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Vol XXXVIII
No. 3

ISSN 0019-5014

CONFERENCE
NUMBER

JULY-
SEPTEMBER
1983

INDIAN JOURNAL OF AGRICULTURAL ECONOMICS



INDIAN SOCIETY OF
AGRICULTURAL ECONOMICS,
BOMBAY

Factor Shares in Indian Agriculture

TEMPORAL AND SPATIAL VARIATIONS IN FACTOR SHARES IN INDIAN AGRICULTURE

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In recent years, the introduction and spread of modern technology have brought about a substantial increase in agricultural productivity in India. But the gains of such increased productivity are said to have been shared unevenly by various factors of production and administrative regions. The studies by Shah¹, Jha² and others³ relating to late sixties and early seventies showed some degree of growing inequality in factor shares in agricultural production. However, since most of these studies did not have any systematic data base over time and space, the results reported remained largely inconclusive. Besides, there were noticeable changes in factor use in farm production in the late seventies and the nature, extent and impact of such changes at the macro level have not thus far been explored. One of the major objectives of the present study, therefore, was to provide the missing links in economic research relating to changes in factor shares in Indian agriculture. As the green revolution made its impact felt mainly in the production of wheat and rice, the scope of this study remained confined to changes in factor shares in respect of these two crops.

Specifically, the main objectives of the study were (i) to examine the nature and extent of temporal and spatial variations in factor shares and factor relations in the production of wheat and rice; (ii) to measure the relative role of different factors in influencing intra-regional and inter-regional variations in productivity; (iii) to estimate the marginal rate of technical substitution between various factors of production; and (iv) to suggest policy measures for the improvement of production relations and farm efficiency in the agricultural sector.

METHODOLOGY

This study was based on Statewise data of factor cost and returns in the cultivation of wheat and rice for the year 1971-72 to 1980-81 as generated under the "Comprehensive Scheme for Studying the Cost of Cultivation/Production of Principal Crops" of the Directorate of

* Scientists, Division of Agricultural Economics, Indian Agricultural Research Institute and Production Economist, Directorate of Economics and Statistics, Ministry of Agriculture, Government of India, New Delhi respectively.

1. C. H. Shah, "Growth and Inequality in Agriculture", *Indian Journal of Agricultural Economics*, Vol. XXXI, No. 4, October-December 1976, pp. 71-92.

2. Dayanatha Jha, "Agricultural Growth, Technology and Equity", *Indian Journal of Agricultural Economics*, Vol. XXIX, No. 3, July-September 1974, pp.207-216.

3. Various Evaluation Studies relating to Economic and Social Implications of High Yielding Varieties Programme, carried out by Agro-Economic Research Centres during the early seventies.

Economics and Statistics, Ministry of Agriculture, Government of India. Keeping in view the availability of data and importance of the State, this was confined to the four major wheat growing States of Haryana, Punjab, Madhya Pradesh and Uttar Pradesh and six major rice growing States, *viz.*, Andhra Pradesh, Assam, Bihar, Orissa, Tamil Nadu and West Bengal. Changes in factor shares in the gross value of output of wheat and rice from 1971-74 (three years' average) to 1978-81 (three years' average), hitherto referred as period I and period II were examined through tabular analysis. Assuming capital-labour ratio and capital-output ratio to be the indices of level of technology and farm efficiency respectively, these ratios were also calculated for the selected States for both the periods and then compared with the land productivity of the respective States. Besides, the marginal rates of technical substitution between human labour and capital and between machine labour and animal labour were computed at the geometric mean levels of these inputs by fitting a double-log type of production function to time-series data for each of the States. Moreover, in order to measure the relative role of various factors in influencing agricultural productivity, the following equation was estimated by ordinary least squares technique for each State using time-series data for the years 1971-72 to 1980-81:

$$Y = \beta_0 N^{\beta_1} A^{\beta_2} K^{\beta_3} L^{\beta_4}$$

where Y = gross returns (in rupees) per hectare, N = expenditure (in rupees) on human labour per hectare, A = expenditure (in rupees) on animal labour per hectare, K = expenditure (in rupees) per hectare on machine labour, seed, fertilizer, manure, pesticides, irrigation, etc., and L = rental value (in rupees) per hectare of land.

