MANAGEMENT AS A FACTOR OF PRODUCTION IN THE SEMI-ARID TROPICS OF RURAL SOUTH INDIA

T. S. Walker, R. P. Singh and M. J. Bhende*

What distinguishes a good from a bad farmer is an intriguing question that cuts across many disciplines. Over the last 30 years economists have increasingly honed their econometric and mathematical programming skills to address this issue. Notable field applications include those of Mundlak[1] and Massel[2] within a production function framework, Lau and Yotopoulos[3] with the profit function, Timmer[4] with the efficiency frontier through linear programming, and more recently Herdt and Mandac[5] who estimated alloca-

*Economics Program, International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru, Andhra Pradesh where T.S. Walker is stationed as an Associate of the Agricultural Development Council (A/D/C). ICRISAT. Approved Journal Article No. 327.

We thank J. B. Hardaker, N. S. Jodha, and K. N. Murty for their helpful comments and M. Asokan and E. Jagadeesh for computational assistance. The views expressed are strictly the authors' and thus do not represent those of ICRISAT.

1. Y. Mundlak, "Empirical Production Functions Free of Management Bias", *Journal of Farm Economics*, Vol. 43, No. 1, February 1961, pp. 44-56.

2. B. F. Massel, "Elimination of Management Bias from Production Functions Fitted to Cross Section Data: A Model and an Application to African Agriculture", *Econometrica*, Vol. 35, Nos. 3-4, July-October 1967, pp. 495-508.

3. L. J. Lau and P. A. Yotopoulos, "A Test of Relative Economic Efficiency and Application to Indian Agriculture", *The American Economic Review*, Vol. LXI, No. 1, March 1971, pp. 94-109.

4. C. P. Timmer, "On Measuring Technical Efficiency", *Food Research Institute Studies*, Vol. 9, No. 2, 1970.

5. R. W. Herdt and A. M. Mandac, "Modern Technology and Economic Efficiency of Philippine Rice Farmers," *Economic Development and Cultural Change*, Vol. 29, No. 2, January 1981, pp. 375-399.

tive and technical efficiency with multi-year experimental data from farmers' fields.[6]

Indian agriculture has been a particularly fruitful site for studying inter-household variation in managerial performance and its impact on productivity. Most researchers have concentrated on the effect of farm size on efficiency as measured by absolute productivity differences in gross returns in irrigated agriculture.[7] In this study, we follow a theoretically more pragmatic but empirically perhaps richer approach in describing and explaining inter-farm variation in management in the Semi-Arid Tropics of rural south India. We focus on the consequences of personal characteristics on efficiency as measured by relative productivity differences in net returns to management per hectare in predominantly dryland agriculture. A unique feature of this study is that managerial performance is statistically evaluated over time with respect to farmers in the same village.

DATA AND ESTIMATING RETURNS TO MANAGEMENT

We base our assessment of returns to management on data over five cropping years from 1975-76 to 1979-80 from the ICRISAT Village Level Studies[8] (VLS). The data pertain to a panel of 30 cultivator households in each of the six villages in three broad soil, climatic, and cropping regions in the Semi-Arid Tropics of rural south India.[9] Data are collected at approximately four-week intervals by resident investigators in each village.

Production conditions across the six villages range from relatively stable in the rainfall-assured Akola district to highly uncertain in drought-prone Sholapur. The soil and water production environment is also precarious in Mahbubnagar, but greater access to tank and well irrigation means that many farmers do not have to rely as heavily on dryland farming as in the other two regions. Value added from crop production and earnings in the daily labour market are the two main sources of household income in each of the six villages.

Improved varieties and practices have penetrated into all six villages, but their diffusion has not been uniform. Kanzara in Akola and Dokur in

6. Despite considerable theoretical and conceptual advances, there are several empirical difficulties in applying these approaches to analyse management behaviour. To apply the profit function the analyst needs significant price variation among farmers and should be able to attribute price variation to its sources such as differences in output and input quality or market power. The problem of outliers besets the efficiency frontier approach as the frontier often degenerates into a point. Productivity gap studies based on experimental data require a concerted field effort and have diminishing returns in a multicrop environment like the Semi-Arid Tropics of India.

7. Studies by Kahlon and Acharya and by Bagi are representative of this genre that usually rely on Cobb-Douglas specifications: A. S. Kahlon and S. S. Acharya, "A Study on Management Input in Farming", *Indian Journal of Agricultural Economics*, Vol. XXII, No. 3, July-September 1967, pp. 45-53. F.S. Bagi, "Economics of Irrigation in Crop Production in Haryana", *Indian Journal of Agricultural Economics*, Vol. XXXVI, No. 3, July-September 1981, pp. 15-26.

