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ESTIMATION OF RELATIONSHIPS BETWEEN FARM MANAGEMENT FACTORS AND FARM INCOME[1]

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Planned improvement in the productivity and income of farm business requires a clear understanding of managerial and organisational problems of individual farms and consequent intelligent application of good farm management principles. Once this is achieved, the existing stock of resources could be organised to give greater returns with the same inputs or the same returns with the use of fewer inputs.

In 'traditional' farm business analysis the use of farm management factors, (as conventionally defined) is one of the widely accepted approaches for the estimation of the soundness of a given farm business organisation. Although in the strict economic sense these 'factors' are neither factors of production, nor factors influencing managerial performances, they are expected to be good and simple indicators of input-use efficiency, closely related to net income levels, and thus could be used to predict success or failure of a farm business in terms of the magnitude of net income generated.

In this paper an attempt was made to analyse the relationships between various factors of farm management and farm earnings using alternative measures for both. The main objective was to estimate the predictive power of the farm management factors and thus facilitate selection among them for use in farm business analysis with a view to diagnose weak and strong points in farm organisation. A large number of alternative measures of management factors and income have been proposed by various authors and are widely used for farm business analysis. Because of their proliferation it seemed useful to test their predictive power and to choose among them and to develop some standard measures of performance which then could be used in the analysis of farm business in the area for which the standards have been developed.

I

THE PROCEDURE

The observations of this study are based on the data collected by the Division of Agricultural Economics, Indian Agricultural Research Institute under the project 'Economics of Farm Management' in Kanjhawla Block of Delhi Villages, 1960-61. Out of 19 villages in the then Intensive Cultivation Block attached to

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this Institute, 8 villages were selected by random sampling method and from each village 8 holdings were selected, 2 from each size-group, *i.e.*, below 5 acres, 5-10 acres, 10-15 acres, 15 acres and larger, by stratified sampling method. Actually, however (because of unavailability of the holdings in below 5 acres and 10-15 acres groups in certain villages), 60 holdings were included in the sample. The data were gathered by cost accounting method. Only crop enterprises have been taken into consideration.

This study started with the calculation of various factors of management influencing farm incomes. For each factor of management various alternative measures were computed to enable a later selection of the best measure predicting the influence of that particular factor on farm earnings. Similarly, various measures of farm earnings have been computed to select the best measure among those for estimating the efficiency of management factors. The various factors of management and farm earnings and the alternative measurements included in this study are given below. The detailed methods of calculating the various measures of factors and income are given in the Appendix.

Management Factors Examined and Measures Used[2]

Factors	Measures
(1) Size of Farm Business	(i) Size of holding.
	(ii) Total cropped area.
	(iii) Total gross farm output.
	(iv) Total investment in fixed capital.
	(v) Total man-equivalent days utilised.
	(vi) Total bullock labour days utilised.
(2) Choice and Combination of Enterprises	(i) Percentage of total cropped area put under major crops.
	(ii) Percentage of total man-equivalent days utilised in major crops.
	(iii) Percentage of total gross farm output coming from major crops.
	(iv) Percentage of total bullock labour days utilised in major crops.
	(v) System Index.
(3) Rate of Production	(i) Crop yield index.
	(ii) Index of gross farm output.

2. Refer W. Y. Yang : Methods of Farm Management Investigations, Food and Agriculture Organization of the United Nations, Rome, pp. 54-68.

Factors	Measures
(4) Intensity of Cultivation	(i) Man-equivalent days utilised per acre of farm area.
	(ii) Bullock labour days utilised per acre of farm area.
	(iii) Working capital utilised per acre of farm area.
	(iv) Total expenditure incurred per acre of farm area.
	(v) Intensity index.
	(vi) Intensity of cropping.
(5) Efficiency Measures	
(a) Human Labour	Gross farm output per man-equivalent day used in crop production.
(b) Capital	Rate of capital turnover.
(c) Output-Input Ratio	Output-input ratio for farm business as a whole.

Income Measures Used

(i) Net returns per acre.
(ii) Total labour earnings per acre.
(iii) Farm business income per acre.
(iv) Total labour earnings per man-equivalent day utilised.
(v) Returns to capital per Rs. 100 invested.

