  $j$ , and is independent of either resource use or discrimination between membership and non-membership. The effects of  $\alpha_1$ ,  $\alpha_2$ , and  $\alpha_3$  are to shift the production function under given elasticities of production, making resources more or less productive according to whether these coefficients are positive or negative. The effects of the  $\gamma_i$ , the  $\delta_i$ , and the  $\varepsilon_i$  are to alter production elasticities of the resources. Returns to scale (degree of homogeneity) are increased, decreased or unaltered depending on whether the sums of the  $\gamma_i$ , the  $\delta_i$  or the  $\varepsilon_i$  are positive, negative or zero.

In terms of this model, variation between groups of members and non-members, and over time is accounted for by five sets of factors:

- (i) the effects of particular years which are common to members and non-members ( $\alpha_j$ );
- (ii) differences in the levels of resources used (the  $X_i$ ) both between groups and over time;
- (iii) differences between the initial productivity characteristics of members and non-members prior to the advent of advisory services ( $\alpha_2$  and the  $\delta_i$ );
- (iv) changes in resource productivity over time which are due to the advent of advisory services and which are shared alike by members and non-members ( $\alpha_3$  and  $\gamma_i$ );
- (v) differences in the productivity of resources over time between members and non-members ( $\alpha_3$  and  $\varepsilon_i$ ).

Models which discriminate in other ways could also be formulated. For example, particular years' effects ( $\alpha_j$ ) could be analysed in terms of membership or non-membership by time, in order to assess the effect of intensive advice on production stability. However, data characteristics do not sustain the further development of models.

Inputs can be aggregated in many ways. Two approaches have been adopted in the analyses which follow. In the first set of analyses, the complete model has been tested in terms of three widely-encompassing aggregates of input. The aim is to test the impact of blocks of variables incorporated in the complete model, with a view to deleting those blocks which make no significant contribution to the observed variation of production. Blocks of variables which are non-significant in the first model have been deleted from the second model, permitting a larger number of less widely-encompassing input aggregates to be used. Considerable experimentation with different bases of aggregation has preceded the choice of input aggregates.

### *Method of Analysis*

The effects of blocks of variables in each of the models have been assessed through analyses of variance of their multiple regression estimates. The sequence of estimates and tests for the first model can be traced through Tables 2, 3 and 4. In Table 2 the total variation of gross production (between farms and over years) of both the sheep-cereal and south-west samples is analysed in terms of the overall regressions estimated from the pooling of observations over all years, and the deviations from the overall regressions in terms of three additive components. This decomposition of the deviations enables two hypotheses to be tested.<sup>7</sup> These tests are summarized in Table 3. The first hypothesis is that the 'slopes' of the regression hyperplanes have remained constant from year to year. That is, the time and membership shifts (the  $\alpha_i$ ) and resource elasticities (the  $\beta_i$ ,  $\gamma_i$ ,  $\delta_i$  and  $\varepsilon_i$ ) are independent of any year-to-year vari-

<sup>7</sup> Comparisons of regressions between groups of observations are treated in standard texts, e.g., Williams, E. J., *Regression Analysis*, John Wiley & Sons, New York, 1959, pp. 129-133. Testing both hypotheses requires the assumption of homogeneity of error variances of regressions for annual data. This assumption was tested for both the sheep-cereal and the south-west samples using Bartlett's test of homogeneity, and in neither case was there sufficient evidence to reject the hypothesis at the 25 per cent significance level.

ation in resources productivities ( $\alpha_j$ ). This is the hypothesis of parallelism in Table 3, which is tested by the ratio of the mean squares of the deviation components  $II_i$  to  $III_i$  in Table 2, having an  $F$  distribution under the hypothesis. If the first hypothesis is not rejected, the second hypothesis is that there has been no significant year-to-year variation in resource productivities, that is, that  $\alpha_j = \alpha^*$ . This is the hypothesis of coincidence in Table 3. Given the first hypothesis, coincidence is tested by the ratio of the mean squares of the deviation components  $II_i$  plus  $III_i$  to  $II_{iii}$ , which also has the  $F$  distribution under the hypothesis.

The rejection of the hypothesis of parallelism (and by implication the hypothesis of coincidence) suggests that further analyses should proceed on the basis of independent annual regressions. This is the basis of the analysis in Table 4 of variation of production on south-west farms, in which components of variation have been estimated from independent annual regressions and summed over all years. The rejection of only the hypothesis of coincidence suggests that further analyses could proceed on the basis of a joint regression estimated from pooled within-year variation. This is the basis for the analysis of variation of production on sheep-cereal farms in Table 4. If neither hypothesis were rejected, further analyses could proceed on the basis of a joint regression estimated from pooled within and between-year variation.

