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RESOURCE USE, FARM SIZE AND RETURNS TO SCALE IN A BACKWARD AGRICULTURE*

J. P. Singh†

The Eastern Uttar Pradesh is one of the most backward regions of India.[1] As high as 92 per cent of the population of the region belong to rural areas and 84.5 per cent of work force is absorbed in agriculture.[2] In view of the very heavy dependence of population on agriculture, the economic uplift of the people of the region would depend, to a great extent, on the growth of agriculture.

The crux of the problem of growth in agriculture in the region is how to increase output per unit of input. One way of approaching the problem of increasing production is to examine how efficiently the farmers are using their resources. If resource use is inefficient, production can be increased by making adjustments in the use of factors of production in optimal direction. In case, it is efficient, the only way out for increasing production would be the adoption of modern inputs and improved technology of production.

The main objectives of this paper are to examine the following hypotheses for the Eastern Uttar Pradesh :

(*a*) The inefficient use of factors of production by the farmer is mainly responsible for the economic backwardness of the region.

(*b*) The size of farm is an important factor to influence the input productivity at the farm level.

(*c*) The returns to scale are constant in agriculture.

And (*d*) the marginal productivity of labour is zero.

In order to examine these hypotheses, Cobb-Douglas production functions have been fitted to work out the elasticities of production of inputs which in turn have been used to calculate their (inputs) marginal value products (at their geometric means) for the average farms. The possibility of increasing production by making adjustments in the present use of factor inputs has been examined on the criterion whether the farmers use their resources efficiently. The resource use efficiency of the farmer has been judged on neo-

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† Fellow, Institute for Social and Economic Change, Bangalore.

1. Report of the Foodgrains Enquiry Committee, Ministry of Food and Agriculture, Government of India, 1957, pp. 122-132, and Planning Commission: Report of Joint Study Team, Uttar Pradesh (Eastern Districts), 1964.

2. Report of Joint Study Team, *ibid*, pp. 7-8.

classical criterion that each factor of production is paid equal to its marginal productivity. A significant difference between marginal value product and market price of individual inputs would indicate that the farmers are using, on the average, their factors of production inefficiently. If the difference between the two is not significant, this would imply that the farmers are efficient, on the average, in the use of their factors of production. The test, however, does not indicate anything about the efficiency of individual farmers.

The whole approach of examining the allocative efficiency of farmers by using Cobb-Douglas production function and judging it on the criterion of the equality of marginal value product (at the geometric mean of input) to the market price of inputs, which is relevant for the 'average farms,' has been questioned.[3] It has been contended that "the equality of market price to the marginal value product at average point directly implies that one section of the farmers are over-allocating the resource concerned and the remaining under-allocating it. In other words, every individual farm is—by the assumption of model itself—inefficient."[4] But, if all the farmers are equally efficient, they would be expected to have the same size, same input combinations and the same input-output ratios. With the result they would be on the same point in the input-output space and hence there could be no regression.[5] Apart from these methodological problems there are reasons to believe that even if all the farmers try to maximize their profits, they may not be equally efficient in the use of their factors of production because of imperfections in the factor and product markets and also because of price and weather uncertainties resulting in widening gaps between expected and actual returns. In spite of these limitations, the test of allocative efficiency for the 'average farmer' is quite relevant, at least, for knowing whether agricultural production of a region or a country could be increased profitably to a significant extent by making adjustments in the existing use of the factors of production.

The 'allocative efficiency' of farmers has already been examined by Hopper[6] for a village in Eastern Uttar Pradesh and by others[7] for other regions in India. It has been inferred from these studies that the farmers, on the average, are fairly efficient in the use of their factors of production. Since all these studies pertained to the 'fifties, it would be worthwhile to examine how efficiently the farmers were using their factors of production in the 'sixties.