Because of the many alternative measures included in the analysis at the beginning, we had to start with an eliminating process. Part of this eliminating process was based on the inter-relationships existing between independent and also between dependent variables. The main idea underlying the choice of analytical methods was to go from the simple type of analysis to the more sophisticated ones. At the same time, the number of variables used was reduced so as to make computation feasible.

In the first instance, the inter-relationships between various income measures were estimated by the use of tabular analysis. The results of these were further analysed by graphical methods permitting easy visual perception of the nature of relationships. In the selection of the final income measure, closeness of the relationships between individual income measures and all the factors of management, with the help of tabular and graphical analysis was taken into consideration. On the basis of the results of this sequence of analyses, one income measure was

selected from among several analysed. This measure (net earnings per acre) was used in subsequent analysis of relationships between farm management factors and farm earnings.

The results of the tabular analysis between management factors and net earnings per acre were verified with analysis of variance. Those relationships which were found statistically significant were further analysed by simple regression analysis. In selecting the relationships to be further analysed double values of 'F' at 5 per cent level of significance were used. This high cutting point was chosen to reduce the number of variables to a manageable size for the regression analysis later on.

In fitting the regression equation, the knowledge gained from the earlier graphical analysis was used in choosing the relevant mathematical forms. Most of the functions fitted were linear. Some were of the Cobb-Douglas type, and for one relationship, a quadratic function was fitted. The estimated parameters of regression analysis were tested by 't' test. The inter-relationships between various management factors were then analysed to reduce the problem of multi-collinearity or specification bias. One measure from each factor of management was selected as independent variable for multivariate regression analysis. A Cobb-Douglas type of multivariate production function was finally derived.

II

INTER-RELATIONSHIPS BETWEEN INCOME MEASURES

Farm income measures are tools to estimate the success of farm business organisation and the differences between the alternative measures are due to differences in the accounting procedures used. One income measure may not be adequate for all purposes. At the same time if these measures are closely correlated, one measure may be as good as another in depicting the success of the farm business.

The various income measures were related to net returns per acre as given in Table I.

TABLE I—INTER-RELATIONSHIPS BETWEEN VARIOUS INCOME MEASURES

Class Interval (net returns per acre) Rs.	No. of Farms	Income Measures (Mean Value in Rs.)				
		Net returns per acre	Labour earnings per acre	Farm business income per acre	Labour earnings per MED	Returns to capital per Rs. 100
Below —150	12	—264.7	—173.3	—111.5	—4.3	—23.4
—150 to 0	13	— 50.1	23.8	47.3	0.3	—5.1
0 to 150	20	66.2	140.8	155.9	3.9	10.4
150 +	15	209.8	281.7	290.2	8.3	33.6
Overall	60	10.7	87.8	112.5	2.6	6.1

With the exception of the lowest size of net returns per acre groups (which reflects great variability with different income measures), the rest of the income groups showed almost constant differences between the group averages with different income measures.

The highest value of correlation coefficient (r = 0.951) was observed with total labour earnings per acre and farm business income per acre. It indicates how labour and capital investment are inseparably associated in terms of household and farm business. The next lower values of correlation coefficients were : net returns and total labour earnings 0.944, net returns and farm business income 0.875 and net returns and returns to capital 0.813. The high correlation between these measures is caused by fairly constant differences between them.

When the relationships with individual income measures with all the management factors were examined, all income measures tended to behave in the same fashion. Consequently, net returns per acre was the measure selected as the dependent variable for further analysis.

III

MANAGEMENT FACTORS IN RELATION TO FARM INCOME

(a) UNIVARIATE RELATIONSHIPS

(1) *Size of Farm Business*

In order to use the factors of production efficiently and to produce adequately for a decent standard of living for the farm family, the size of the farm business must be reasonably large. Because of the indivisibility of certain input factors, too small farms cannot operate with efficiency. Farm expenses per acre usually decrease as the size of business increases because fixed factors such as buildings, machinery, bullock labour and also family human labour can be more efficiently utilised on reasonably large farms.

The relationships of net returns per acre with alternative measures of size of farm business, estimated with the help of tabular analysis and analysis of variance is given in Table II.