Factor shares in inter-regional inequality in the output of wheat and rice during the early and late seventies were further examined by fitting the above type of Cobb-Douglas production function to cross-State data for the two periods, namely, (i) 1971-74 and (ii) 1978-81. Following Atkinson,⁴ $\text{Var}(\log X)$ was taken as a measure of inequality in the use of factor X . For Cobb-Douglas type of production relationship, it can be seen that

$$\begin{aligned} \text{Var}(\log Y) = & \sum_i \beta_i^2 \text{Var}(\log X_i) + 2 \sum_{i>j} \beta_i \beta_j \text{Cov}(\log X_i, \log X_j) \\ & + \text{Residual variance,} \end{aligned}$$

where β_i 's are the production elasticities. The above equation represents the inequality in the distribution of crop output as the sum of (i) the weighted factor inequalities (weights being the square of production elasticities) and their interactions, and (ii) the inequality caused by residual factors

4. A. B. Atkinson, "On the Measurement of Inequality", *Journal of Economic Theory*, Vol. 2, No. 3, September 1970.

such as management, level of technology, etc. On the basis of β_i 's obtained, the share of each factor in inter-regional inequality was calculated.

CHANGES IN FACTOR SHARES AND FACTOR RELATIONS

Table I gives the factor shares in the gross output of wheat and rice in period I (1971-74) and period II (1978-81). It may be seen from the table that the labour's share in the gross output of wheat was higher in period II than in period I in all the States except Punjab where a marginal increase in the share of hired labour was offset by a decline in the share of family labour. The decline in the share of family labour in Punjab (from 7.6 per cent in period I to 4.4 per cent in period II) was probably due to increasingly low involvement of family labour in cultivation as income

TABLE I—FACTOR SHARES IN THE PRODUCTION OF WHEAT AND RICE BY STATES

(per cent)

State	Period	Factor shares						Total
		Labour			Capital	Land	Entrepreneur, management, etc.	
		Hired	Family	Total				
Wheat								
Haryana	I	6.0	12.0	18.0	44.6	18.4	19.0	100.0
	II	8.1	12.7	20.8	60.8	20.6	-2.2	100.0
Punjab	I	7.9	7.6	15.5	39.9	27.0	17.6	100.0
	II	9.4	4.4	13.8	50.8	25.8	9.6	100.0
Madhya Pradesh	I	6.4	8.2	14.6	36.4	25.8	23.2	100.0
	II	5.3	9.8	15.1	32.4	24.4	28.1	100.0
Uttar Pradesh	I	5.9	8.8	14.7	38.9	22.5	23.9	100.0
	II	6.0	9.7	15.7	53.7	21.1	9.5	100.0
Rice								
Andhra Pradesh	I	13.8	4.2	18.0	39.1	28.6	14.3	100.0
	II	18.8	4.1	22.9	45.6	24.9	6.6	100.0
Assam	I	5.6	17.6	23.2	24.7	25.7	26.4	100.0
	II	10.8	16.6	27.4	26.8	20.5	25.3	100.0
Bihar	I	10.2	5.9	16.1	23.4	27.8	32.7	100.0
	II	21.5	12.6	34.1	36.4	28.9	0.6	100.0
Orissa	I	10.2	11.8	22.0	27.1	24.2	26.7	100.0
	II	15.8	10.5	26.3	31.2	20.6	21.9	100.0
Tamil Nadu	I	14.8	10.4	25.2	38.5	25.9	10.4	100.0
	II	12.9	9.2	22.1	35.5	21.6	20.8	100.0
West Bengal	I	10.1	11.6	21.7	22.9	24.5	30.9	100.0
	II	18.0	16.6	34.6	37.5	23.5	4.4	100.0

TABLE II—FACTOR RATIOS AND PRODUCTIVITY IN THE SELECTED STATES DURING PERIOD I (1971-74) and PERIOD II (1978-81)

State	Period	Capital-labour ratio	Capital-output ratio	Gross output (Rs./ha.)
Wheat				
Haryana	I	2.47	0.44	1,860.47
	II	2.92	0.61	2,987.30
Punjab	I	2.58	0.40	2,094.40
	II	3.69	0.51	3,506.27
Madhya Pradesh	I	2.49	0.36	881.21
	II	2.14	0.32	1,723.97
Uttar Pradesh	I	2.65	0.39	1,909.92
	II	3.42	0.54	2,926.49
Rice				
Andhra Pradesh	I	2.17	0.39	1,884.61
	II	1.99	0.46	3,415.92
Assam	I	1.06	0.25	1,038.28
	II	0.98	0.27	1,843.89
Bihar	I	1.45	0.23	1,862.41
	II	1.07	0.36	2,113.42
Orissa	I	1.23	0.27	1,131.24
	II	1.19	0.31	1,971.99
Tamil Nadu	I	1.53	0.38	1,870.40
	II	1.61	0.36	4,415.13
West Bengal	I	1.06	0.23	1,832.25
	II	1.08	0.37	2,760.27