8. H.P. Binswanger and J. G. Ryan, "Village Level Studies as a Locus for Research and Technology Adoption", in ICRISAT: Proceedings of the International Symposium on Development and Transfer of Technology for Rainfed Agriculture and the SAT Farmer, ICRISAT, 28 August-1 September 1979, Patancheru, A.P., 1980, pp. 121-129.

9. Of the 180 cultivator households in the sample, 136 have data on crop income for each of the five cropping years. The majority of the other 44 households leased out their land for one or more cropping years; the minority left the sample and were replaced. Thus there are 136 farmers for whom returns to management are analysed.

Mahbubnagar are the most technologically advanced of the six villages. In contrast, the adoption of recommended inputs and practices has been negligible in the two Sholapur villages.

Returns to management is estimated as a residual or what remains after the monetary and opportunity costs of all factors of production are subtracted from gross crop returns which also includes the marketed and imputed value of all crop outputs. The relative factor shares to value added are presented in Table I for land, labour, capital, and management. Value added is conceptually equivalent to net returns to family owned resources comprising family labour, owned draft power, capital, land, and management. Land, labour, and capital are valued at their respective opportunity costs. Details are given in the notes to Table I.[10]

Land is by far the largest claimant on value added in the more dryland farming villages (Table I). In Dokur where about 40 per cent of gross cropped area is irrigated, labour has the highest relative factor share. The relative rewards to factors of production in Dokur is similar to that estimated by Hayami[11] in an intensive study of an irrigated village in the Philippines.

TABLE I—MEAN RELATIVE FACTOR SHARES TO VALUE ADDED BY VILLAGE FROM 1975-76 TO 1979-80

Factor of production	Village					
	Aurepalle	Dokur	Shirapur	Kalman	Kanzara	Kinkheda
Land[b]	55 (27)[a]	33 (36)	43 (33)	52 (18)	48 (13)	43 (20)
Labour[c]	25 (56)	37 (26)	24 (22)	22 (13)	25 (7)	28 (12)
Capital[d]	30 (64)	22 (19)	19 (27)	24 (17)	20 (5)	23 (15)
Management[e]	—11	8	14	3	6	6

a. Factor shares are calculated by dividing the payments to each factor by value added. Mean relative factor shares are calculated by taking the simple average across the five cropping years in each village. Coefficients of variation are reported in parentheses and refer to the simple averages across the five cropping years.

b. Payment to land was estimated as described in the text.

c. The relative factor share of labour includes both hired labour and the opportunity cost of family labour assessed at prevailing wage rates.

d. An 18 per cent rate of interest is charged to fixed production capital encompassing bullocks, implements, and machinery; working capital on current production inputs is assessed at 10 per cent.

e. Coefficients of variation are not reported for management because it is estimated as a residual and is therefore susceptible to wide fluctuations.

10. Land is particularly difficult to value because there were few purchases and sales from 1975-80 in the villages. To derive an opportunity cost we regressed the rental rates and imputed value of land payment in share-cropping on land price for each field owned by the household. The estimated regression coefficients were statistically significant at ($p \leq \cdot 05$) in each village, and ranged from the equivalent of 6 to 8 per cent of the land value. This rate was then multiplied by the value of owned land to yield a flow estimate of land value in crop production.

11. Y. Hayami *et al.*: Anatomy of a Peasant Economy: A Rice Village in the Philippines, International Rice Research Institute, Los Baños, Laguna, Philippines, 1978.

Because management is estimated as a residual it is not surprising that its relative factor share is so low. There was little evidence of trends in the factor shares over the five cropping years. This finding conforms to the observation that technological change has been gradual and piecemeal in the six villages. Relative factor shares were most stable in rainfall-assured Kanzara.

WITHIN VILLAGE VARIATION IN RETURNS TO MANAGEMENT

To estimate inter-farm differences in management behaviour within a village, we regress returns to management for each cultivator household on resource endowment characteristics and on cropping year and farmer binary variables. The data are pooled over the cropping years from 1957-76 to 1979-80. The regression specified in equation (1) is estimated separately for each village.

$$R_{it} = \alpha_0 + \beta_1 IRR_{it} + \beta_2 LV_{it} + \beta_3 BUL_{it} + \sum_{t=1}^{n-1} \theta_t x_t + \sum_{i=1}^{m-1} \delta_i x_i + \mu_{it} \qquad \ldots\ldots (1)$$

where R_{it} = returns to management per hectare of operated area for farmer i in year t, i=1, ..., m; t=1, ..., n;

IRR_{it} = percentage irrigated area;

LV_{it} = land value in hundred rupees per hectare of operated area;

BUL_{it} = owned bullocks per hectare operated area;

x_t = 0—1 binary variable for cropping year t;

x_i = 0—1 binary variable for farmer i;

μ_{it} = disturbance term assumed to be $N(0, \sigma^2)$.