3. Ashok Rudra, " "Allocative Efficiency" of Indian Farmer: Some Methodological Doubts," *Economic and Political Weekly*, Vol. VIII, No. 3, January 20, 1973, pp. 107-112.
4. *ibid*, pp. 109-110.
5. Pan A. Yotopoulos, "On the Efficiency of Resource Utilization in Subsistence Agriculture," *Food Research Institute Studies*, Vol. VIII, No. 2, 1968, pp. 125-135.
6. W. D. Hopper, "Allocation Efficiency in Traditional Indian Agriculture," *Journal of Farm Economics*, Vol. 47, No. 3, August, 1965, pp. 611-624.
7. V. Chennareddy, "Production Efficiency in South Indian Agriculture," *Journal of Farm Economics*, Vol. 49, No. 4, November, 1967, pp. 816-820; G. S. Sahota, "Efficiency of Resource Allocation in Indian Agriculture," *American Journal of Agricultural Economics*, Vol. 50, No. 3, August, 1968, pp. 585-605 and G. R. Saini, "Resource-Use Efficiency in Agriculture," *Indian Journal of Agricultural Economics*, Vol. XXIV, No. 2, April-June, 1969, pp. 1-18.

This study is based on farm level data pertaining to crop enterprises of a sample of 150 farms spread over 15 villages in Deoria district, Eastern Uttar Pradesh. The data, which relate to 1967-68—a fairly good agricultural year—were collected by the Directorate of Economics and Statistics, Ministry of Agriculture, Government of India.

We are quite aware that our sample is too small to be representative for the Eastern Uttar Pradesh as a whole. However, in view of the general similarity in economic and social conditions among the districts of the region, a few broad inferences may be drawn from the sample for the region as a whole.

SPECIFICATION OF MODEL AND MEASUREMENT OF VARIABLES

As mentioned earlier, Cobb-Douglas production function has been fitted to work out the elasticities of production of factor inputs. The choice of the function is based on its theoretical fitness to agriculture and its computational manageability. Further, almost all production function studies in agriculture have used this function, and in order to have comparability with other studies, the choice of the function became necessary. The single equation Cobb-Douglas function has been estimated by the ordinary least squares method. The specification of the function is as follows :

$$\log Y = \log A + b_1 \log X_1 + b_2 \log X_2 + b_3 \log X_3 + b_4 \log X_4 + b_5 \log X_5$$

where Y = value of output (Rs.),
X_1 = land (standardised hectares),
X_2 = human labour (man-days),
X_3 = bullock team (days),
X_4 = manures and fertilizers (Rs.),
X_5 = fixed capital (Rs.),
A = constant (intercept term), and
b_1 to b_5 = elasticity coefficients of respective inputs.

The definition and the measurement of the above variables for individual holdings are as follows :

Output

The output has been defined as the sum of gross value of output (main plus by-products) of all crops evaluated at harvest prices in the reference year irrespective of being consumed, sold or maintained in the stock; less the value of seed.[8]

8. Farm produced seeds have been evaluated at the prices prevailing in the village at the time of sowing whereas the value of purchased seeds has been taken at the actual price paid by the farmer plus the cost of transport.

Land

Land input has been measured in terms of hectares adjusted for the differences in the fertility. The standardisation of land was considered necessary in view of the wide variations in the quality of land on individual farms. It has been found that the land on comparatively smaller farms are more fertile than that on the larger farms.[9] If land that is not adjusted for the differences in fertility is used in the production function, the land input would be under-estimated and consequently its coefficient over-estimated in the case of small farms and vice versa for the large farms. Further, all the land on individual farms is not homogeneous and also the variation in its quality is not uniform on all the farms. Since the cultivated land of all quality on a farm makes the land input, its use in the production function without standardisation would bias the land coefficient. "Ignoring qualitative differences within a factor is equivalent to omitting several variables, plus including the imperfectly specified variable."[10] In view of these considerations, the land input has been adjusted for the differences in its quality.

As such, there is no accepted criterion on which land input should be adjusted. In the past, land had been adjusted in relation to irrigation.[11] Undoubtedly, irrigation improves the productivity of land considerably; it, however, does not take into account the differences arising out of natural fertility of land. Land revenue has been considered another measure.[12] No doubt, while fixing land revenue (which was done a few decades back), due weights were given to the natural fertility, improvements, and location of land, it may not represent the present productive capacity of land owing to its non-accountability of the recent improvements in land, particularly through irrigation.