### *Tests of Production Hypotheses*

#### *Three input-aggregate model*

In the first model only a small number of input aggregates have been selected to avoid an excessive proliferation of variables in the complete model. Variables used are:

- $X_1$  log of value of land, plant and machinery, and livestock at the beginning of the year.
- $X_2$  log of expenditure during the year which does not directly service  $X_1$  or  $X_3$ .
- $X_3$  log of man-months of labour used during the year.
- $X_4$  number of years since the advent of intensive advice (equals 0 in the base year prior to contact with an advisory service).
- $X_5$  membership dummy variable (equals 1 for members or 0 for non-members).
- $X_6$   $X_4$  by  $X_5$
- $X_7$  to  $X_9$   $X_4$  by  $X_1, X_2, X_3$  respectively.
- $X_{10}$  to  $X_{12}$   $X_5$  by  $X_1, X_2, X_3$  respectively.
- $X_{13}$  to  $X_{15}$   $X_6$  by  $X_1, X_2, X_3$  respectively.

The geometric means of variables  $X_1, X_2, X_3$ , and  $Y$  are given in Table 1 for the base year and for the modal total time periods after the advent of advice. The average levels of input and output increased for all groups, the rates of increase being faster for members. The average output of members increased proportionately more than each of the inputs. This is also true of sheep-cereal non-members, but not of south-west non-members.

The tests summarized in Table 3 provide strong evidence for rejecting the hypothesis of parallelism in the case of the south-west sample, but there is little evidence to reject this hypothesis in the case of the sheep-cereal sample. Even if this hypothesis were not rejected for the sheep-

TABLE 1

*Geometric Means of Variables  $X_1$ ,  $X_2$ ,  $X_3$  and  $Y$  for Years prior to and Following the Advent of Advisory Services*

| Variable <sup>(a)</sup>   | Members               |                      | Non-members           |                      | Percentage Change |             |
|---------------------------|-----------------------|----------------------|-----------------------|----------------------|-------------------|-------------|
|                           | Before <sup>(b)</sup> | After <sup>(c)</sup> | Before <sup>(b)</sup> | After <sup>(c)</sup> | Members           | Non-members |
| <i>South-west Farms</i>   | (29 farms)            | (21 farms)           | (25 farms)            | (18 farms)           |                   |             |
| $X_1$ \$                  | 57,520                | 77,669               | 45,337                | 55,509               | 35.0              | 22.4        |
| $X_2$ \$                  | 5,130                 | 7,887                | 3,867                 | 4,366                | 53.7              | 12.9        |
| $X_3$ mo                  | 21.2                  | 27.1                 | 16.1                  | 19.8                 | 27.8              | 23.0        |
| $Y$ \$                    | 11,825                | 18,319               | 9,452                 | 11,142               | 54.9              | 17.9        |
| <i>Sheep-cereal Farms</i> | (26 farms)            | (25 farms)           | (23 farms)            | (21 farms)           |                   |             |
| $X_1$ \$                  | 103,720               | 144,234              | 84,596                | 101,153              | 39.1              | 19.6        |
| $X_2$ \$                  | 8,409                 | 12,296               | 5,876                 | 7,067                | 46.2              | 20.3        |
| $X_3$ mo                  | 23.4                  | 28.4                 | 20.9                  | 21.0                 | 21.4              | 0.5         |
| $Y$ \$                    | 18,307                | 31,449               | 14,458                | 20,214               | 71.8              | 39.8        |

<sup>(a)</sup>  $X_1$  = Value of land plant and livestock at beginning of year (1967 dollars)

$X_2$  = Expenditure which does not directly service  $X_1$  or  $X_3$  (1967 dollars)

$X_3$  = Man-months of labour used during year.

$Y$  = Gross value of production during year (1967 dollars).

<sup>(b)</sup> Year prior to the advent of a management service.

<sup>(c)</sup> Four years after the advent of a management service for sheep-cereal farms and five years after for south-west farms.

cereal group, there is strong evidence for rejecting the hypothesis of coincidence. The outcomes of these tests suggest that further analyses of the south-west sample should proceed on the basis of regressions estimated independently from annual data,<sup>8</sup> whereas further analyses of the sheep-cereal sample could justifiably be based on a joint regression estimated from pooled within-year variation.

The 15 regressor variables used in the analyses reported in Tables 2 and 3 can be grouped into five convenient blocks for testing hypotheses about the parameters of the complete model. The results of these analyses are summarized in Table 4, where the following block symbols are used:

*A* for input variables  $X_1$ ,  $X_2$ ,  $X_3$ .