TABLE II—RELATIONSHIPS BETWEEN VARIOUS MEASURES OF SIZE OF FARM BUSINESS AND NET RETURNS PER ACRE

Measure	Management Factors			Net Returns per Acre		
	Class Interval	Mean Value	No. of Farms	Mean Value	Average marginal change	Ratio
Size of holdings (acres)	0—4.99	3.5	19	—170.7		
	5—9.99	7.5	17	9.7	+41.17	F = 5.040*
	10—14.99	11.7	14	48.4	+ 9.21	
	15+	24.5	16	93.7	+ 3.53	
	Mean of total	12.1	60	10.7		

(Contd.)

TABLE II (*Concluded*)

Measure	Management Factors			Net Returns per Acre		
	Class Interval	Mean Value	No. of Farms	Mean Value	Average marginal change	Ratio
Total cropped area	0 — 7.99	6.1	15	—132.4		
	8 —14.99	11.8	19	6.0	+22.17	F = 7.930*
	15—21.99	17.7	11	98.9	+17.77	
	22 +	35.5	15	110.4	+ 0.64	
	Mean of total	17.4	60	10.7		
Total gross farm output (Rs.)	0—1,999	1362	13	—203.2		
	2,000—2,999	2427	12	— 24.6	+16.7	F = 21.190*
	3,000—4,999	3878	19	60.4	+ 5.8	
	5,000 +	8053	16	152.0	+ 2.1	
	Mean of total	4156	60	10.7		
Total fixed capital (Rs.)	0 — 5,999	4099	18	—180.3		
	6,000—9,999	7990	16	31.6	+ 3.5	F = 5.527*
	10,000—13,999	10480	12	124.5	+ 3.7	
	14,000 +	20745	14	25.6	— 0.9	
	Mean of total	10403	60	10.7		
Total man-equivalent days	0—249.9	173.2	15	—122.1		
	250—349.9	300.7	11	— 12.8	+ 0.85	F = 6.750*
	350—449.9	393.8	16	29.5	+ 0.45	
	450 +	629.0	18	119.1	+ 0.38	
	Mean of total	392.1	60	10.7		
Total bullock labour days	0 — 99.9	73.3	14	—130.2		
	100—149.9	129.5	15	31.3	+ 2.87	F = 4.777*
	150—199.9	171.4	16	66.2	+ 0.83	
	200 +	263.0	15	62.5	— 0.04	
	Mean of total	161.0	60	10.7		

*Significant at 1 per cent level.

The various measures of the size of the farm business when related to net returns per acre showed positive and significant relationships. In its relation to net returns per acre, total gross farm output showed the highest F value, followed by total cropped acreage. However, the F values were significant at 1 per cent for all the tested measures of size.

After the analysis of variance, in case the relationships were significant, we further estimated the critical difference (least significant difference) between the income of each group with that of its next higher size-group. With the size of holding, the difference between income of 0—4.99 acre and 5—9.99 acre-groups was significant. However, the differences between 5—9.99 acre and 10—14.99 acre as well as 10—14.99 acre and 15 + acre-groups were not significant. With total cropped acreage, the differences only between 0—7.99 acre and 8—14.99 acre as well as 15—21.99 acre and 22 + acre-groups were significant. With total gross farm output the groups Rs. 0—1,999 and Rs. 2,000—2,999 as well as groups Rs. 3,000—4,999 and Rs. 5,000 + showed significant differences. With total investment in fixed capital only the groups Rs. 0—5,999 and Rs. 6,000—9,999 showed significant difference. With total man-equivalent days used, the groups 0—249.9 days and 380—449.9 days showed significant difference. With bullock labour days groups 0—99.9 days and 100—149.9 days showed significant difference.

Farm businesses in the lower most size-groups, as measured by the various management factors were associated with reduced earnings to the extent that if both inputs and products are valued at market rates, the following size-groups of farm businesses are not expected to be sound business proposition :

(*i*) size of holding group below 5 acres.

(*ii*) total cropped acreage group below 8 acres.

(*iii*) total gross farm output group below Rs. 2,000.

(*iv*) investment of fixed capital group below Rs. 6,000.

(*v*) total utilised man-equivalent days group below 450.

(*vi*) total utilised bullock labour days group below 100.

The various regression equations derived, relating each measure of size of net returns per acre, are summarised in Table III.