increased for either leisure preference or migration to non-agricultural occupation of the family labour. In the case of rice also, the labour's share in output rose in period II everywhere except Tamil Nadu where the percentage shares of both family and hired labour declined. Although the relative share of capital increased in all the States except Tamil Nadu, the order of increase was more profound in Haryana, Punjab and Uttar Pradesh for wheat and Andhra Pradesh, Bihar and West Bengal for rice. However, in period II, the relative shares of both land and entrepreneur declined in all the States under study except Tamil Nadu and Madhya Pradesh for entrepreneur and Bihar and Haryana for land. In fact, the declining trend in the share of entrepreneur, commonly known as profit, is likely to affect the growth rate of output adversely except for the reason that a unique combination of ownership of land, capital and entrepreneurship in present day rural India remains a saving grace in most cases.

Table II indicates the changes in capital-labour ratio and capital-output ratios over time. In the case of wheat the capital-labour ratio

ranged between 2.47 in Haryana to 2.65 in Uttar Pradesh in period I and 2.14 in Madhya Pradesh to 3.69 in Punjab during period II. The capital-labour ratio increased during period II in almost all the States except Madhya Pradesh where it declined marginally. In contrast to this, four out of the six major rice growing States under study showed a falling trend in the capital-labour ratio. It could be further seen from the table that the capital-output ratio increased almost everywhere except Tamil Nadu in the case of rice and Madhya Pradesh in the case of wheat. While the rising capital-labour ratio is considered to be an index of technological change that lead to positive growth in factor productivity, an increase in the capital-output ratio might affect the growth rate of output adversely. A further analysis of the data provided in Table II reveals that States like Punjab, Haryana, Uttar Pradesh, Andhra Pradesh and Tamil Nadu which had relatively higher capital-labour ratio as compared to other States, had also higher levels of output per unit of land. Conversely, Assam in the case of rice and Madhya Pradesh in the case of wheat had both the lowest capital-labour ratio and lowest output per unit of land.

The marginal rates of technical substitution of machine labour for animal labour and of capital for human labour are given in Table III.

It could be seen from the table that in the case of rice, a definite case of factor substitution between machine labour and animal labour was observed only in West Bengal, although in the case of wheat, the marginal rate of technical substitution of machine labour for animal labour was high in three out of the four wheat growing States. In the remaining one wheat growing and five rice growing States, machine labour and animal labour were found to be complementary to each other. Similarly, capital was found to have been substituted for human labour in Bihar and West

TABLE III—MARGINAL RATE OF TECHNICAL SUBSTITUTION OF MACHINE LABOUR FOR ANIMAL LABOUR (MRTS_{MA}) AND OF CAPITAL FOR HUMAN LABOUR (MRTS_{KL}): 1971-72 TO 1980-81

State	MRTS _{MA}	MRTS _{KL}
Wheat		
Haryana	—0.8516	10.4001
Punjab	0.2000	—0.0762
Madhya Pradesh	—0.3383	—0.3487
Uttar Pradesh	—0.5266	—0.2073
Rice		
Andhra Pradesh	0.3257	0.2588
Assam	151.2989	6.1540
Bihar	17.8081	—1.3729
Orissa	62.2733	1.1257
Tamil Nadu	1.0157	0.3379
West Bengal	—553.0974	—0.5289

Bengal for rice and Punjab, Uttar Pradesh and Madhya Pradesh for wheat. In other States, capital was used as an aid rather than as a substitute for labour. This contradicts the generally held notion that increased use of mechanical power replaces labour and necessarily creates unemployment.

FACTORS INFLUENCING PRODUCTIVITY AND THEIR RELATIVE
ROLE IN INTER-REGIONAL INEQUALITY

The results of the regression analysis showing the elasticity coefficients of factors influencing the output of wheat and rice in different States are presented in Table IV. In the case of wheat, land was found to be the most important determinant of output. The elasticity coefficients of land