This specification is a linear fixed effects model and is equivalent to carrying out simple analysis of variance for cropping year and farmer effects with a balanced design.

The δ_i's are our coefficients of interest. The other variables are included in the model to control for confounding effects of weather (cropping year) and inter-household differences in resource endowment that could bias the estimated management coefficients. We include irrigation, land value, and bullock availability in (1) because these resources are imperfectly

TABLE II—ESTIMATED DIFFERENCES IN RETURNS TO MANAGEMENT AMONG FARMERS IN A VILLAGE FROM 1975-76 TO 1979-80

Effect	Regions and villages					
	Mahbubnagar		Sholapur		Akola	
	Aurepalle	Dokur	Shirapur	Kalman	Kanzara	Kinkheda
Resource endowment						
Irrigation	10·48‡ (3·91)[a]	14·00 (0·28)	—0·65 (—0·37)	12·47 (0·86)	96·16† (2·32)	—0·93 (—0·12)
Land value ..	—0·07 (—1·77)	—0·12‡ (—3·95)	—0·05‡ (—11·37)	—0·06‡ (—4·20)	—0·13‡ (—10·06)	—0·02 (—0·35)
Bullocks	54·45 (0·51)	—219·50 (—0·99)	—38·99 (—0·25)	145·92 (1·36)	112·56 (0·86)	98·18 (0·94)
Cropping year[b] ..						
1976-77	—84·51 (—1·03)	506·50 (1·53)	245·93‡ (3·33)	78·41 (1·79)	—61·85 (—0·86)	8·04 (—0·12)
1977-78	480·72‡ (5·10)	—289·92 (—0·88)	62·51 (0·82)	200·00‡ (4·48)	130·57 (1·81)	193·87‡ (2·81)
1978-79	303·61‡ (2·87)	411·37 (1·21)	171·28† (2·23)	107·57† (2·23)	—143·32† (—1·98)	6·13 (0·09)
1979-80	303·58 (3·11)	135·26 (0·38)	231·11‡ (3·05)	134·19‡ (2·71)	—50·94 (—0·70)	284·39‡ (4·28)
Farmer[c]						
Positively significantly different[d]	0	3	1	3	2	0
Negatively significantly different[d]	1	0	0	0	3	0
Not significantly different[d]	25	17	21	21	20	21
Size of management differences[e]	855	2932	630	640	1472	708
$\overline{R}^2$ ..	0·40	0·32	0·66	0·67	0·74	0·40
Number of observations	130	100	110	120	125	105

a. t values are in parentheses; ‡ and † indicate statistical significance in a two-tailed test at the ·01 and ·05 levels respectively.

b. 1975-76 is the reference year.

c. With reference to the farmer who is estimated to have median net returns to management in the village. The level of statistical significance is ·05 for a two-tailed test.

d. For lack of space, estimated regression coefficients for each farmer are not presented.

e. Represents the range in rupees per hectare between the two farmers with the lowest and highest regression coefficients respectively.

costed in the calculations of returns to management. Irrigation water is subsidised in the villages, land value is also derived from non-agricultural productivity attributes, and bullock hire markets do not exist during seasonally peak demand periods such as planting.

Adjusting for individual farmer-management effects is a two-step procedure. Equation (1) is estimated to determine the 'median' farmer against whom returns from the other farmers are statistically compared. Once the median farm household is selected as a benchmark or reference point, the regression equation is re-estimated.

The regression results in Table II show that only a few farmers were significantly ($p \leq .05$) better or worse managers than the representative median farmer in each village.[12] Of the 138 farmers in the VLS sample, 7 per cent had significantly higher returns to management than the median farm households, 3 per cent had significantly lower returns, and the remaining 90 per cent had about the same level of returns. If we consider a lower statistical level of significance ($p \leq .10$), the corresponding percentages are 12, 4, and 84. The results weakly suggest that the distribution of managerial ability in a village may be positively skewed—there are more significantly good than significantly poor managers.

Despite the absence of statistical significance for the majority of farmers, the range in the estimated coefficients from the worst to the best performer in each village is fairly wide particularly in more heavily irrigated Dokur and rainfall-assured Kanzara where a productive resource base allows a more marked expression of managerial potential. For all villages, inter-farm differences between the poorest and best manager have a much more pronounced effect on returns to management than inter-temporal variation between the poorest and best cropping year. For example, in Dokur the average difference between the two management extremes is about Rs. 3,000 per hectare; a comparable range for the two extreme cropping years comes to only about Rs. 700.