With respect to total investment in fixed capital though tabular analysis showed significant relationship and the graphical analysis indicated a quadratic function, the estimated function did not show significant relationship. The various regression coefficients in case of other measures of farm size were found significant at 1 per cent level. For 1 per cent change in the size of holding, total cropped acreage and total bullock labour days utilised, net return per acre is expected to change by 0.3418, 0.3328, and 0.4491 per cent respectively. In case of total gross farm output and total man-equivalent days, unit change in these variables is expected to affect net returns per acre by 4 and 42 *Paise* respectively. The values of coefficients of determination (r^2) indicated that 35 per cent, 26 per

cent, 45 per cent, 1 per cent, 23 per cent and 28 per cent variations in net returns per acre could be explained due to the variation in size of holding, total cropped acreage, total gross farm output, total capital investment, total man-equivalent days, and total bullock labour days, respectively.

TABLE III—SINGLE VARIABLE REGRESSION EQUATIONS, RELATING EACH MEASURE OF SIZE OF FARM TO NET RETURNS PER ACRE

Independent variable, measures of size of farm business	Production function estimated and values of Ep* and MR**	't' value of regression coefficient	Coefficient of determination
1. Size of holding	$Y^a = 266.4 \cdot X^{.34186}$ (MR[b] at GM = 20.91)	5.597	0.35
2. Total cropped acreage	$Y = 238.3 \cdot X^{.3328}$ (MR at GM = 13.79)	4.565	0.26
3. Total gross farm output	$Y = 165.05 + .042\ X$ (Ep at AM[c] = 16.46)	7.066	0.45
4. Total investment in fixed capital	$Y = -22.24 + 3.781X - .039\ X^2$	(F = 0.337)	0.01
5. Total man-equivalent days	$Y = -156.36 + .426\ X$ (Ep at AM = 15.61)	4.217	0.23
Total bullock labour days	$Y = 61.43 \cdot X^{.4491}$ (MR at GM = 1.79)	4.702	0.28

Where * Ep denotes elasticity of production
** MR denotes marginal returns
[a] Y stands for net returns per acre
[b] GM denotes geometric mean
[c] AM denotes arithmetic mean

(2) *Choice and Combination of Enterprises*

Judicious selection and combination of enterprises is one of the most important factors associated with the economic efficiency of farm business. Generally, individual farmers follow the type of farming prevalent in the region but the kinds and sizes of existing enterprises, even in a particular type of farming area are many and varied and their returns differ greatly. Farmers should select those crops which pay best and eliminate those that cause losses. However, in making comparison of the relative profitableness of various enterprises, the effect of their choice upon total net farm income should always be kept in mind. Because some enterprises are supplementary and others complementary in most situations, a good farming system, that yields maximum net income usually includes more than a single enterprise.

The estimation of the efficiency of choice and combinations of enterprises on a multiple enterprise farm posed a problem. Land being the most limiting factor, we examined the effect of allocations of cropped acreage to major enterprises, *viz.*, wheat, gram, bajra and jowar (together representing 90 per cent of

total cropped area) on net returns per acre. In respect of the most important enterprise—wheat, we also examined the effect of allocations of man-equivalent days, bullock labour days to wheat and percentage value of gross farm output coming from wheat by relating these to net returns per acre. Finally, system index was used to estimate the aggregate effect of choice and combinations of enterprises on net returns per acre.

The percentage allocation of land to wheat, gram, bajra and jowar when related to net returns per acre indicated that an allocation of the total cropped area to wheat exceeding 45 per cent, to gram below 12 per cent and above 24 per cent, bajra above 30 per cent, and to jowar below 12 per cent were associated with reduced net earnings. However F ratios were significant only in case of gram and bajra. In case of wheat, with respect to the allocations of other factors, net returns per acre increased up to the point where 50 per cent man-equivalent days and 70 per cent bullock labour days were used for wheat and 45 per cent value of gross farm output came from this crop. Beyond these points net returns per acre started to decline.

The system index exhibited positive and significant relationship with per acre net income. F ratio was significant at 5 per cent level. A linear function was estimated, *viz.*,

$$Y = -389.664 + 3.830X$$

(Ep at AM = 36.40)

$t_b = 2.716$

$r^2 = 0.11$

Y = Net returns per acre.

X = System index.