The rental value of land,[13] which is based on its prevailing market value in the village in the reference year, may be considered a better indicator to represent the productive capacity of land, as it takes into account the up-to-date improvements in land apart from its natural fertility, and location. Hence, it was decided to adjust land input on the basis of its rental value in the following manner.

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9. A. M. Khusro, "Returns to Scale in Indian Agriculture" in A. M. Khusro (Ed.): Readings in Agricultural Development, Allied Publishers, Bombay 1968, pp. 123-159. It was also observed from our data.

10. Pan A. Yotopoulos : Allocative Efficiency in Economic Development, Centre of Planning and Economic Research, Athens, Greece, 1967, p. 57.

11. Raj Krishna, "Some Production Functions For Punjab," *Indian Journal of Agricultural Economics*, Vol. XIX, Nos. 3 and 4, July-December, 1964, pp. 87-97.

12. C. H. Hanumantha Rao, "Production Function For Hyderabad Forms" in A. M. Khusro (Ed.) : Readings in Agricultural Development, *op. cit.*, pp. 160-172, and A. M. Khusro, *op. cit.*

13. The rental value of land has been calculated at the rate of 6 per cent of the market value of land. The per hectare rental value corresponds quite well with the prevalent cash rent of leased land in the district.

$$\text{Adjusted land input per farm} = \frac{\text{Rental value of land on farm K}}{\text{Average rental value per hectare for the sample as a whole}^{14}}.$$

Human Labour

Human labour has been measured in terms of man-days of eight hours. The differences in the efficiency of labour have been taken into account by converting female and child labour days into man-days on the criterion that three female labour days are equal to two man-days and two child labour days are equal to one man-day. In order to avoid multi-collinearity between human labour and bullock labour inputs, the number of days of human labour worked with bullocks have not been included under this head.

Bullock Team

Bullock team has been defined in terms of eight hours' day worked by a pair of bullocks and a person (needed to operate the bullocks).

Manures and Fertilizers

Farm produced manures have been evaluated at the rate of Rs. 5.00 per cart-load of five quintals whereas the purchased manures and fertilizers have been evaluated at their actual cost including the cost of transport.

Fixed Capital

It includes depreciation and interest on farm buildings, implements and machinery in value terms.[15]

The irrigation input has not been included as a separate variable in the production function because of the following reasons :

(*a*) There were difficulties in the measurement of real irrigation input because the major sources of irrigation for the sample farms—*Charasa* and Persian wheel—depend mainly on human and bullock labour which are included under their respective categories.

(*b*) The cash expenditure on irrigation (payments made for tube-well and canal irrigation)[16] was not only a small part of the actual irri-

14. The reason for taking the average rental value per hectare for the sample as a whole in the denominator is to adjust the land input for the differences in its quality on individual farms without changing the total sown area of the sample.

15. For the method of calculation of interest and depreciation on fixed capital, see Farm Management in India : A Study Based on Recent Investigations, Ministry of Food and Agriculture, Government of India, 1966, pp. 79-80.

16. The average per hectare cash expenditure on irrigation was only Rs. 8.80 for the sample.

gation input but also was incurred by a small number of farmers (only one-third of the sample).

And (*c*) the adjustment in the land input should take into account the irrigation facilities in so far as they affect the market value of land.

Similarly, seed input is also not included in the production function. It was found that seed input is highly correlated with land and human labour inputs. In order to avoid the problem of multi-collinearity, the seed variable was omitted from the production function and its value was subtracted from the value of output.

All the above-mentioned adjustments in the variables not only reduced multi-collinearity, but also improved the level of significance of elasticity coefficients.[17]

Factor Price

The factor price is the opportunity cost of inputs which they should earn if employed elsewhere. In agriculture, it is quite difficult to calculate the opportunity cost of inputs, since most of the factors of production are owned by the farmers and there is no market for some factors. The factor price of inputs has been imputed in the following manner.