*B* for time, membership, and time by membership variables  $X_4$ ,  $X_5$ ,  $X_6$ .

*C* for time by input variables  $X_7$ ,  $X_8$ ,  $X_9$ .

*D* for membership by input variables  $X_{10}$ ,  $X_{11}$ ,  $X_{12}$ .

*E* for time by membership by input variables  $X_{13}$ ,  $X_{14}$ ,  $X_{15}$ .

In the case of sheep-cereal farms, blocks *B*, *C*, *D* and/or *E* account for only minor variation after the effect of Block *A*. Therefore, although there is strong evidence that resource productivities fluctuated from year to year, there is little evidence that they varied systematically between members and non-members, either before or after the advent of advisory services. The principal effect attributed to increased production

<sup>8</sup> Testing hypotheses by summing components of variations from independent annual regressions implies the homogeneity of error variances between years. This assumption was tested and not rejected. See footnote 7.

TABLE 2

*Analysis of Variance for Farms in Each Region  
First Model*

|   | Symbol | South-west Farms |                | Sheep-cereal Farms |                |
|---|--------|------------------|----------------|--------------------|----------------|
|   |        | d.f.             | Sum of Squares | d.f.               | Sum of Squares |
| I Overall regression  |        | 15               | 16·446900      | 15                 | 12·953381      |
| II Deviations from overall regression:  |        |                  |                |                    |                |
| i) Deviations about independent annual regressions  | $S_1$  | 159              | 2·316843       | 122                | 1·592877       |
| ii) Independent annual regressions about annual regression hyperplanes with common "slopes" based on pooled within-year variations. | $S_2$  | 90               | 2·348337       | 90                 | 1·079266       |
| iii) Annual means about a common regression hyperplane based on pooled within-year variation.                                       | $S_3$  | 6                | 0·256010       | 6                  | 0·342259       |
| III Total   |        | 270              | 21·368090      | 233                | 15·967783      |

TABLE 3

*Tests of Hypothesis of Parallelism and Coincidence  
First Model*

| Test        | Sheep-cereal Farms |            |         | South-west Farms |            |         |
|-------------|--------------------|------------|---------|------------------|------------|---------|
|             | F                  | d.f.       | Signif. | F                | d.f.       | Signif. |
| Parallelism | 0·92               | 90 and 122 | n.s.    | 1·79             | 90 and 159 | **      |
| Coincidence | 4·53               | 6 and 212  | **      |                  |            |         |

n.s. Not significant at the 5 per cent level.

\*\* Significant at the 1 per cent level.

in the sheep-cereal region is the increase in resources which were committed to production, and these increases were much greater for farmers receiving advice.

The situation is not so clear-cut in the south-west region where, in addition to the effect of block *A*, blocks *C* and *E* account for variation which is significant at the 5 per cent level. Therefore, although there appears to have been little difference between the productivities of resources of members and non-members prior to the advent of intensive advice, resource elasticities appear to have changed systematically since the advent of advice, and to have changed at different rates for members and non-members.



TABLE 4  
*Analysis of Variance for Blocks of Regressor Variables*  
*First Model*

|                          | South-west Farms (based on sums of independent annual regressions) |                | Sheep-cereal Farms (based on pooled within-year variation) |                |
|--------------------------|--|----------------|--|----------------|
|                          | d.f.   | Sum of Squares | d.f.   | Sum of Squares |
| I Regression             | 105  | 17.502989      | 15   | 11.151082      |
| Blocks A, B, C, D, E     | 84   | 15.824919      | 12   | 8.331710       |
| i) Blocks B, C, D, E     | 21   | 1.678070**     | 3  | 2.819372**     |
| Block A after B, C, D, E | 84   | 17.022159      | 12   | 11.121071      |
| ii) Blocks A, C, D, E    | 21   | 0.480830n.s.   | 3  | 0.030011n.s.   |
| Block B after A, C, D, E | 84   | 16.786617      | 12   | 11.116002      |
| iii) Blocks A, B, D, E   | 21   | 0.716372**     | 3  | 0.035080n.s.   |
| Block C after A, B, D, E | 84   | 17.109267      | 12   | 11.129364      |
| iv) Blocks A, B, C, E    | 21   | 0.393722n.s.   | 3  | 0.021718n.s.   |
| Block D after A, B, C, E | 84   | 16.942708      | 12   | 11.120348      |
| v) Blocks A, B, C, D     | 21   | 0.560281*      | 3  | 0.030734n.s.   |
| Block E after A, B, C, D |  |                |  |                |
| II Deviations            | 159  | 2.316843       | 212  | 2.672400       |
| III Total                | 264  | 19.819832      | 227  | 13.823482      |

n.s. Corresponding mean square not significant at the 5 per cent level.