In other words, for unit change in the value of system index, net return per acre is expected to change by Rs. 3.830. The coefficient of determination indicated that 11 per cent variation in net returns per acre is associated with the variation in the system index.

(3) *Rate of Production*

The aggregate physical efficiency of all input factors is reflected in the level of production. Crop yields must be at a reasonably high rate to have enough income left out of the farmer's earnings after meeting the expenses of production. Although there is a limit beyond which the yield per acre cannot rise by further intensification of use of resources, it is a common observation that the economic limit is seldom reached.

A comparison of the different measures of rate of production adopted and their influence on farm earnings indicated that crop yield index and index of gross farm output are good substitutes for each other for the purpose of this analysis. Net returns per acre increased with increase in the crop yield index and index of gross farm output. The rate of increase was almost constant with crop yield index (weighted with acreage). It showed a declining rate of increase with crop

yield index (weighted with man-equivalent days) and with index of gross farm output. The analysis of variance indicated significant relationship with all the three measures of rate of production. Mean net incomes per acre of farms on either side of 100 level crop yield index were significantly different. Groups of farms having crop yield index 100 were associated with reduced net earnings. A linear production function was estimated relating the crop yield index weighted with cropped acreage to net returns per acre. The equation obtained was :

$$Y = -345.79 + 3.870X$$
(Ep at AM = 33.31)

$t_b = 4.078$
$r^2 = 0.25$
Y = Net returns per acre.
X = Crop yield index.

The regression coefficient was significant at 1 per cent level. It indicated that if crop yield index be increased (or decreased) by unit, the net returns per acre is expected to increase (or decrease) by Rs. 3.87. The coefficient of determination indicated that 25 per cent of variability in net returns per acre could be explained by the variation in crop yield index.

(4) *Intensity of Cultivation*

Intensity of cultivation refers to the amount of labour, material and capital applied per unit of farm area. It naturally takes into account the number of crops raised during the year over a particular area of land. In most situations, a more intensive use of one resource in relation to land entails an increase in the level of the other related inputs. However, the marginal productivities of various resources being used in the combination depend on the level on which they are already being used. The various measures used in our study to indicate the intensity of cultivation are alternate substitutes only in a broader sense, except total expenditure per acre and intensity index which could be thought of as close substitute measures. The various relationships are shown in Table IV.

TABLE IV—RELATIONSHIPS BETWEEN MEASURES OF INTENSITY OF CULTIVATION AND NET RETURNS PER ACRE

Management Factor — Intensity of cultivation						
Measure	Class interval	Mean Value	No. of Farms	Mean Value	Average marginal change	F ratio
Man-equivalent days per acre	0—25	20.4	9	6.7		
	25—35	29.7	18	39.5	+3.5	F = 0.767
	35—45	40.5	18	17.5	—2.0	
	45 +	55.3	15	—55.0	—4.8	
	Mean of total	39.8	60	10.7		

(Contd.)

TABLE IV (*Concluded*)

Management Factor — Intensity of cultivation						
Measure	Class interval	Mean Value	No. of Farms	Mean Value	Average marginal change	F ratio
Bullock labour days per acre	0—11.9	9.4	14	27.8		
	12—15.9	13.7	17	91.0	+14.7	F=4.250*
	16—19.9	17.5	15	—54.2	—38.2	
	20 +	25.7	14	—79.3	—3.1	
	Mean of total	16.4	60	10.7		
Cropping intensity	0—124.9	106.6	13	—46.3		
	125—144.9	134.5	16	20.0	+2.32	F =2.278
	145—174.9	160.0	18	87.9	+2.66	
	175 +	201.1	13	—50.5	—3.36	
	Mean of total	150.4	60	10.7		
Total expenditure per acre	0—249.9	213.5	15	84.8		
	250—324.9	281.8	13	146.6	+0.93	F =12.738†
	325—399.9	352.6	16	—7.7	—2.17	
	400 +	613.8	16	—150.7	—0.54	
	Mean of total	372.1	60	10.7		

* Significant at 5 per cent level.
† Significant at 1 per cent level.