(1) The factor price of land has been taken as the average rental value of land per hectare of the net sown area.

(2) The average wage rate has been taken as the factor price of human labour and has been worked out from dividing the total labour cost (imputed plus paid out) by the total number of labour days used.

(3) The factor cost of bullock team has been taken as the sum of average working cost (net maintenance cost plus charges paid for hired bullocks) of a pair of bullocks per day and the average wage rate of labour per day.

(4) The factor price of manures and fertilizers and fixed capital has been taken as one rupee, since these inputs have been measured in value terms.

RESOURCE USE ON THE SAMPLE FARMS

The elasticities of production and related production function statistics for the entire sample farms are presented in Table I. The adjusted coefficient

17. J. P. Singh: Resource Allocation in Uttar Pradesh Agriculture: A Case Study of Deoria District, *op. cit.*, pp. 38-45.

TABLE I—PRODUCTION ELASTICITIES AND RELATED PRODUCTION FUNCTION STATISTICS FOR THE ENTIRE SAMPLE OF FARMS

Output	Constant (in log)	Variables					Sum of elasticity coefficients	Standard error of estimate	$\bar{R}^2$	Degrees of freedom
		Land X_1	Human labour X_2	Bullock team X_3	Manures and fertilizers X_4	Fixed capital X_5				
				Coefficients						
	2.1139 (.1380)	.3315* (.0613)	.2586* (.0815)	.2083* (.0737)	.0774* (.0326)	.1198* (.0430)	.9956 (.0353)	.1569	.86	144
				Sample Means (Geometric)						
3919.20		1.77	206.60	49.95	110.88	245.27				
				Marginal Value Products						
		733.83 (145.06)	4.90 (1.61)	16.34 (5.99)	2.74 (1.99)	1.91 (0.71)				
				Ratio of Marginal Value Products to Factor Costs						
		1.89+	1.99	1.46	2.74	1.91				

Starred (*) coefficients are significantly different from zero at a probability level of $\leqslant$ 1 per cent using a one tail t-test.

Numbers in parentheses are standard errors.

Plus sign (+) indicates that the ratio is significantly different from unity at a probability level of $\leqslant$ 5 per cent using a two tail t-test.

of multiple determination ($\bar{R}^2$) indicates that 86 per cent of the variations in the inter-farm output have been explained by the independent variables. It is also worth noting that the inter-correlations between the independent variables are not very high (Appendix Table 1).

The sum of production elasticities is equal to unity and hence supports the hypothesis of constant returns to scale in the agriculture of Eastern Uttar Pradesh.[18] Since the sum is equal to one, the magnitudes of individual elasticity coefficients indicate the relative shares of different factors of production in the total crop output of the region.

It is clear from Table I that all the elasticity coefficients have the right sign and are significantly different from zero at a probability level of one per cent. The magnitude of elasticity coefficient is 0.33 for land, 0.26 for labour, 0.21 for bullock team, 0.12 for fixed capital and 0.08 for manures and fertilizers. The magnitude of individual coefficients indicates the percentage growth in output in response to a one per cent increase in the input concerned, while having the other factors of production constant. Land seems to be the most important factor of production, while labour being the second in importance. The highly significant labour coefficient suggests that our data reject the hypothesis of 'zero marginal product of labour' on the average farms of Eastern Uttar Pradesh in general and Deoria district in particular. The significant coefficient of bullock team implies that the bullocks are very much an economic factor of production.[19] The capital inputs seem to play relatively a less important role in the crop production of the region, since they account for only 20 per cent of the total growth in the crop output.