DETERMINANTS OF INTER-HOUSEHOLD VARIATION IN RETURNS TO MANAGEMENT

We hypothesize that inter-farm variation in returns to management is explained by personal characteristics and resource base features that should be intimately linked to managerial productivity. The personal characteristics include age (AGE), education (EDUC), level of risk aversion (RIAV), and caste (CAS1, CAS2, CAS3, CAS4). Age is a proxy for experience; therefore, we expect older farmers to have a better management performance than younger farmers. Increased education should enhance the farmer's access to information and his ability to process it. More risk averse farmers are expected to allocate resources such that over time their average productivity levels are inferior to those of their less risk averse counterparts. We also expect that

12. If we had not included land value in the regression analysis, we would have significantly biased the analysis against farmers holding higher priced land in four of the six villages. The uniformly negative coefficients for the value of land again underscore the point that land is either over-valued or is prized for attributes that do not directly relate to productivity.

households from traditional farming and higher castes (CAS1) have either greater managerial ability or more access to productive opportunities.[13] Therefore age, education, and caste rank are expected to contribute positively to returns to management while risk aversion should negatively affect managerial performance.

The resource endowment features include the size of the family farm work force per hectare (FLAB) and farm size (FZE). More family workers per unit operated area should be able to supervise more effectively hired labour and should have greater incentives to increase land productivity. Including both personal characteristics and resource endowment features gives the following behavioural equation (2):

$$\delta_i = \gamma_1 + \gamma_2 \text{EDUC}_i + \gamma_3\text{RIAV}_i + \gamma_4\text{CAS2}_i + \gamma_5\text{CAS3}_i + \gamma_6\text{CAS4}_i + \gamma_7\text{FLAB}_i + \gamma_8\text{FZE}_i + e_i \quad \ldots.(2)$$

The expected determinants of farmers' differences are described in Table III.[14] Because the δ_i's are estimated relative to the median farmer in each

TABLE III—MEANS AND COEFFICIENTS OF VARIATION OF THE EXPECTED DETERMINANTS OF RETURNS TO MANAGEMENT

Explanatory variable	Measurement unit	Region[a]			
		Mahbubnagar	Sholapur	Akola	All regions
AGE ..	Years	49·42 (25)	45·04 (24)	41·78 (25)	45·42 (26)
EDUC ..	Years of schooling	1·89 (150)	1·58 (187)	4·00 (101)	2·50 (139)
RIAV ..	Risk insurance premium[b]	1·37 (64)	1·36 (67)	0·70 (121)	1·14 (81)
CAS1 ..	High caste[c]	34·80	62·20	34·80	43·75
CAS2 ..	Moderately high caste[c]	17·40	28·90	37·00	21·20
CAS3 ..	Moderately low caste[c]	~~32·60~~	~~28·90~~	~~15·20~~	25·55
CAS4 ..	Low caste[c]	15·20	0·00	13·00	9·50
FLAB ..	Family workers per hectare operated area	2·53 (161)	0·814 (77)	1·16 (105)	1·50 (171)
FZE ..	Operated area in hectares	5·10 (118)	7·62 (51)	7·15 (104)	6·62 (91)

a. For the continuous variables, means are reported and coefficients of variation are given in parentheses. For the caste rank binary variables, the table gives percentages in each caste grouping.

b. Taken from H. P. Binswanger, "Attitudes Toward Risk: Theoretical Implications of an Experiment in Rural India", *The Economic Journal*, Vol. 91, No. 364, December 1981. Higher values of the risk insurance premium indicate greater aversion to risk.

c. Taken from V. S. Doherty: A Guide to the Study of Social and Economic Groups and Stratification in ICRISAT's Indian Village Level Studies, ICRISAT, Patancheru, Andhra Pradesh, 1982 (unpublished manuscript). This grouping was drawn up by J. G. Ryan and is based on religious, social, and economic criteria.

13. The vast majority of higher caste households (CAS1) in the sample regard farming as their traditional occupation. Sampled cultivator households were drawn from the population that listed farming as their main occupation. Therefore, there are few Brahmin or other traditionally non-farming higher caste households in CAS1.

14. The variable LUCK is included in the regression to correct for potential bias in the effect of risk aversion on returns to management. We use Binswanger's (see Note *b* in Table III) experimental estimates of risk aversion. He found that household choices in the experimental games were significantly influenced by luck in previous games. A luck variable equal to the difference between wins and losses in previous games is inserted so that the pure effect of risk attitudes is estimated.

village, equation (2) is estimated in deviation form as the first differences from the mean values of the independent variables are taken in each village. Four regressions are estimated, three regional and one pooled across the six villages.

