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F-computed comes to 280.00. Since this computed value is greater than F-critical (2.32) at one per cent level for 10 and 9931 degrees of freedom, statistically significant explanatory power of the model is established. This low R^2 could perhaps be attributed to the omission of some variable such as weight and height of bullocks, working efficiency, health conditions and auspicious and inauspicious marks from the specification of the bullock pricing model. Due to lack of data, these variables could not be incorporated into the model.

SUMMARY AND CONCLUSION

The main objective of the study was to account for price discount and price premiums in bullock marketing. In order to determine the net effects of age, colours, breeds, seasons and years on bullock price variations, a quadratic econometric model has been formulated and empirically verified with data from the Mudalagi cattle market. Four major results have been obtained.

First, while the local bullocks fetch average prices, Khillar bullocks are indicated to have fetched a price pemium. Second, when the white bullocks carry average prices, the red and black colour bullocks depress the prices below the average, and the mixed colour bullocks bring price premium. Third, the bullocks sold during the rainy season receive the average prices, whereas the winter season provides a price premium and the summer season gives rise to a price discount. Fourth, compared to the base year 1973, price premiums are recorded for the years 1974 and 1975.

S. G. RATHOD,* S. BISALIAH† AND K. C. HIREMATH*

PRICE RESPONSE OF A PERENNIAL CROP—A CASE STUDY OF INDIAN TEA‡

Indian tea has a chequered history. It has periods of rise and fall. The lack of stability in the industry has retarded the pace of its development. Thus the performance of tea industry, although impressive occasionally in absolute terms, has been found inconsistent and disheartening in contrast to other tea growing countries. The last experience on price slump was during the late sixties and the early seventies. Though recently it has been able to stage some recovery from depression, nothing can be said in unequivocal terms about the longevity of the situation. Problems like excessively high cost of production, lower yields, employment fixities, export slackness, climatic specificities, etc., are some of the other ills plaguing the industry.

A thorough probe into all aspects of the tea economy at this juncture would, therefore, be necessary. The present study was, however, confined

* Department of Agricultural Economics, University of Agricultural Sciences, Dharwar Campus Dharwar.

† Department of Economics and Sociology, University of Agricultural Sciences, G. K. V. K. Campus, Bangalore (Karnataka).

‡ This paper is a part of the first author's M.Sc. Thesis entitled "The Impact of Price Changes on Area, Production, Yield and Employment in the Indian Tea Industry", Indian Agricultural Research Institute, New Delhi-12, 1975.

only to certain limited but very important aspects, *viz.*, area, production, productivity and employment. The basic objective of the study was to make an empirical assessment of the impact of price on area, production, yield and employment of labour.

The study was attempted to fulfil the objective for the Northern region comprising West Bengal, Assam, Tripura and a part of Punjab; Southern region covering the States of Karnataka, Kerala and Tamil Nadu; and all-India to get an aggregate supply function covering the period 1953-73. The relevant data for the present study were obtained from Tea Statistics and *Agricultural Situation in India.*

ANALYTICAL FRAMEWORK

Tea is a perennial crop characterized by a long gestation period between initial input and first output; an extended period of output flowing from the initial production and eventually a gradual deterioration of the productive capacity of the plants. Thus the models for crops like tea must explain the planting process along with the removal and replacement of plants and must explicitly consider the lags between input and output and the effects of non-bearing plants on production.

Broadly, three models were used in the whole study: (*i*) Area as a function of the lagged acreage, relative price and trend variable; (*ii*) Industrial yield (yield of whole tea industry) as a function of non-bearing area, current relative price of last year's relative price, rainfall and trend variable; (*iii*) Employment as a function of current relative price, yield, area under tea and trend variable. An additional model for output was derived from area model and yield model.

1. *Area Model*

The model considered here is similar to that of Bateman[1] but differs on the following points which have been elaborated by Govindan and Gupta:[2]

(*a*) The bearing period of tea being relatively high, it is assumed to tend to infinity; and

(*b*) The built-in mechanism enables us to estimate the subjective discount rate by which producers discount the future net returns from the model itself:

$$A_t - A_{t-1} = a + b\, II^e_t + W_t \qquad \ldots (1)$$

where

$$II^e_t = K^h II^*_{t+h} + K^{h+1} II^*_{t+h+1} + \ldots + \qquad \ldots (2)$$

and II^*_{t+h} is the expected profit during the period 't+h'.