The marginal value products of individual inputs have been calculated at their geometric means.[20] The marginal value product and its ratio to factor price for individual inputs have also been presented in Table I. Most of the ratios, excepting the one for land, are not significantly different from unity and hence indicate that all the inputs, except land, have been used efficiently on the 'average farms.' The ratio for land, which is significantly greater than unity, implies that production on 'average farms' could have been increased significantly by using more land. In view of the acute scarcity of land in the region, the farmers seem to have no alternative but to maximize the returns per unit of land. The higher marginal value product than the factor price in the case of other factors of production may be the result

18. Similar results have been obtained for some other regions of India. See A. M. Khusro, *op. cit.*; Raj Krishna, *op. cit.*; D. Radhakrishna, "A Study of Regional Productivities of Agricultural Inputs," *Indian Journal of Agricultural Economics*, Vol. XIX, No. 1, January-March, 1964, pp. 237-242, and G. R. Saini, *op. cit.*

19. In some studies the bullocks were considered uneconomic factor of production. See Dipak Mazumdar, "Size of Farm and Productivity: A Problem of Indian Peasant Agriculture," *Economica*, Vol. XXXII, No. 126, May, 1965, pp. 161-173, and G. R. Saini, *op. cit.*

20. We are quite aware of the limitations of calculating marginal value product at the geometric mean of inputs.

of the difference between the expected and actual weather,[21] price uncertainties and inaccurate knowledge about production relationships, particularly with regard to the high-yielding varieties which were grown by about one-third of the sample farmers. This could have also happened because of our estimation of marginal value products from the actual output, regardless of the farmers' resource allocation for the expected output. Further, the marginal productivity of specified inputs could also be higher on account of non-inclusion of certain factors of production, especially the management.

The foregoing analysis indicates that there are only a few significant inefficiencies in the present use of factor inputs on the 'average farms' of Eastern Uttar Pradesh. This, in fact, implies that a mere reallocation of resources would have only a limited impact on the total crop output of the region. Therefore, the economic backwardness of the region may not be due to inefficient resource use, but may be largely due to the low stock and the poor quality of factors of production. In view of these considerations, the main strategy for the development of agriculture of the region would be the adoption of modern inputs and improved technology of crop production. In this context, it would be appropriate to refer to our own study which indicated that the elasticity coefficient of land, the most scarce factor in the region, and its marginal value product (at geometric mean) were 1.5 times and 2.5 times higher for the high-yielding varieties of paddy and wheat than those of the local varieties.[22] It is also noteworthy that the effect of formal education, as seen from its elasticity coefficient, was significant for the high-yielding varieties whereas it was not significant for the aggregate of crops.[23] This, in fact, implies that the education of the farmers can play an important role in the adoption of new technology.

FARM SIZE AND RESOURCE USE

The analysis in the previous section was based on the entire sample of farms and was carried on under the assumption that all the farms operate under the same input-output relationships and follow the same cropping pattern. These are, however, quite serious assumptions and might not be true for different category of farms. The differences in the production efficiency may arise due to the differences in the factor endowments and in the managerial efficiency of the farmer. As it is difficult to work out the impact of the latter on production owing to difficulties in its measurement, the effect of the former may, however, be analysed by categorising the sample farmers

21. The difference between expected and actual weather would be quite substantial for Eastern Uttar Pradesh where the occurrence of flood is quite frequent, while the occurrence of drought being not very uncommon. It is, therefore, expected that the farmers would use comparatively less amount of inputs than what they could have done under a more stable weather. Since the reference year was a fairly good agricultural year, the actual production could have been higher than the expected one, resulting in the higher marginal productivity of inputs.

22. J. P. Singh: Resource Allocation in Uttar Pradesh Agriculture, *op. cit.*, pp. 111-119.

23. *ibid*, pp. 92-99.

on the basis of resource endowments. Since land is the most scarce and the most important among all the factors of production in Indian agriculture, and the use of other factors being positively correlated with it, the grouping of farms on the basis of land area might be considered the most appropriate one. This assumes added weight in view of the importance of the distribution of land ownership from the policy point of view. It is possibly the latter which led to a wide discussion on the 'inverse relationship between farm size and productivity per acre'[24] in Indian agriculture. Further, there are reasons to believe that the productivity of land would be higher on the farms operating relatively smaller size of land holdings as compared to those with larger size holdings and vice versa in the case of labour, for land is a scarcer factor of production on the former whereas labour is on the latter. Similarly, the productivity of other inputs might also differ with the farm size. In view of these considerations, we have divided our sample farms into small and large size-groups. This would help us in knowing how the productivity of inputs and returns to scale differ between the two farm sizes.