\* Corresponding mean square significant at the 5 per cent level.

\*\* Corresponding mean square significant at the 1 per cent level.

*Five input-aggregate model*

Though resource productivities in the south-west appear to have changed significantly more for members than for non-members since the advent of intensive advice, the analysis of Table 4 is too gross to show the manner in which specific resource productivities differed. The distributions of inputs in the various samples of farms are not sufficiently independent to investigate response to individual input aggregates. However, to strengthen the inferences which can be drawn about the impact of advice, particularly in the south-west, a second model has been formulated in which the highly aggregated and relatively fixed input  $X_1$  of the first model is expanded into three input aggregates, while material from the non-significant blocks  $B$  and  $D$  of the first model is deleted.<sup>9</sup> The following variables are used.

|                      |  |
|----------------------|--|
| $X_1$                | log of value of land at beginning of the year.   |
| $X_2$                | log of value of plant and machinery at the beginning of the year.                                    |
| $X_3$                | log of value of livestock at the beginning of the year.  |
| $X_4$                | log of expenditure during the year which did not directly service $X_1$ , $X_2$ , $X_3$ or $X_5$ .   |
| $X_5$                | log of man-months of labour used during the year.  |
| $X_6$ to $X_{10}$    | time ( $X_4$ in complete model) by $X_1$ , $X_2$ , $X_3$ , $X_4$ , $X_5$ respectively.               |
| $X_{11}$ to $X_{15}$ | time by membership ( $X_6$ in complete model) by $X_1$ , $X_2$ , $X_3$ , $X_4$ , $X_5$ respectively. |
| $Y$                  | log of value of gross production during the year.  |

For convenience of analysis the regressor variables used in the partial model are again grouped into blocks, though in this case the groupings are made in two ways. The results from the first groupings are summarized in Table 5, where the following block symbols are used:

- $A$  for input variables  $X_1$  to  $X_5$ .
- $B$  for time by input variables  $X_6$  to  $X_{10}$ .
- $C$  for time by membership by input variables  $X_{11}$  to  $X_{15}$ .

In the analysis of south-west farms, the 15 regressor variables of the partial model account for a greater proportion of the variation of  $Y$  than do the 15 regressor variables of the complete model. The effects of each block of regressor variables in Table 5 are significant at the 1 per cent level. However, the land inputs independently have made only a minor contribution to the variation of production. This is indicated by the analysis in Table 6 where the following block symbols are used:

- $D$  land variables  $X_1$ ,  $X_6$ ,  $X_{11}$ .
- $E$  plant and machinery variables  $X_2$ ,  $X_7$ ,  $X_{12}$ .
- $F$  livestock variables  $X_3$ ,  $X_8$ ,  $X_{13}$ .
- $G$  expenditure variables  $X_4$ ,  $X_9$ ,  $X_{14}$ .
- $H$  labour variables  $X_5$ ,  $X_{10}$ ,  $X_{15}$ .

<sup>9</sup> Strictly, results of analyses made on the basis of each re-aggregation of variables should be reported in similar terms to Tables 2, 3 and 4. However, in all subsequent analyses, evidence for rejecting the hypothesis of parallelism was considerable for south-west farms and scant for sheep-cereal farms. Rather than become overburdened with tables, this conclusion is reported but analyses along the lines of Tables 2 and 3 are not subsequently documented.

TABLE 5  
*Analysis of Variance for Blocks of Regressor Variables, A, B, C, Second Model*

|                    | South-west Farms (based on sums of independent regressions) |                | Sheep-cereal Farms (based on pooled within-year variation) |                |
|--------------------|---|----------------|--|----------------|
|                    | d.f.  | Sum of Squares | d.f.   | Sum of Squares |
| I Regression       |   |                |  |                |
| Blocks A, B, C     |   |                |  |                |
| i) Blocks B, C     | 105   | 18·151710      | 15   | 11·345767      |
| Block A after B, C | 70  | 9·438789       | 10   | 4·587490       |
| ii) Blocks A, C    | 35  | 8·712921**     | 5  | 6·758277**     |
| Block B after A, C | 70  | 16·959865      | 10   | 11·251720      |
| Block B after A, C | 35  | 1·191845**     | 5  | 0·094047n.s.   |
| iii) Blocks A, B   | 70  | 17·496930      | 10   | 11·298768      |
| Block C after A, B | 35  | 0·654780**     | 5  | 0·046999n.s.   |
| II Deviations      | 159   | 1·668122       | 212  | 2·477715       |
| III Total          | 264   | 19·819832      | 227  | 13·823482      |

n.s. Corresponding mean square not significant at the 5 per cent level.