The suffix 't+h' is introduced because the new plants start giving returns only after a specific peiod, say, h years. Here, $K = \frac{1}{1+r}$ is the discount factor.

1. M. J. Bateman, "Aggregate and Regional Supply Functions for Ghanaian Cocoa, 1946-1963", *Journal of Farm Economics*, Vol. 43, No. 2, May 1965, pp. 384-401.
2. A. Govindan and Y. P. Gupta, "A Supply Response Model for Indian Coconuts", *Memo No.* 37, Københavns Universitets, Økonomiske Institut, 1975.

In order to combine Equations (1) and (2), $K\Pi^e_t$ has to be first evaluated with the help of Equation (2) and then it will be subtracted from Π^e_t resulting in

$$\Pi^e_t - K\Pi^e_{t-1} = K^h\Pi^*_{t+h} \quad \ldots.(3)$$

Now giving lead by one period to both sides of Equation (1), multiplying the resulting equation by K, subtracting the result from Equation (1) and after rearranging the terms we get,

$$A_{t+1} - A_t = a\ (1-1/K) + 1/K\ (A_t - A_{t-1}) - bK^{h-1}\ \Pi^*_{t+h}$$

$$+ (W_{t+1} - 1/K\ W_t)$$

or

$$A_t - A_{t-1} = a' + K'\ (A_{t-1} - A_{t-2}) + b'\ \Pi^*_{t+h-1} + W'_t \quad \ldots.(4)$$

where

$a' = a(1-1/K)$
$K' = 1/K$
$b' = -b\ K^{h-1}$
$W'_t = (W_t - 1/K\ W_{t-1})$

Π^*_t, the expected profit for the tth year is hypothesized to be a linear function of the expected price-wage index ratio $(P_t/W^*_t)^*$, where P_t is the growers' price and W^*_t is an index of farm wage rates. Since tea crop takes five to six years to be productive, it suggests that the value of $(P_t/W^*_t)^*$ may be approximated by the average of the actual value of P_t/W^*_t over the last six years.

Denoting this average by P_{lt} and on substitution in Equation (4), the estimating equation becomes:

$$A_t - A_{t-1} = a' + K'\ (A_{t-1} - A_{t-2}) + b'P_{lt} + W'_t \quad \ldots.(5)$$

In the present study a trend variable T was added to see the change in area over time. Thus the final estimating equation is:

$$A_t - A_{t-1} = a' + K'\ (A_{t-1} - A_{t-2}) + b'P_{lt} + c'T + W'_t \quad \ldots.(6)$$

where A_t = area (extension[3] or replacement[4] or replanting[5] or total[6]) under tea crop in the t period;

P_{lt} = average of last six years' prices deflated by the cost of production per kilogram of tea; and
T = trend variable.
W'_t = disturbance term.

2. Yield Model

The yield model considered here is the one that was developed by French and Matthews[7] for estimating the price response of a perennial vegetable crop.

3. Extension represents new area brought under the new plantation.
4. Replacement is the term used to represent the area where the seedlings have been replaced because of disease, etc.
5. Replanting means removal of the old and uneconomic plants, and new planting in that area.
6. Total means summation of extension, replacement and replanting.
7. Ben C. French and Jim L. Matthews, "A Supply Response Model for Perennial Crops", *American Journal of Agricultural Economics*, Vol. 53, No. 3, August 1971, pp. 478-490.

This is based on the consideration that productivity of a perennial crop varies with (*a*) the age of bearing plants; (*b*) technological changes; and (*c*) weather and biological factors.

Formally, the average yield (Y_t) in year t is expressed as:

$$Y_t = \sum_{i=k}^{H} a_i A_{it} + bT + U_t$$

where

A_{it} = the acreage of the plant of ith age in year t;
k = the initial bearing age;
H = economic age of the plant; and
U_t = a disturbance term.

Since the present equation will contain a very large number of variables for plants that live very long life, it was proposed to classify the planting into three or four age groups in each year and then replace $\sum_{i=k}^{H} a_i A_{it}$ by acreage of these classes. Thus the equation becomes

$$Y_t = a_o + a_i A_{it} + a_2 A_{2t} + a_3 A_{3t} + hT + W_t.$$

Because of non-availability of time-series data the equation has been approximated to:

$$Y_t = a + b(A_t - A_{t-h}) + cT + U_t$$

where h represents an appropriate lag period. The logic behind introducing ($A_t - A_{t-h}$) the non-bearing area as an independent variable is that the current yield is negatively related to the non-bearing area and this factor is an approximation to that effect.