Per acre input of man-equivalent days did not show significant relationship with net returns per acre. However, it indicated that net returns increased at first but later showed negative average marginal returns at an increasing rate when input level exceeds 35 days per acre. The per acre input of bullock labour days exhibited significant relationship. Here too, beyond the level of 15 bullock labour days, net returns per acre started falling. The cropping intensity did not show significant relationship, although the net returns tended to increase with increase in the cropping intensity up to 175 per cent, beyond which it tended to decline. Total expenditure per acre exhibited negative relationship. F ratio was significant at 1 per cent level. The intensity index also showed the same trend as observed with total expenditure per acre. Net returns per acre decreased with increase in working capital. This is possibly due to the inclusion of value of concentrates for the maintenance of bullocks.

A linear function was estimated to predict the relationship with total expenditure per acre (X) and net returns per acre (Y). The equation obtained was :

$$Y = 264.98 - 0.715\,X$$

(Ep at AM = —24.86)

$t_b = 7.295$

$r^2 = 0.47$

The regression coefficient (significant at 1 per cent level) indicated that for Re. 1 increase in total expenditure per acre net return per acre is expected to decrease by 72 *Paise*. The coefficient of determination indicated that 47 per cent of the total variation in net return per acre could be explained due to variation in total expenditure per acre.

(5) *Efficiency Factors : (a) Labour*

Gross farm output per man-equivalent day utilised in crop production has been used to estimate the efficiency of labour. Although a crude measure, it indicates the relative performance of labour used on different farms. In a significant relationship, net returns per acre increased at a declining rate with the increase in gross farm output per man-equivalent day. The nature of relationship approximated a linear function :

$$Y = 380.88 + 38.182\,X$$

(Ep at AM = 36.25)

$t_b = 17.27$

$r^2 = 0.53$

Y = Net returns per acre.

X = Gross farm output per man-equivalent day.

The regression coefficient (significant at 1 per cent) indicated that for per Re. 1 increase in gross farm output per man-equivalent day, net return per acre is expected to increase by Rs. 38.18. The coefficient of determination indicated that 53 per cent of the total variation in net returns per acre could be explained due to the variation in gross farm output per man-equivalent day.

Alternatively, a Cobb-Douglas type of production function was estimated which was :

$$Y = 75.72\,X^{.878}$$

$(r^2 = 0.43)$

The equation explains that for 1 per cent change in gross farm output per man-equivalent day, net returns per acre is expected to change by 88 per cent. However, only 43 per cent of total variation could be explained due to the variation in gross farm output per man-equivalent day.

(*b*) *Capital Efficiency*

Rate of capital turnover was used to estimate the efficiency of capital. When related to net return per acre it showed significant and positive relationship. F ratio was significant at 1 per cent level.

(*c*) *Output-Input Ratio*

This measure estimates the aggregate effect of all factors when both outputs and inputs are aggregated in terms of value. This measure showed strongest

relationship with net returns per acre. Actually this is an alternative measure of net returns per acre. Net returns increased with increase in output-input ratio. A linear function was estimated which was :

$$Y = 367.469 + 327.956\ X$$
(Ep at AM=34.94)

$r^2=0.84$
Y = Net returns per acre.
X = Output-input ratio.

The regression coefficient indicated that for unit change in output-input ratio, net return per acre is expected to change by Rs. 327.96; 84 per cent of the total variation in net returns per acre could be explained due to the variation in output-input ratio.

(b) MULTIVARIATE RELATIONSHIP

Farm earnings are influenced simultaneously by a number of factors. No single factor alone is sufficient to maximise the economic efficiency of farm business. After examining the individual relationships, an attempt has been made here to estimate a Cobb-Douglas type of production function. The various factors included are :

Y = Net returns per acre (Rs.).
X_1 = Total cropped acreage.
X_2 = Crop yield index.
X_3 = System index.
X_4 = Total expenditure per acre (Rs.).
X_5 = Gross farm output per man-equivalent day (Rs.).

The estimated function was :

$$Y = 11.164X_1^{\cdot 106449}\ X_2^{\cdot 344338}\ X_3^{\cdot 857797*}\ X_4^{-\cdot 435787*}\ X_5^{\cdot 304669}$$

$$MR = \quad (4.41) \quad (1.97) \quad (4.90) \quad (-0.73) \quad (17.86)$$

(t, values of regression coefficient, $b_1=1.264$, $b_2 = 1.791$, $b_3 = 3.695$, $b_4= 3.270$, $b_5 = 1.717$).