\*\* Corresponding mean square significant at the 1 per cent level.

TABLE 6  
*Analysis of Variance for Blocks of Regressor Variables D, E, F, G, H,  
 Second Model*

|                          | South-west Farms (based on sums of independent regressions) |                | Sheep-cereal Farms (based on pooled within-year variation) |                |
|--------------------------|---|----------------|--|----------------|
|                          | d.f.  | Sum of Squares | d.f.   | Sum of Squares |
| I Regression             | 105   | 18·151710      | 15   | 11·345767      |
| Blocks D, E, F, G, H     | 84  | 17·844842      | 12   | 11·288727      |
| i) Blocks E, F, G, H     | 21  | 0·306868n.s.   | 3  | 0·057041n.s.   |
| Block D after E, F, G, H | 84  | 17·577338      | 12   | 11·061628      |
| ii) Blocks D, F, G, H    | 21  | 0·574372**     | 3  | 0·284139**     |
| Block E after D, F, G, H | 84  | 17·490587      | 12   | 11·296058      |
| iii) Blocks D, E, G, H   | 21  | 0·661123**     | 3  | 0·049709n.s.   |
| Block F after D, E, G, H | 84  | 17·097829      | 12   | 9·861939       |
| iv) Blocks D, E, F, H    | 21  | 1·053881**     | 3  | 1·483828**     |
| Block G after D, E, F, H | 84  | 17·460512      | 12   | 11·317067      |
| v) Blocks D, E, F, G     | 21  | 0·691198**     | 3  | 0·028700n.s.   |
| Block H after D, E, F, G | 159   | 1·668122       | 212  | 2·477715       |
| II Deviations            | 264   | 19·819832      | 227  | 13·823482      |
| III Total                |   |                |  |                |

n.s. Corresponding mean square not significant at the 5 per cent level.

\*\* Corresponding mean square significant at the 1 per cent level.

As in the first model, there is scant evidence that either time, membership, their interactions with each other, or their interactions with levels of inputs altered input productivities for sheep-cereal farms. Nor is there strong evidence that resource elasticities changed, though significant shifts in year-to-year resource productivities ( $\alpha_j$ ) occurred. For this reason regression estimates have been made using pooled within-year variation, incorporating only the resource levels as regressor variables. The estimate is:

$$Y = \hat{\alpha}_j + 0.1199 X_1 + 0.1712 X_2 + 0.0199 X_3 + 0.7424 X_4 + 0.1187 X_5$$

(0.062)      (0.033)      (0.042)      (0.060)      (0.054)

with  $R^2 = 0.809$ . Since the coefficient of  $X_3$  is small in relation to its standard error, this variable is deleted from subsequent sheep-cereal analyses. The revised regression is:

$$Y = \hat{\alpha}_j + 0.1299 X_1 + 0.1693 X_2 + 0.7500 X_4 + 0.1191 X_5$$

(0.058)      (0.033)      (0.058)      (0.054)

with  $R^2 = 0.808$ . Although, as a group, the values of the  $\alpha_j$  differ significantly from each other in the second equation, they have exhibited no particular trend through time (Table 7).

TABLE 7

*Annual Values of Intercepts and Their Antilogs for Regression of Y on  $X_1$ ,  $X_2$ ,  $X_4$ , and  $X_5$ . Based on Pooled Within-year Variation—Sheep-Cereal Farms*

| Year | Intercept | Antilog Intercept |
|------|-----------|-------------------|
| 1961 | -0.0132   | 0.9700            |
| 1962 | -0.0681   | 0.8549            |
| 1963 | -0.1377   | 0.7286            |
| 1964 | -0.1171   | 0.7637            |
| 1965 | -0.1200   | 0.7586            |
| 1966 | -0.0645   | 0.8619            |
| 1967 | -0.0604   | 0.8702            |

In both equations the sum of coefficients (elasticities) is greater than 1.0, indicating the likelihood of increasing returns to scale. The hypothesis of constant returns to scale has been tested by fitting a regression to the data with the coefficients constrained to sum to 1.0 and by seeing whether the residual sums of squares in the constrained and unconstrained models differ significantly.<sup>10</sup> In the second equation the residual sum of squares is 2.6429 with 222 degrees of freedom, whereas the residual sum of squares for the corresponding regression with coefficients constrained to sum to unity is 2.8188 with 223 degrees of freedom. The difference between them is significant at the 1 per cent level, providing strong evidence of increasing returns to scale in the sample. This accounts for the apparent increase in the productivity of resources

<sup>10</sup> Tests of hypotheses of constraints on parameter values are treated in standard texts, e.g., Williams, E. J., *op. cit.*, pp. 49-58.

seen in Table 1 where output of the sheep-cereal farms increased by a greater proportion than any of the inputs, even though no significant improvement appears to have taken place in the overall production relationship.