As expected from cross-sectional data with relatively few observations and with net returns per hectare as a dependent variable, the independent variables do not explain a great deal of the inter-farm variation in returns to management. An F-test suggests that we can reject the null hypothesis of equality of the regression equations across the three regions; therefore, pooling is not valid and these results are not presented.

Despite the overall low explanatory power, several independent variables exert a significant influence on the mean levels of returns to management. Age is a significant determinant in the Mahbubnagar and Akola regions where an additional year above the mean age in each region increases returns to management by Rs. 14.60 and Rs. 9.70 per hectare respectively (Table IV). Age is highly correlated with farming experience which Binswanger *et al.*[15]

TABLE IV—ESTIMATED REGRESSION COEFFICIENTS OF THE EXPECTED DETERMINANTS OF RETURNS TO MANAGEMENT BY REGION

Explanatory variable	Region		
	Mahbubnagar	Sholapur	Akola
AGE	14·60* (2·12)[a]	—0·23 (—0·10)	9·70** (2·77)
EDUC	—19·24 (—0·47)	—0·55 (—0·06)	29·55* (—2·17)
RIAV	—0·51 (—0·01)	—4·09 (—0·14)	10·89 (0·22)
CAS2[b]	—568·23 (—1·90)	71·74 (0·75)	227·44* (2·37)
CAS3[b]	—930·13** (—3·07)	—126·23* (—2·26)	114·53 (0·94)
CAS4[b]	—829·74* (—2·42)	—	176·89 (1·29)
FLAB	40·38 (1·77)	—16·41 (—0·29)	—14·56 (—0·41)
FZE	—38·06* (—2·01)	—2·79 (—0·33)	—5·27 (—0·92)
$\bar{R}^2$	0·22	0·11	0·10
F value	2·41	1·69	1·54
Number of observations	45	45	46

a. t values are in parentheses; ** and * indicate statistical significance in a two-tailed test at the ·01 and ·05 levels respectively.
b. With reference to CAS1.

15. H. P. Binswanger, D. Jha, T. Balaramaiah, and D. Sillers: The Impact of Attitudes Towards Risk on Agricultural Decisions in Rural India, ICRISAT Economics Program Progress Report 42, Patancheru, A. P., 1981 (unpublished).

found to be the most important variable conditioning fertilizer use in these six villages.

Across the three regions, the variable that contributes most to explaining variation in managerial performance is caste. In Mahbubnagar and Sholapur, the higher status castes (CAS1) who traditionally regard farming as a full-time occupation have significantly higher returns than lower castes (CAS3) who usually practise farming as a secondary or tertiary profession. In Mahbubnagar, Reddys comprise most households in CAS1 and apparently their reputation for being good farmers is well founded. In contrast, in Akola the Deshmukhs, the higher status, traditional land owning caste, have significantly lower returns than those in CAS2. Unlike the Marathas in Sholapur, farmers in CAS1 in Akola do not allow their wives to work in the field, and they do not participate in the daily agricultural labour market.

Better educated farmers are significantly better managers in Akola where primary and secondary education have a longer history and are more developed than in the other two regions. Farm size appears to be weakly and negatively associated with returns to management per hectare across the three regions. Relative family size is marginally significant in Mahbubnagar, but in general differences in resource endowment do not seem to play a significant role in conditioning inter-household variation in managerial performance.

CONCLUSIONS

In the six predominantly dryland farming villages, farming experience in acquiring access to productive opportunities and in efficiently allocating resources was the overriding consideration separating good from bad managers. Older farmers, those born into ~~traditional farming occupations, and those~~ who received hands-on farming had significantly higher returns to management.

Because of our small sample size and possible errors in evaluating opportunity costs, these results are illustrative and not conclusive. They merely illustrate that managerial performance can be significantly different within dryland farming villages and that variation in personal characteristics and social stratification can in part explain such inter-farm differences.

If these results apply to other villages in the Semi-Arid Tropics of rural south India, they imply that policies that cost effectively generate non-farm employment and hence hasten farm-non-farm migration will have the additional benefit of increasing private agricultural land productivity provided part-time farmers from traditionally non-farming occupations are more responsive to migration incentives than full-time traditionally farming households. This policy implication highlights the importance in understanding the determinants of migration. Moreover, the significance of caste in partially explaining inter-farm differences in returns to management further suggests that other social sciences can contribute to the agricultural economist's understanding of farm management performance.