TABLE IV—COEFFICIENTS OF FACTORS INFLUENCING THE OUTPUT OF WHEAT AND RICE BY STATES

State	R ²	Intercept	Human labour	Animal labour	Capital other than animal	Land
Wheat						
Haryana	0.96	3.7894	0.0111 (0.2492)	-0.2285 (0.2849)	0.2273† (0.1108)	0.5998‡ (0.0939)
Punjab	0.97	1.9205	1.0749‡ (0.3041)	-0.4122 (0.4433)	-0.2073* (0.1291)	0.4708† (0.2170)
Madhya Pradesh ..	0.98	0.0173	0.3383 (0.4217)	0.3809 (0.3415)	-0.1986 (0.3815)	0.8034† (0.2878)
Uttar Pradesh ..	0.96	2.5444	-1.6807‡ (0.4832)	0.1767 (0.1747)	0.7398‡ (0.1398)	1.4723‡ (0.3742)
Rice						
Andhra Pradesh ..	0.97	1.8537	0.8347 (0.6804)	-0.5173 (0.6321)	0.3588 (0.2855)	0.4556† (0.2009)
Assam	0.95	2.3591	0.1245 (0.2231)	0.3455† (0.1542)	0.3592* (0.1869)	0.0903 (0.1269)
Bihar	0.97	3.1395	-0.0529 (0.0548)	0.1202 (0.1345)	0.0531 (0.0857)	0.6017‡ (0.1204)
Orissa	0.89	1.8344	0.2191 (0.5788)	0.0347 (0.3946)	0.1979† (0.0825)	0.4909 (0.4487)
Tamil Nadu	0.94	0.6911	0.7152* (0.4127)	0.1738 (0.3054)	0.3014 (0.3595)	-0.0567 (0.1310)
West Bengal	0.96	0.5860	0.1475* (0.0751)	-0.0923 (0.1212)	-0.0469 (0.1156)	1.1102† (0.3765)

Figures in parentheses indicate the standard errors.

* Significant at 10 per cent level.

† Significant at 5 per cent level.

‡ Significant at 1 per cent level.

varied between 0.47 in Punjab and 1.47 in Uttar Pradesh. Although the effect of capital on output was found positive and significant in Uttar Pradesh and Haryana, the negative and significant coefficient of capital (-0.21) in Punjab could be explained through the relatively higher than the desired level of capital use in production. On the contrary, human labour is scarce in relation to demand in Punjab and therefore, the elasticity coefficient of human labour (1.07) was found high, positive and significant. In the case of rice, the contribution of land was found positive and significant in Assam, West Bengal and Bihar. The effect of human labour on output was positive and significant in both West Bengal and Tamil Nadu. In all other States except Bihar, the effect of human labour was found non-significant, albeit positive. Animal labour influenced the output of rice positively and significantly in Assam and Orissa which are relatively backward States. The relationship between capital and output was positive but non-significant in Andhra Pradesh, Bihar and Tamil Nadu. Besides, the negative coefficients of capital (although non-significant) in the backward States of West Bengal for rice and Madhya Pradesh for wheat indicate that mere increase in the use of capital would not raise productivity, unless supported by appropriate changes in production technology and institutional set-up. Table V further reveals that while in period I, spatial variations in the output of wheat were mainly due to inter-regional inequality in the productivity of capital (36.8 per cent) and human labour (33.5 per cent), in period II, the contribution of land (7.4 per cent) was found to be relatively more important. However, in both period I and period II, interaction effects of human labour and capital (X_1X_2) as well as of human labour and land (X_1X_3) as shown by their negative coefficients, reduced the degree of inter-regional inequality in wheat output. Capital accounted for the largest share in spatial variations in the output of rice, although the interaction effects of capital and human labour and of capital and land helped reduce the degree of inter-regional inequality to a great extent. Thus, the overall impact of modern technology as reflected through the interaction effects of factor use in production remained favourable for balanced regional development.

POLICY IMPLICATIONS AND CONCLUSIONS

A relative increase in the percentage shares of both labour and capital in the gross value of output of wheat and rice in the majority of the States studied exhibits a measure of success of India's public policy to maintain harmony in production relations for economic growth with social justice. The rising capital-labour ratio without affecting the absolute share of labour in gross output would help not only in raising farm output but also in maintaining an egalitarian order in the economy. However, our planners and the policy makers would be required to evolve suitable strategy for augmenting the use of capital in the relatively backward States like Assam, Bihar, Orissa, West Bengal and Madhya Pradesh where the phenomena of low

TABLE V.—FACTOR SHARES IN INTER-REGIONAL INEQUALITY IN WHEAT AND RICE OUTPUT DURING PERIOD I (1971-74) AND PERIOD II (1978-81)