The analysis of south-west farms is less straightforward, because interactions of input levels with time, and time by membership have to be taken into account, and no single regression estimate by pooling within-year variation is justified. Variables of block *D* have been omitted from further consideration, since from Table 6 they have not made a significant independent contribution to the variation of production. The effects of the 12 remaining regressor variables are estimated in the following ways: first, under three restraints which test scale relationships; and second, under four restraints which test changes taking place in specific elasticities of production. The first set of tests is based on the analyses of variance summarized in Table 8, where:

- (i) constraint I is that returns to scale prior to the advent of advisory services have been constant, i.e., coefficients of  $X_2$  to  $X_5$  sum to unity;
- (ii) constraint II is that returns to scale have remained unaltered for non-members, i.e., coefficients of  $X_7$  to  $X_{10}$  sum to zero;
- (iii) constraint III is that there have been no differences in changes of returns to scale between members and non-members over time, i.e. coefficients of  $X_{12}$  to  $X_{15}$  sum to zero.

Evidence to reject the hypothesis of constant returns to scale prior to the advent of advice (constraint I) is not strong, and evidence to reject the hypothesis that returns to scale have not changed for non-members

TABLE 8

*Constrained and Unconstrained Analysis of Variance for Blocks of Regressor Variables E, F, G, H, Second Model, Based on Sums of Independent Annual Regressions, South-West Farms*

|   | d.f. | Sum of Squares |
|---|------|----------------|
| Unconstrained Regression                                    | 84   | 17.844707      |
| (i) Constrained regression I                                | 77   | 17.720797      |
| Difference between constrained and unconstrained regression | 7    | 0.123910n.s.   |
| (ii) Constrained regression II                              | 77   | 17.784991      |
| Difference between constrained and unconstrained regression | 7    | 0.059716n.s.   |
| (iii) Constrained regression III                            | 77   | 17.665897      |
| Difference between constrained and unconstrained regression | 7    | 0.178810*      |
| Deviations  | 180  | 1.975125       |
| Total   | 264  | 19.819832      |

n.s. Corresponding mean square not significant at the 5 per cent level.

\* Corresponding mean square significant at the 5 per cent level.

(constraint II) is even weaker. Evidence is much stronger to reject the hypothesis that returns to scale have not changed for members (constraint III). It is likely that returns to scale of members increased, since the sum of coefficients of  $X_{12}$  to  $X_{15}$  is positive in six of the seven years.

The second set of tests, based on the analyses of variance summarized in Table 9, is designed to test whether specific elasticities of production have remained unchanged, where:

- (i) constraints IA and IB are that the elasticity of production of plant and machinery remained unchanged for non-members (IA) and members (IB); in IA it is assumed that the coefficients of  $X_7$  in each year are zero, and in IB it is assumed that the sums of the coefficients of  $X_7$  and  $X_{12}$  in each year are zero;
- (ii) constraints IIA and IIB are corresponding restraints for livestock ( $X_8$  and  $X_{13}$ );
- (iii) constraints IIIA and IIIB are corresponding restraints for expenditure ( $X_9$  and  $X_{14}$ );
- (iv) constraints IVA and IVB are corresponding restraints for labour ( $X_{10}$  and  $X_{15}$ ).

TABLE 9

*Constrained and Unconstrained Analyses of Variance for Changes in Elasticities of Input Variables, Second Model, Based on Sums of Independent Annual Regressions, South-West Farms;*

|   |      | d.f. | Sum of Squares |
|---|------|------|----------------|
| Unconstrained Regression                                    |      | 84   | 17.844707      |
| (i) Constrained regression                                  | IA   | 77   | 15.626750      |
|   | IB   | 77   | 15.683154      |
| Difference between constrained and unconstrained regression | IA   | 7    | 0.242832*      |
|   | IB   | 7    | 0.186428*      |
| (ii) Constrained regression                                 | IIA  | 77   | 15.804350      |
|   | IIB  | 77   | 15.683154      |
| Difference between constrained and unconstrained regression | IIA  | 7    | 0.065232n.s.   |
|   | IIB  | 7    | 0.039960n.s.   |
| (iii) Constrained regression                                | IIIA | 77   | 15.739926      |
|   | IIIB | 77   | 15.698546      |
| Difference between constrained and unconstrained regression | IIIA | 7    | 0.129656n.s.   |
|   | IIIB | 7    | 0.171036*      |
| (iv) Constrained regression                                 | IVA  | 77   | 15.823443      |
|   | IVB  | 77   | 15.818415      |
| Difference between constrained and unconstrained regression | IVA  | 7    | 0.046139n.s.   |
|   | IVB  | 7    | 0.051167n.s.   |
| Deviations  |      | 180  | 1.975125       |
| Total   |      | 264  | 19.819832      |

n.s. Corresponding mean square not significant at the 5 per cent level.

