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0.5 (q/ha.) to about 3.0 (q/ha.) depending upon at what level the fertilizer is applied. As would be expected, the decrease in yield becomes steeper as the percentage increase in price becomes higher. Thus at higher levels of application of fertilizers when there is a 30 per cent increase in the price of fertilizers the decrease in yield of HYV of rice could be as high as 19.59q/ha. (Anantapur *kharif*, 1972-73). It is, however, interesting to note that in certain areas where the response is non-linear an increase in price could also lead to an increase in yield, *e.g.*, Anantapur (*kharif* 1973-74 and *rabi*, both in 1972-73 and 1973-74) and Chittoor (*kharif* both in 1972-73 and 1973-74). This is because at lower level of application the marginal returns to fertilizers are more than those at higher levels.

In almost all the districts studied it was seen that the yield of wheat also could decrease substantially due to an increase in the price of fertilizers. However, the decrease in yield is less fluctuating in the case of wheat than in the case of rice. An increase in the price of fertilizers could also lead to an increase in yield of wheat (*e.g.*, Bulandshahr and Sangrur both in 1972-73 and 1973-74) but mostly at higher levels of application. A comparison between the years shows that except in Anantapur and Chittoor *kharif* rice the decrease in yield due to an increase in the price of fertilizers did not vary much from year to year or in other words the impact of price rise is somewhat stable. This is particularly true at the low and moderate levels of application, *i.e.*, from 50 to 150 kg./ha. The stability was all the more high in the case of SFT districts. It is not difficult to see that the decrease in yield will lead to a loss to the farmer and this loss could be heavy in many cases.

A perusal of Tables IV and V indicates that if a rise in the price of fertilizer is compensated by a corresponding increase in the price of wheat/rice, the profit of the farmers growing the high-yielding varieties would increase considerably at all levels of application of fertilizers and under responses of different types. However, the increase in profits varies more violently in the case of rice than in the case of wheat. The stability of increase in profits from year to year is higher in the case of *rabi* crops than in the case of *kharif* crops.

IMPORTANCE OF PURCHASED INPUTS ON COST STRUCTURE— AN ANALYTICAL STUDY

Bhanudeb Bagchi and K. Sain*

In a developing economy still largely dependent on agriculture the general price level is substantially influenced by the prices of foodgrains. Introduction of modern technologies for reorganizing agriculture since the beginning of the 'sixties necessarily implies increasing use of non-farm inputs for the

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enhancement of yield and improvement of its quality. An attempt is made in this paper to analyse the relative importance of purchased inputs in the cost structure of some principal crops grown in India and to study the relationship, if any, between operational size of farms and per hectare use of purchased inputs as well as per hectare yield. The analysis is mainly based on data taken from the Farm Management Studies and Studies on the Cost of Cultivation of Crops conducted by the Government of India.

Inputs originating in the agricultural sector itself such as labour, bullocks and organic manure are included in the group of inputs—"agricultural source." Inputs like fertilizers, pesticides, electric power, diesel oil, farm machinery, etc., which are produced in the non-agricultural sector are included in the input group—"industrial source." Some inputs like irrigation water which comprise elements from both the farm and the non-farm sectors are included in the group—"common source."

The proportions of purchased inputs used in agriculture from different sources in different districts covered by the Farm Management Studies along with the ratio of gross income per cultivated hectare to the value of purchased inputs per cultivated hectare are indicated in Table I.

TABLE I.—PERCENTAGE OF PURCHASED INPUTS IN COST C* AND RATIO BETWEEN GROSS INCOME AND PURCHASED INPUTS IN DIFFERENT DISTRICTS OF INDIA

Source	Cudappah 1967-68 to 1969-70	Thanjavur 1967-68 to 1969-70	Ahmednagar 1967-68	Surat and Bulsar 1967-68	Cuttack 1967-70	Ferozepur (1967-68 to 1969-70)
Agricultural source	14.98	24.18	9.94	14.37	13.35	12.62
Industrial source	2.19	8.05	11.11	4.32	1.44	5.72
Common source	2.45	2.29	6.15	1.32	0.42	4.26
Total	19.62	34.52	27.20	20.01	15.21	22.60
Gross income (Rs.) (per cultivated hectare)	854.39	1,840.35	799.53	838.57	1,363.15	1,831.90
Gross income : purchased inputs	5.07:1	3.25:1	3.79:1	4.81:1	9.30:1	4.94:1

Source: Studies in the Economics of Farm Management in Cudappah, Thanjavur, Ahmednagar, Surat and Bulsar, Cuttack and Ferozepur, Directorate of Economics & Statistics, Ministry of Agriculture, Government of India, New Delhi.

*Cost C indicates total cost as defined in the Farm Management Studies.

Inputs purchased from agricultural source as a percentage of the total cost C varied from 9.94 in Ahmednagar in the year 1967-68 to 24.18 in Thanjavur in the year 1967-68-1969-70. Purchased inputs from industrial source as a percentage of the total cost C varied from 1.44 in Cuttack district (1967-70) to 11.11 in Ahmednagar (1967-68). Inputs from common sources as a percentage of cost C varied from 0.42 in Cuttack (1967-70) to 6.15 in Ahmed-

nagar (1967-68). Purchased inputs in the aggregate constituted a minimum of 15.21 per cent in Cuttack to a maximum of 34.52 per cent in Thanjavur. Gross income per cultivated hectare in rupees varied from Rs. 793.53 in Ahmednagar to Rs. 1,840.35 in Thanjavur. Gross income as a multiple of purchased inputs constituted a maximum of 9.30 in Cuttack and a minimum of 3.25 in Thanjavur. It appears that purchased inputs in the aggregate constituted a significant proportion of the total inputs in terms of cost C. Of the purchased inputs, the share of inputs from agricultural source is still maximum. The relative contribution of inputs from agricultural source to gross income also appears to be the highest in general. A look at the constituents of purchased inputs and gross income per hectare for the districts of Cuttack and Ahmednagar shows this clearly.