A farm size of 7.5 acres has been considered as a minimum plough and work unit for all-India, though it does not satisfy the criterion of minimum income of a family.[25] It could, however, be presumed that 7.5 acres would satisfy the criterion of minimum income for the Eastern Uttar Pradesh where levels of living are generally low. Thus, we accept 7.5 acres as dividing line between the small and large size farms. But, with a view not to disturb the farm size classifications adopted at the time of sampling, holdings with less than 7.6 acres (3.08 hectares) of operated area have been considered as small size farms[26] and those above this level as large size farms. The number of farms included in the former category is 97 and in the latter category is 53.

The production function and the related results for the small and large size farms are presented in Table II. The regressions for both the groups of farms are significant and a major part of variations in the inter-farm output (more than 70 per cent) has been explained by the independent variables. It is also noteworthy that the inter-correlation between the independent variables are not very high (Appendix Table 1). The sum of production elasticities is 0.91 for the small farms and 0.83 for the large farms. None of them is significantly different from unity at a probability level of 5 per cent and hence supports the hypothesis of constant returns to scale for both the groups of farms.

The elasticity coefficient of land and bullock team is significant for both the sizes of farms whereas that of fixed capital is significant for the small farms

24. Most of the important papers on this issue are referred by G. R. Saini, *op. cit.* Also see P. K. Bardhan, "Size, Productivity, and Returns to Scale : An Analysis of Farm-Level Data in Indian Agriculture," *Journal of Political Economy*, Vol. 81, No. 6, November-December, 1973, pp. 1370-1386, and Pan A. Yotopoulos, Lawrence J. Lau and Kutlu Somel, "Labour Intensity and Relative Efficiency in Indian Agriculture," *Food Research Institute Studies*, Vol IX, No. 1, 1970, pp. 43-55.

25. A. M. Khusro, "Farm Size and Land Tenure in India," *Indian Economic Review*, Vol. 4 (New Series), No. 2, October, 1969, pp. 123-145.

26. At the time of sampling, the farms were categorised into four size-groups. The first three size-groups are included in the category of small farms whereas the fourth represents the large farms.

TABLE II—ELASTICITY COEFFICIENTS AND THE RELATED PRODUCTION FUNCTION STATISTICS FOR SMALL AND LARGE SIZE FARMS

Farm group	Constant (in log)	Variables					Sum of elasticity coefficients	Standard error of estimate	$\bar{R}^2$	Degrees of freedom
		Land	Human labour	Bullock team	Manures and fertilizers	Fixed capital				
		X_1	X_2	X_3	X_4	X_5				
Small farms ..	2.3357	.3447**	.0943	.2662**	.0598	.1472**	.9122	.1728	.71	91
	(.1886)	(.0782)	(.1366)	(.1094)	(.0417)	(.0571)	(.0630)			
Large farms ..	2.3765	.2266**	.3597**	.1525*	.1311**	—.0412	.8288	.1108	.75	47
	(.2867)	(.0904)	(.0803)	(.0898)	(.0477)	(.0813)	(.0899)			

Double starred (**) coefficients are significantly different from zero at a probability level of ⩽ 1 per cent and single starred (*) at a probability level of ⩽ 5 per cent using a one tail t-test.

Numbers in parentheses are standard errors.

only and of labour and manures and fertilizers for the large farms only. The coefficients of labour and fixed capital of two farm sizes are significantly different at a probability level of 10 per cent.

As expected, the magnitude of elasticity coefficient of land is greater for the small farms than that for the large farms. This implies that land has been cultivated more intensively on the small farms as compared to the large farms, which is quite understandable in view of their smaller land input. The average (geometric) land input (adjusted) for the small farms was only 1.09 hectares as compared to 4.32 hectares in the case of large farms. The higher marginal product of land on the small farms seems to be due to the higher use of human and bullock labour per hectare of land input (Table III).