Factor	Period I			Period II		
	Factor inequality	Weights	Factor share in income inequality	Factor inequality	Weights	Factor share in income inequality
Wheat						
X ₁	0.037192	0.244550	0.009095 (33.51)	0.002762	0.014874	0.000041 (0.07)
X ₂	0.037812	0.264424	0.009998 (36.83)	0.019902	0.019274	0.000384 (0.64)
X ₃	0.022308	0.022407	0.000500 (1.84)	0.010347	0.427647	0.004425 (7.40)
X ₁ X ₂	0.036518	-0.508586	-0.018573 (-68.43)	0.006671	-0.033864	-0.000226 (-0.38)
X ₁ X ₃	0.023563	-0.148050	-0.003489 (-12.85)	0.003346	-0.159512	-0.000534 (-0.89)
X ₂ X ₃	0.025224	0.153949	0.003883 (14.31)	0.009969	0.181578	0.001810 (3.03)
Omitted variables	—	—	0.025729 (94.79)	—	—	0.053909 (90.13)
Income (Y)			0.027143 (100.00)			0.059809 (100.00)
Rice						
X ₁	0.012994	0.020074	0.000261 (2.43)	0.014305	0.072426	0.001036 (4.83)
X ₂	0.027697	0.060340	0.001671 (15.58)	0.034223	0.469773	0.016077 (75.03)
X ₃	0.015935	0.077261	0.001231 (11.48)	0.022546	0.050068	0.001129 (5.27)
X ₁ X ₂	0.014361	0.069607	0.001000 (9.32)	0.017157	-0.368911	-0.006329 (-29.53)
X ₁ X ₃	0.007533	0.078764	0.000593 (5.53)	0.014723	0.120436	0.001773 (8.27)
X ₂ X ₃	0.015158	0.136556	0.002070 (19.30)	0.026291	-0.306727	-0.008064 (-37.63)
Omitted variables	—	—	0.003900 (36.36)	—	—	0.015807 (73.76)
Income (Y)			0.010726 (100.00)			0.021429 (100.00)

Note:— Figures in parentheses represent the percentage shares in income inequality; X₁ = Human labour, X₂ = Capital, X₃ = Land.

capital-labour ratio and low productivity exist simultaneously. In addition, our results indicate that mere increase in the use of capital would not raise factor productivity in States like West Bengal and Madhya Pradesh, unless supported by other measures of technological and institutional changes. Besides, a planned effort should be made to maximize the interaction effects of human labour, capital and land which in turn would reduce inter-regional inequality in agricultural output and provide the basis for balanced agricultural development in the country.

FACTOR SHARES IN INDIAN AGRICULTURE: TEMPORAL AND SPATIAL VARIATIONS AND THEIR IMPLICATIONS

M. V. George, N. J. Kurian and C. Chandra Mohan*

Factor combinations and factor shares in agriculture depend on a number of factors such as the resource endowments of the region, the type of crops grown, level of technology used, factor prices and government policy. Distribution of factor shares and their change over time and space is important in the context of economic growth and social justice. Estimation of factor shares in agriculture can be viewed in two ways. One approach is to estimate the contribution of various factors in the total agricultural output through the method of production function analysis.¹ Another method is to estimate the factor proportion in the total cost of production and their shares in the total value of output and to determine how these shares vary among different crops and over time as well as among different regions and to indicate the reasons thereof. The latter approach² has been followed in the present paper in respect of two major cereals, *viz.*, paddy and wheat and two commercial crops, sugarcane and jute produced in the country.

Cost of Production and Net Returns from Selected Crops in Different Regions

For the present analysis, data from the "Comprehensive Scheme for the Cost of Cultivation of Principal Crops" and Farm Management Studies sponsored by the Directorate of Economics and Statistics, Ministry of Agriculture, Government of India have been used. Because of the paucity of data, analysis was mainly confined to the period 1970-71 to 1980-81, and comparisons were made for the triennia ending 1972-73 and 1980-81. For the purpose of estimating the factor shares in different regions, paddy and wheat growing States were divided into three broad categories *viz.*, high,

* Agricultural Prices Commission, Government of India, New Delhi.

1. C. A. Robertson: *An Introduction to Agricultural Production* Economics and Farm Management, Agricultural Economics Research Centre, University of Delhi, Delhi, 1966.

All Farm Management Studies sponsored by the Directorate of Economics and Statistics, Ministry of Agriculture, Government of India, derived the elasticities of output with respect to resource inputs by fitting Cobb-Douglas production function and explained the relative shares.

2. Government of India: National Accounts Statistics, Central Statistical Organisation, New Delhi.