In the present study a variable R_t (rainfall) was included as a proxy for weather factor. The influence of one year lagged price is conceivable as producers are likely to respond through proper management, *e.g.*, using heavy fertilizer doses, etc.

Again in the case of tea, yield can be altered in response to a change in the current price through the changes in methods of plucking, *e.g.*, heavy plucking can increase the yield considerably and finer plucking will result in reduced production. Therefore, an additional variable for price with two specifications, one with lag and another without lag, was included in the model. Each one was considered separately to avoid multicollinearity. Thus the yield model is:

$$Y_t = a + b(A_t - A_{t-h}) + cP_{it} + dR_t + cT + U_t, \quad i = 2, 3$$

where

P_{2t} = P_t/W^*_t and P_{3t} = P_{t-1}/W^*_{t-1};
P_t = price of tea in year t (weighted average);
W^*_t = wage per kilogram of tea in year t (weighted average).

3. *Employment Model*

In fact area is not a fool-proof proxy for planned production. To be realistic enough, an all input index would be most appropriate to serve as a proxy. Studies on supply response have not attempted this due to lack of time-series data on inputs other than land. The present study endeavours to incorporate employment on which the time-series data are available as a proxy foı inputs used in tea plantation. This is quite appropriate also as the wage constitutes a major part of total cost of production of Indian tea. The proposed employment model is:

$$L_t = a + bP_{1t} + cA_t + dT$$

where L_t is the total number of labourers employed per day and other variables are the same as defined above.

Ordinary least square technique was used foı estimating these equations.

RESULTS

1. *Area Model*

In order to obtain an exact estimate of tea planters' response in terms of acreage to price change, the area model outlined above was put to empirical operation. The results of the analysis are presented in Table I.

TABLE I—ESTIMATED AREA RESPONSE FUNCTIONS FOR NORTH INDIAN, SOUTH INDIAN, AND ALL-INDIA TEA: LOGARITHMIC

Specification of area	Log a	Regression coefficients			Coefficients of multiple determination
		Area lagged by one year	Relative price (average of last six years)	Trend variable	
		$A_{t-1}-A_{t-2}$	P_{1t}	T	R^2
North India					
Extension	3·196	0·1213	—1·4990	0·7288***	·71
		(0·2090)	(1·0141)	(0·1684)	
Replacement ..	1·512	0·5935**	—0·7473	—	·36
		(0·2477)	(0·6588)		
Replanting	1·838	0·5451***	—0·4147	0·1213***	·87
		(0·1323)	(0·3155)	(0·0454)	
Total	1·276	0·7177**	—0·4095	—	·44
		(0·2184)	(0·3868)		
South India					
Extension	2·107	0·3672*	—0·8995	—	·29
		(0·2093)	(0·8016)		
Replacement ..	1·445	0·1750	—0·6566	—	·04
		(0·2674)	(0·2803)		
Replanting	1·094	0·3759	—1·1490	—	·12
		(0·2831)	(1·7420)		
Total	1·915	0·4094*	—0·6987	—	·29
		(0·2159)	(0·7889)		
All-India					
Extension	2·909	0·3364	—1·6880	0·4677***	·71
		(0·2061)	(0·9931)	(0·1154)	
Replacement ..	1·857	0·5664***	—0·1141	—	1·41
		(0·2331)	(0·7134)		
Replanting	1·620	0·5723***	—0·1791	0·1471***	·83
		(0·1567)	(0·4446)	(0·0503)	
Total	1·417	0·7031***	—0·5215	—	·45
		(0·2122)	(0·4130)		

Figures in parentheses are standard errors.
*** Significant at 1 per cent probability level.
** Significant at 5 per cent probability level.
* Significant at 10 per cent probability level.

A cursory reading of the table reveals that the price coefficients (for all the three zones and also for all the four types of area, *i.e.*, extention, replacement, replanting and total) were surprisingly negative, although statistically insignificant. The negative sign of price coefficients was really puzzling and difficult to explain. Some of the plausible explanations for the 'wrong sign' of the price coefficients could be mis-specification and inadequate definition of the variables.[8] However, since these coefficients were not significantly different from zero, it may be inferred that price as defined in this study was not an important explanatory variable in the concerned equations. The probable reasons for the price variable to become insignificant could be:

(*i*) Geographical limitations: The area under tea has reached a near saturation level with little scope for expansion. The fact that hardly 10 per cent of the tea gardens have any spare land to extend cultivation lends support to this argument.[9]

(*ii*) Weather inclemency: It is another factor preventing tea gardens from expansion. Tea crop requires a particular type of agro-climatic condition which is probably not available in other regions except where tea is being cultivated at present.