\* Corresponding mean square significant at the 5 per cent level.

There is scant evidence to reject hypotheses of constant elasticities of production for livestock or labour for either group (constraints II and IV). Evidence is much stronger for rejecting hypotheses of constant elasticities of production for (i) plant and machinery (constraints IA and B) and (ii) expenditure (constraint IIIB). It is likely that the elasticity for plant and machinery has decreased for both groups but at a faster rate for non-members, because the coefficients of  $X_7$  are negative in six of the seven years, whereas the coefficients of  $X_{12}$  are positive in four of the seven years. Though there is little evidence that the elasticity for expenditure has changed for non-members, it is more likely that it has risen for members, because the coefficients of  $X_{14}$  are positive in five of the seven years. However, conclusions based on signs of coefficients must be held with caution, because the correlations between regressor variables are high and the covariances of their coefficients are correspondingly large.

### *Rates of Growth*

It has been established that members achieved faster rates of growth than non-members in both the south-west and sheep-cereal regions. It has also been established that gross incomes and assets of members were on average initially larger than those of non-members in both regions. It has not been established whether rate of growth is directly associated with membership of farm management advisory services, after initial size is taken into account.

To test whether or not any such association exists, rates of growth have been regressed against initial size and membership or non-membership.<sup>11</sup> In all the analyses which follow, rate of growth,  $r$ , is the least squares estimate under a semi-logarithmic transformation of the compound growth function:

$$y_t = a(l + r)^t$$

The variables are:

- $X_1$  value of gross production during year 0.
- $X_2$  value of land, plant and machinery, and livestock at the beginning of year 0.
- $X_3$  membership dummy variable (equals 1 for members or 0 for non-members).
- $X_4$  rate of growth of the value of gross production.
- $X_5$  rate of growth of the value of land, plant and machinery, and livestock.

Results for the south-west farms are:

$$X_4 = 9.68 - 0.00023 X_1 + 3.15 X_3 \quad R^2 = 0.05$$

(0.00018)      (2.27)

$$X_5 = 6.94 - 0.000020 X_2 + 1.71 X_3 \quad R^2 = 0.08$$

(0.000012)      (1.31)

Results for the sheep-cereal farms are:

$$X_4 = 10.00 - 0.00020 X_1 + 6.26 X_3 \quad R^2 = 0.17$$

(0.00012)      (2.23)

$$X_5 = 9.33 - 0.000056 X_2 + 4.46 X_3 \quad R^2 = 0.26$$

(0.000018)      (1.44)

<sup>11</sup> Prior analyses included an interaction variable between size, and membership or non-membership. Its effect was negligible in all cases.



Although the total variation of rates of growth accounted for by the regression is low in all cases, signs of the coefficients are consistent and each coefficient is greater than its standard error. Membership is positively associated with rates of growth, expressed either in terms of gross income or value of assets, and in the sheep-cereal region this association is significant at the 5 per cent level. The more rapid business growth of members has not been due to their greater initial size. In fact, in both groups and in both regions, farms which were initially larger apparently have grown less rapidly than farms which were initially smaller, after accounting for the effect of membership.<sup>12</sup>

#### *Summary of Empirical Results*

In certain respects the findings are similar for farms in the south-west and sheep-cereal regions. On average, members in both regions were initially using greater amounts of resources than non-members, and have increased them at faster rates. Differences in levels of resource use have dominated all other differences in accounting for variation in output. There is little evidence to suggest any initial differences between the production relationships of members and non-members before the advent of advice, nor is there much evidence that productivity changes have occurred due to time, membership, or time by membership independently of the levels of resource use. On average, members in both regions had farms which were initially larger and which sustained more rapid rates of growth but, after taking the effect of membership into account, initial size has been associated negatively with rates of growth.

In other respects the findings differ. There is strong evidence of increasing returns to scale in the sheep-cereal region. Thus, although there is little evidence of any systematic change in production relationships over time or through the impact of intensive farm management advice, ratios of output to input have increased faster for members, due to faster rates of growth of resource use. There is little evidence that there were any economies or diseconomies of scale in the operations of either members or non-members prior to the advent of intensive advice in the south-west region, but there is some evidence that returns to scale increased for members over time, mainly as a result of an increasing elasticity associated with the current expenditure input. The output of members increased at a faster rate than any of the input categories, but this was not so for non-members.