TABLE III—INPUTS AND OUTPUT PER HECTARE OF LAND INPUT (STANDARDISED) FOR SMALL AND LARGE FARMS*

Input	Small farms	Large farms	All farms
Human labour(days)	122.93	105.60	116.72
Bullock team (days)	30.23	24.77	28.22
Manures and fertilizers (Rs.) ..	57.44	73.06	62.65
Fixed capital (Rs.)	122.38	173.11	138.58
Output (Rs.)	2,166.05	2,293.86	2,214.24

* The figures in this table have been worked out from the geometric means of inputs.

The production coefficient of labour is not only highly significant but also its magnitude is as high as 0.36 for the large farms, whereas it is not significantly different from zero for the small farms. This indicates that the marginal productivity of labour is quite high on the large farms whereas it is zero on the small farms. The zero marginal productivity of labour on the small farms implies "either that the marginal utility of the product is infinite or that marginal disutility of work is zero."[27] The root cause of the difference in the marginal productivity of labour between the two farm sizes is the differing pressure of population on land which is high for the small farms and low for the large farms.[28] This is vindicated from the intensive use of labour on the former than the latter. The input of labour on the small farms was 123 days per hectare as compared to 106 days on the large farms (Table III). In order to bring a balance in the marginal productivity of labour between the two farm sizes, it could have been expected that a part of labour used on the small

27. S. Wellisz, "Dual Economies, Disguised Unemployment and the Unlimited Supply of Labour," *Economica*, Vol. XXXV, No. 137, February, 1968, p. 34.
28. V. M. Dandekar, "Transforming Traditional Agriculture : A Critique of Professor Schultz," *Economic and Political Weekly*, Vol. I, No. 1, August 20, 1966, pp. 25-36.

farms should have been used on the large farms. This could have, however, not happened partly because of the reluctance on the part of small farmers to work as agricultural labour on the large farms owing to institutional rigidities[29] and partly because of their inability to hire them out during the peak season when the demand for hired labour is high on the large farms. On the other hand, the large farmers might not have been willing to use more labour or they might not have been able to get more hired labour for their agricultural operations, particularly during the peak season. Apart from these considerations, the difference in the intensity of labour use and hence in its marginal productivity might also have been due to the imperfections in the labour market faced by the two groups of farms. It can be observed from Table IV that the average wage rate for the large farms is higher than that for the small farms. Since the average wage rate for the family labour, which is an imputed wage, is the same for both the farm sizes,[30] the difference in the wage rate between the two sizes of farms is mainly due to the differences in the average wage rate of hired labour which is Rs. 2.37 per day for the small farms as compared to Rs. 2.78 per day for the large farms. This difference in the wage rate of hired labour between the two farm sizes may be either because the large farms hire more labour during the peak season when wages are high or because they have to pay higher wages for the same operation or because of both. We believe that the former is more close to reality.

TABLE IV—WAGE RATES OF HIRED AND FAMILY LABOUR FOR SMALL AND LARGE FARMS

	Wage rates (Rs.)		
	Small farms	Large farms	All farms
Hired labour	2.37	2.78	2.69
Family labour	2.26	2.28	2.27
All labour	2.29	2.56	2.46

The elasticity coefficient of bullock team is greater for the small farms as compared to the large farms. This appears little ironical as the per hectare use of bullock labour is also higher for the former than the latter (Table III). Since the bullock labour days could not be adjusted for the differences in the quality of bullocks, the number of days of bullock labour used on the two farm sizes should not be taken at their face value because of the well-known fact that the quality of bullocks on the large farms is much superior to that on the small farms and hence a day of bullock labour used on the large farms

29. It is quite often observed in Eastern Uttar Pradesh that the farmers of certain backward castes, even if they operate small farms, do not prefer to work on others' farms.