(*iii*) Lack of adequate capital: It may be yet another constraint. An expansion of area under tea requires heavy investments for deforestation, levelling of land and proper drainage management. According to a report,[10] it cost about Rs. 6,250 per acre or Rs. 17,000 per hectare to uproot and replant the area under tea plantation. Besides, the revenue losses on the resown of one hectare patch could amount to another Rs. 10,000 before the replanted tea starts giving results.

Lagged area turned out to be significant in almost all the cases except for area extension in North and all-India, and area replacement and area planting in South India. The trend variable was found to be significant in the case of extension and replanting of tea for North India as well as for all-India. For North and all-India tea, the area equation gave a better picture than that of South Indian tea by way of higher values of the coefficients of multiple determination. The overall performance of the area model was, however, far from the level of satisfaction in terms of explaining the variability of tea acreage.

2. *Yield Model*

In the milieu of traditional economic theory, a firm's production has to be consistent with the maximum profit. Herein producers' response to increased price of output will be reflected either in an increased area or a higher use of non-land inputs or both. The response of acreage to prices was examined and found insignificant in the preceding discussion. To examine if there was any response of yield to price change, the analysis of yield-price relationship was done and the results of the analysis are presented in Table II.

8. P. Rao and R. L. Miller: Applied Econometrics, Prentice-Hall of India Private Limited, New Delhi, 1972, p. 44.
9. S. N. Khanna "Tea: Past and Present—I", *The Hindustan Times*, June 24, 1975.
10. Khanna, *ibid.*

TABLE II—ESTIMATED YIELD RESPONSE FUNCTIONS FOR NORTH INDIAN, SOUTH INDIAN AND ALL-INDIA TEA: LOGARITHMIC

Specification of zones	Log a	Regression coefficients					Coefficient of multiple determination
		Non-bearing area $A_t - A_{t-6}$	Current relative price P_{2t}	Last year's relative price P_{3t}	Trend variable T	Rainfall (weather) R_t	R^2
North India	4·458	—0·3906*** (0·1307)	0·2510* (0·1349)	—	0·0835*** (0·0289)	—	·61
	4·751	—0·4664*** (0·1506)	—	0·2841*** (0·0932)	0·1064*** (0·0275)	—	·71
South India	2·863	—	0·0204 (0·1219)	—	0·1893*** (0·0179)	—	·90
	1·866	—0·2145** (0·0839)	—	0·3539*** (0·1232)	0·2626*** (0·0304)	—	·94
All-India	4·177	—0·3311 (0·1256)	0·3221** (0·1472)	—	0·0798*** (0·0243)	—	·81
	4·280	—0·3550*** (0·1098)	—	0·3001*** (0·0937)	0·1003*** (0·0179)	—	·87

Figures in parentheses are standard errors.

*** Significant at 1 per cent probability level.

** Significant at 5 per cent probability level.

* Significant at 10 per cent probability level.

It may be noticed from the table that weather (rainfall) was an insignificant attribute of yield for all the regions and was, therefore, dropped from the model in the final run equation. The insignificance of weather factor in tea plantation could, however, not be upheld as there is empirical evidence[11] to assert the relationship of weather with the fortunes of tea industry. This would have happened possibly because of the aggregation involved over the regions and seasons and an imprecise specification of weather index. The folly of trying to estimate an aggregate supply function for a perennial crop like cocoa grown under heterogeneous weather and soil characteristics has been also substantiated by Bateman.[12]

The non-bearing area turned out to be significant with a negative sign attached to it. This is quite appropriate as the yield and non-bearing area move in opposite directions. One year lagged price had more influence on tea growers' decision than current price. The trend variable also turned out to be significant in all the three cases. The overall performance of the model was, thus, found to be quite satisfactory.

3. *Output Elasticity*

Based on the above estimates of area and yield response, the price elasticities of output could be derived. Output elasticity is the sum total of area elasticity and yield elasticity.[13] As observed earlier, the area response with respect to price was insignificant whereas the yield response was positive and highly significant in almost all the cases. Therefore, the yield response could be taken to reflect the output response.