#### *Conclusion*

The overriding impression that this study has left with its authors is that farmers who have been associated with continuous intensive farm management advice have been able to develop their businesses at very much faster rates than farmers who have not. It cannot be claimed that this is a conclusion without bias, since the method of selecting the samples of farmers excluded those who had left farming during the period of the study, and these, too, could have been influenced by the impact of advice. Nor can it be claimed that these rates of growth have been due to the impact of advice, since farmers who were predisposed

<sup>12</sup> A similar conclusion has recently been reported. See Jarrett, F. G., On the growth of the agricultural firm, *Austr. Jour. Agr. Econ.*, 12: 1-15, 1968.

to rapid growth may have been those who joined farm management advisory services.

Unfortunately, it was not possible to elucidate from the survey data the processes by which members of advisory services were able to acquire assets for growth at faster rates than those who were not, but the simplest inference is that the adviser played an important role. It has often been suggested that the initial impact of intensive advice is technical,<sup>13</sup> but this has not been borne out by this study of the early impact of several services in Western Australia. Admittedly, the distinction between technical and economic (or financial) is often not made clear. Technical change has been implicitly interpreted in this study as a shift in the functional relationship between resources and outputs rather than as a shift in the amounts or intensities of resources used within a functional relationship. There is considerable evidence for differences between members and non-members in rates at which resource use has changed, but evidence for the production relationships themselves changing at different rates is much weaker. Under growth and increasing returns to scale, particularly in the sheep-cereal region, this has given the appearance of marked improvements in input/output rates.

No attempt has been made in this study to answer many questions which have been raised about the impact of private farm management extension services in Australia.<sup>14</sup> However, there are some wider implications than those already discussed. The purchase of intensive advice has been a major innovation in Australian and New Zealand agriculture over the last decade. We have established that, for a sample of farms in Western Australia, this innovation has been associated with a larger than average rate of growth and development. Furthermore, this management innovation appears to have been more of a vehicle for growth through capital formation than through the introduction of technical change. Herr, studying a different problem with different sources of information, came to a similar conclusion about development in Australian agriculture.<sup>15</sup> His results were 'interpreted as meaning that capital problems of agriculture deserve our careful and continuous attention'.

With current needs for accelerated farm growth, the role of intensive farm management advice in affecting farmers' willingness and ability to expand inputs, coupled with borrowing, credit-worthiness, and financial management, appear to be worthwhile areas for further investigation of the capital problem.

## APPENDIX

### *Definition of Terms Used*

All items are expressed in 1967 quantities or dollars, adjusted from the following sources: Bureau of Agricultural Economics, Rural Valua-

<sup>13</sup> For example, Hassall, H., Method of development of a farm improvement programme as applied to an advisory service in the Wagga area, *Review, Papers, and Reports, Australian Agricultural Extension Conference 1962*, C.S.I.R.O., Melbourne, 1963.

<sup>14</sup> See Druce, P. C., Some developments in farm management extension in Australia, *Austr. Jour. Agr. Econ.*, 8: 112-123, 1964.

<sup>15</sup> Herr, W. McD., Capital formation: its importance and determinants, *Austr. Jour. Agr. Econ.*, 8: 97-111, 1964.

tion Section of the Commonwealth Taxation Department, Western Australian Department of Labour, actual sales and/or purchases of different classes of livestock.

The following aggregates have been used for estimating the production relationships:

- (i) *Gross farm production* (\$): All farm receipts from sales of produce, insurance, contracting work using farm equipment, agistment and rent, produce consumed, skins and rebates, livestock trading profit or loss including changes between opening and closing inventories.  
Excluded: Depreciation written back on disposal of plant, off-farm earnings, interest on non-farm investments, commissions.
- (ii) *Land* (\$): Average district 'paddock' values of improved and unimproved land at 1967 rates, including goodwill value of whole-milk licences.  
Excluded: Farm dwelling and other buildings, yards.
- (iii) *Labour* (Man-months): Employed permanent, casual and family labour valued at award rates ruling in each year for general farm hands, plus farmer's assessment of work contributed by himself, unpaid family, and partners,
- (iv) *Plant* (\$): Book value of plant inventory at 1st July each year adjusted to 1967 values.
- (v) *Livestock* (\$): Numbers on 1st July each year adjusted to average selling prices for each class of stock in 1966/67 taxation year.
- (vi) *Expenses* (\$): All farm expenditure which does not directly service land, labour, or plant.  
Excluded: Wages and sustenance, depreciation and primary production allowances, interest and hire purchase, rent, land rates and taxes, income tax.