$R^2 = 0.665$

* Statistically significant.

The values of partial regression coefficient were statistically significant only with respect to system index and total expenditure per acre. The regression coefficients indicated that for one per cent change in the value of X_1, X_2, X_3, X_4 and X_5 variables net return per acre is expected to change by .106449, .344338, .857797, (—) .435787 and .304669 per cent, respectively. The coefficient of multiple determination ($R^2 = 0.665$) indicated that 67 per cent of the total variation in net returns per acre could be explained by this function.

IV

CONCLUSION

This study revealed that several of the widely used measures of factors of farm management tested for their influence on farm earnings have sufficient predictive ability so that these measures could be helpful in diagnosing the soundness of the farm business of individual farmers. They could serve as practical guides to farmers in locating the weak and strong points in their present farm organisation.

Among the various alternative measures tested for the size of farm business, it was observed that total gross farm output has the maximum predictive ability (45 per cent) followed in descending order by size of holding (35 per cent), total bullock labour days (27 per cent), total cropped acreage (26 per cent), and total man-equivalent days (23 per cent). In case of rate of production both the measures, *i.e.*, crop yield index and the index of gross farm output were found to be equally good. 25 per cent variability in net returns per acre could be explained due to the variations in crop yield index. As regards the choice and combination of enterprises, system index is the only tool suitable for estimating the aggregate effect of enterprises concerning farm business as a whole on a multiple enterprise farm. However, the value of r^2 was only 0.11. For measuring the intensity of cultivation, total expenditure per acre showed sufficient predictive ability (48 per cent). However, individual factors have to be examined separately for the level of their use. As regards the efficiency measures, though they have very high predictive power yet they are not expected to be of direct use in better organisation of farm business.

This study also indicated some of the important adjustment possibilities for increasing farm earnings. Farm earnings increase with the increase in size of farm business, rate of production, labour and capital efficiency, output-input ratio and system index. Net returns per acre showed negative relationship with total expenditure per acre. Possibilities of increasing the size of farm business in terms of acreage is obviously limited but the volume of the business can be increased in terms of total gross farm output by making more intensive use of the existing resources. Farm earnings could be increased by increasing the physical efficiency of production, *i.e.*, crop yield per acre by using more variable inputs in the existing system of farming or by making better choice and combination of enterprises or both. To reduce the total expenditure per acre (accruing mainly from fixed investments) seems one of the most difficult problems of small farmers and usually is not within their control.

APPENDIX

THE METHODS OF COMPUTATION OF MEASURES OF FARM MANAGEMENT FACTORS AND INCOME

I. *Measures of Size of Farm Business*

(*i*) Size of holding: This is the entire farm area in acres operated by the farmer.

(*ii*) Total cropped area: This is the sum of the acres actually cropped during the year.

(*iii*) Total gross farm output: This is the sum of the values of main and by-products of all crops grown on the farm during the year.

(*iv*) Total fixed capital investment: This includes the value of the farm buildings, cattle-sheds, draught animals, wells, machinery and equipments (value of land and residential buildings have been excluded).

(*v*) Total employed man-equivalent days: This is the sum of all standardised man-equivalent days utilised on the farm during the year for production of crops (excluding the labour required to look after the draught animals). A man-equivalent day represents 8 hours of work done by an adult male. Woman and child labour days have been standardised by the ratio, IM = 1.25 w = 2c.

(*vi*) Total employed bullock labour days: This is the sum of all work days of 8 hours, done by a pair of bullocks for raising the crop over the year.

II. *Measures of Choice and Combination of Enterprises*

(*i*) System Index: In the computation of system index, average value per acre of all the sample farms for individual enterprises has been taken as the standard value for the particular enterprises. The standard values of production per acre for the various enterprises was taken and weighted by the proportion (%) of the total cropped area under respective enterprise on particular farms. Thus aggregate value production was obtained individually for all the farms. With the same process total value production was obtained for the group as a whole. The system index was obtained by dividing the total value on individual farms by the value of the group as a whole and expressing it in percentages.

III. *Measures of Intensity of Cultivation*

(*i*) Total employed man-equivalent days per acre of farm area.