4. *Employment Functions*

The discussions of the results obtained from the acreage and the yield response functions revealed the tea growers' neutrality in terms of acreage and their rationality in terms of yields to price variations. The yield response is, in fact, a derivative of the response of package of inputs. The idea behind current discussion is to confirm if inputs really responded to prices. Non-availability of data on all factor inputs precluded this comprehensive analysis. Time-series data on employment of labour in tea industry are available and hence the analysis was extended to see the responsiveness of labour use to various stimuli. The results of regression of employment on yield, current relative price, area under tea and the time trend as a proxy for technology are shown in Table III. The proxying of time trend is, however, a very crude way of quantifying technology as has been used and mentioned by Nerlove.[14] Because of its statistical insignificance, yield was not included in the final run.

11. K. N. Sircar, "Tea: Progress and Problems", *The Economic Times*, June 23, 1975.
12. Bateman, *op. cit.*
13. Mahar Mangahas, Aida E. Recto and V. W. Ruttan, "Price and Market Relationships for Rice and Corn in the Philippines", *Journal of Farm Economics*, Vol. 48, No. 3, Part I, August 1966, pp. 685-703.
14. Marc Nerlove: Dynamics of Supply: Estimation of Farmers' Response to Price, The Johns Hopkins Press, Baltimore, U.S.A., 1958.

TABLE III—ESTIMATED LABOUR EMPLOYMENT FUNCTIONS FOR NORTH INDIAN, SOUTH INDIAN AND ALL-INDIA TEA: LOGARITHMIC

Specification of zones	Log a	Regression coefficients				Coefficient of multiple determination
		Current relative price P_{2t}	Total area A_t	Trend variable (technology) T	Yield Y_t	R^2
North India	5·898	—0·3393*** (0·1061)	0·0636* (0·0365)	—0·0934*** (0·0188)	—	·94
South India	5·263	0·0401 (0·1746)	—	—0·0724*** (0·0168)	—	·61
All-India	5·955	—0·3737*** (0·1056)	0·0789** (0·0302)	—0·7830*** (0·0164)	—	·96

Figures in parentheses are standard errors.

*** Significant at 1 per cent probability level.

** Significant at 5 per cent probability level.

* Significant at 10 per cent probability level.

It is interesting and at the same time startling to note that price significantly and negatively influenced the employment of labour in tea industry in North India as well as at all-India level. It was, however, insignificant for South Indian tea. The area under plantation also appeared to have significant influence on employment in tea industry in North India and at all-India level but it was insignificant for South Indian tea and was, hence, excluded from South Indian model in the final run. The trend variable also turned out to be highly significant with a negative sign for all of the three regions. This reveals an interesting story. Over time, employment in the tea industry has declined. This has been happening possibly because of the adoption of labour replacing technology in the industry. This is partially being confirmed by the negative price coefficients which tell us that employment is declining with a rise in the price of tea and, therefore, leading the owners to higher profit by adopting the labour replacing technology.

CONCLUSION

The study shows that tea planters respond to price not in terms of acreage but in terms of yield. The employment of labourers is surprisingly adversely affected by favourable price position and this perhaps occurs due to labour substituting mechanization.

The result of the study may provide very valuable basis for evaluating suitable policies for the development of the industry. Any effort to increase production should not be conceived through enhanced acreage. The possibility of exploring the avenues of increased production basically lies in yield improvements through intensive use of inputs.

ASHOK CHOWDHURY AND G. S. RAM*

POTENTIALITIES OF INCREASING FARM INCOME AND EMPLOYMENT THROUGH DAIRYING

A Dairy Development Scheme has been initiated in the Phulera tehsil of Jaipur district by the United Commercial Bank, the 'lead Bank' for Jaipur district, in collaboration with S. K. N. College of Agriculture, Jobner (University of Udaipur), Rajasthan. To start with, 20 farmers have been selected and a sum of Rs. 1,74,250 has been advanced as loan to these farmers for the purchase of milch cattle.

The Dairy Development Scheme is likely to be of great economic importance for the area where the majority of the people are vegetarian and ill-nourished. Introduction of dairy enterprise on farms would not only spread the risk but also become a source of continuous income throughout the year. This would also introduce an element of complementarity on the farm. The recipient farmers would, however, need to make necessary adjustments in

* Graduate Research Assistant, Department of Economics, Iowa State University, Ames, U.S.A. and Scientist S-2 (Agricultural Economics), Division of Agricultural Economics, Indian Agricultural Research Institute, New Delhi-12, respectively.