30. The minor difference in the wage rate of family labour between the small and large farms may be due to the conversion of female and child labour days into man-days. Otherwise, the wage for family labour has been imputed on a uniform wage rate irrespective of the size of farms.

may be much superior in terms of energy supplied and work done compared to that on the small farms, leading to a faster decline in their marginal productivity.

The highly significant coefficient of fixed capital for the small farms as compared to the insignificant one for the large farms is quite compatible with the substantially higher investment in the input on the latter than the former (Table III). But the highly significant coefficient of manures and fertilizers for the large farms as compared to the insignificant one for the small farms seems little intriguing in view of the higher per hectare expenditure on the input (Table III) accompanied by a higher proportion of expenditure on fertilizers to the total expenditure on the input of manures and fertilizers[31] in the case of the former than the latter. This can, however, be explained in terms of relatively higher rate of adoption of high-yielding varieties of wheat, paddy and maize accompanied by the higher proportion of area devoted to these varieties by the large farms (Table V), since the productivity of nutrient supplying inputs are significantly higher under the high-yielding varieties than that under the local (traditional).

TABLE V—PERCENTAGE OF FARMERS ADOPTING HIGH-YIELDING VARIETIES (H Y V) OF PADDY, WHEAT AND MAIZE AND THE PERCENTAGE OF AREA UNDER H Y V TO THE TOTAL AREA UNDER EACH CROP ON THE FARMS ADOPTING H Y V BY SIZE OF FARMS

Size of farms	Percentage of sample farms adopting HYV of			Percentage area under H Y V to the total area under the crop on the farms adopting HYV of		
	Paddy	Wheat	Maize	Paddy	Wheat	Maize
Small farms	37.11	31.96	19.59	38.17	41.28	37.66
Large farms	43.40	39.93	22.81	42.07	46.49	40.07
All farms	39.33	36.00	21.33	40.97	44.80	39·17

It is clear from the foregoing analysis that the elasticity coefficient of most of the inputs differ considerably between the small and the large farms. In order to know whether the sub-samples of small and large farms belong to different regression model, Chow's test[32] of equality has been applied. The ratio F(6, 138) is 1.74 which is not significant at a probability level of 10 per cent. This indicates that the sub-samples of small and large farms belong to the same regression model and hence their overall production relationships do not differ significantly. This is also corroborated from the relationships of total cost and total output (Table VI).

31. The expenditure on fertilizers as a percentage to the total expenditure on manures and fertilizers was 28 for the large farms as compared to only 19 for the small farms.

32. Gregory C. Chow, "Test of Equality between Sets of Coefficients in Two Linear Regressions," *Econometrica*, Vol. 28, No. 3, July, 1960, pp. 591-605.

TABLE VI—RATIO OF TOTAL COST (COST C*) TO TOTAL OUTPUT

Size of farms	Ratio of total cost to total output
Small farms	0·63
Large farms	0·61
All farms	0·62

* Includes both imputed and paid-out costs, see Farm Management in India, Government of India, *op. cit.*

APPENDIX TABLE 1

CORRELATION MATRIX FOR THE ENTIRE SAMPLE OF FARMS, SMALL FARMS, AND LARGE FARMS

Group of farms		Output Y	Land X_1	Human labour X_2	Bullock team X_3	Manures and fertilizers X_4	Fixed capital X_5
	Y	1.000	.868	.876	.845	.712	.803
Entire sample of farms	X_1		1.000	.824	.783	.593	.792
	X_2			1.000	.860	.710	.779
	X_3				1.000	.740	.691
	X_4					1.000	.601
	Y	1.000	.766	.764	.726	.505	.685
	X_1		1.000	.712	.634	.344	.658
Small farms	X_2			1.000	.833	.527	.692
	X_3				1.000	.575	.515
	X_4					1.000	.398
	Y	1.000	.675	.770	.718	.668	.287
	X_1		1.000	.579	.576	.397	.433
Large farms	X_2			1.000	.558	.480	.245
	X_3				1.000	.670	.245
	X_4					1.000	.286