(*ii*) Total employed bullock labour days per acre of farm area.

(*iii*) Total working capital per acre of farm area : This includes the expenses of seed and fertilizer, hired labour and expenses on concentrates for the maintenance of draught animals and implements and machinery expenses.

(*iv*) Total expenses per acre of farm area : This includes the expenses of labour, material, and machinery, interest and depreciation expenses. This includes both the actual and the imputed expenses of all the production factors.

(*v*) Intensity index: This has been obtained by dividing the total farm expenses per acre on a particular farm by the average expense per acre of all the sample farms and multiplying it by 100.

(*vi*) Cropping intensity: It represents the number of crops raised on a particular area of land during the year. It is expressed in percentage.

IV. *Measures of Rate of Production*

(*i*) Crop yield index: This index represents the yield of all crops on a farm compared with the average crop yield of all the sample farms. In calculating the crop yield index, first, the average yield per acre of all the sample farms for individual crops was obtained. Thereafter by dividing the yield per acre of a crop on a particular farm by the average yield of that crop of all the sample farms and multiplying it by 100 a percentage figure was obtained, which gave the index number of yield of that particular crop on that farm. This was calculated for all the crops grown on the particular farm. Using the area devoted to each crop as weight, these indexes were multiplied with the acreages under respective crops. Thus total of all crops were obtained on each farm, which when

divided by the total cropped acreages of respective farms gave the crop yield index on the particular farm.

(*ii*) Index of gross farm output: This index was calculated by determining the average value output per acre of a particular enterprise of all sample farms. On individual farms these values were multiplied with the respective acreages under various crops and the total values of all crops were obtained. Thereafter the actual values of outputs on individual farms were divided with the respective new values calculated, which when multiplied by 100 expressed index of gross farm output on individual farms. Unlike crop yield index this measure includes the weight of prices and the value of by-products.

V. *Measure of Labour Efficiency*—Gross farm output per man-equivalent day.

VI. *Measure of Capital Efficiency*

Rate of capital turnover: It was obtained by dividing the total gross income by the total value of capital invested.

VII. *Output-Input Ratio*: This is obtained by dividing the total gross farm output by the total expenditure on the respective farms.

Income Measures

There are several ways of calculating farm income. The choice depends on the purpose of the analysis and on the local farming conditions. The method of computing income measures used here is known as the "Residual Method." The imputed costs of different factors have been computed on the basis of their market price. The wages for unpaid family labour were imputed on the basis of wage rates for permanent hired labour. The cost of maintenance of bullocks on the farm was taken as the cost for bullock labour. The interest on the value of fixed assets as land, buildings, wells, and equipments was charged @ 3 per cent per annum. The varying rates of depreciation for *kachha* and *pucca* buildings, wells and different kinds of equipment were used to estimate the depreciation costs.

After deducting the input costs from the total value of output, the remainder is termed as 'net income'. The various income measures discussed below are evolved from the net returns by excluding from the total cost, the various costs such as family labour, interest on owned capital, etc. Except the returns to capital, all other income measures have been expressed in terms of per acre.

(*i*) Net returns: This is the final residual obtained by deducting the gross expenditure from the gross output or gross return.

(*ii*) Family labour income: This value has been obtained by deducting from the gross expenditure, the imputed value of wages of the operator and his family for their physical labour in crop production and then deducting the expenditure (less wages of family labour) from the gross returns.

(*iii*) Total labour earnings: This value has been obtained by deducting from the gross expenditure, the imputed and paid wages of all labour used in crop production and then deducting the gross expenditure (less imputed and paid wages of labour) from the gross returns.

(*iv*) Total labour earnings per employed man-equivalent day: This value has been obtained by dividing the total labour earnings by the total employed man-equivalent days in crop production.

(*v*) Farm business income: This has been obtained by deducting from the total costs, the imputed costs due to family labour and the imputed interest on owned capital and deducting from the gross returns the gross expenditure (less the imputed wages of family labour and interest on owned capital).

(*vi*) Returns to capital per Rs. 100 invested: This has been obtained by deducting from the gross expenditure, the interest on fixed capital (excluding land and residential buildings) and deducting the gross expenditure (less interest on owned capital excluding land and building) from the gross returns and dividing it by that capital and multiplying it by 100.