In the case of Ferozepur district of Punjab, the proportion of inputs purchased from the three sources together increased from 12.47 per cent of the total cost during 1954-57 to 22.60 per cent during 1967-68 to 1969-70.

The relative importance of purchased inputs from different sources in the cost of production of two principal crops, paddy and wheat in some States of India is analysed from the data contained in different reports prepared by the Directorate of Economics and Statistics, Government of India (Tables II and III). These data relate to the year 1971-72 except the data for wheat in West Bengal which relate to the year 1974-75.

TABLE II—PERCENTAGE OF PURCHASED INPUTS IN COST C AND PER HECTARE
PRODUCTION OF PADDY: 1971-72

Source	Andhra Pradesh	Orissa	Punjab	West Bengal
Agricultural source	19.50	15.09	16.30	18.44
Industrial source	12.59	2.62	11.31	7.75
Common source	1.22	0.05	14.21	0.36
Total	33.31	17.76	41.82	26.55
Production in quintals/hectare	23.37	16.84	36.28	18.39

TABLE III—PERCENTAGE OF PURCHASED INPUTS IN COST C AND PER HECTARE
PRODUCTION OF WHEAT: 1971-72

Source	Uttar Pradesh	Punjab	West Bengal*
Agricultural source	7.88	9.97	10.88
Industrial source	8.93	19.14	5.02
Common source	7.28	7.40	5.00
Total	24.09	36.51	20.90
Production in quintals/hectare	21.61	26.43	22.28

* For the district of Nadia only, 1974-75.

No less than 41.82 per cent of the total cost C is composed of purchased inputs in Punjab in the year 1971-72. The production per hectare of 36.28 quintals is also maximum in this case. One notable feature for the State is that purchased inputs from common source constituted 14.21 per cent of the total cost C. This reflects on Punjab's advance in respect of irrigation extension. Industrial sources and common sources taken together constituted 25.52 per cent or one-fourth of the total input cost for paddy in Punjab. The share of purchased inputs in the aggregate of 17.76 per cent was minimum in Orissa. Per hectare production of paddy was correspondingly minimum. Purchased inputs from agricultural source were predominant in this State. In other States, about one-third of the total cost C was composed of purchased inputs. It also appears that an increase in purchased inputs is closely followed by an increase in per hectare yield.

The relative share of purchased inputs in the aggregate cost C for wheat followed closely the pattern observed for paddy. An higher percentage of purchased inputs was associated with an higher per hectare yield in wheat also. The fact that per hectare yield is maximum in Punjab and that the share of industrial input is also highest in the State—this share being even higher than that in the case of paddy—induces one to think of the increasing importance of inputs from industrial source with the progress of the agrarian economy.

The share of inputs purchased from different sources in the total cost of production of paddy in the different agro-climatic zones of the State of West Bengal for the year 1972-73 varied from 9.62 per cent in zone III to 25.66 per cent in zone VI (Table IV). Contrary to expectations, the share of purchased inputs in the aggregate in the total cost has been low in zone IV which is an agriculturally advanced zone containing the IADP district of Burdwan. This is largely explained by abnormal weather conditions causing droughts and sending the underground water table unusually low and by sudden spurt in prices of fertilizer and other inputs with the scarcity of such

TABLE IV.—PERCENTAGE OF PURCHASED INPUTS AND PER HECTARE YIELD OF PADDY IN DIFFERENT AGRO-CLIMATIC ZONES OF WEST BENGAL: 1972-73

Source	Zone I	Zone II	Zone III	Zone IV	Zone V	Zone VI
Agricultural source	—	9.15	5.31	7.65	13.54	21.18
Industrial source	—	0.11	4.24	2.80	3.32	4.35
Common source	—	1.36	0.07	0.59	0.03	0.13
Total	—	10.62	9.62	11.04	16.89	25.66
Production in quintals/hectare	—	13.75	12.49	22.18	14.66	20.42

inputs. Such erratic behaviour in weather conditions and fluctuations in the supply of industrial inputs do not enable us to reach any definite conclusion as to the relative importance of different types of purchased inputs in the cost structure of paddy as between different agro-climatic zones. No clear relationship is also revealed as between the proportion of purchased inputs used and per hectare yield.

The share of purchased inputs in the total cost of jute which is mainly a rainfed crop in West Bengal varied from 10.21 per cent in zone I (North Bengal) to 24.40 per cent in zone VI (South Bengal). Inputs from agricultural source still predominate in the cost structure. A close association is observed between the proportion of purchased inputs used and per hectare yield in all the zones (Table V). The fact that jute is cultivated in North Bengal during

TABLE V—PERCENTAGE OF PURCHASED INPUTS IN TOTAL COST OF PRODUCTION OF JUTE IN DIFFERENT AGRO-CLIMATIC ZONES OF WEST BENGAL: 1973-74

Source	Zone I	Zone II	Zone III	Zone IV	Zone V	Zone VI
Agricultural source	9.91	23.65	18.69	—	—	20.00
Industrial source	0.30	0.88	2.93	—	—	2.40
Total	10.21	23.53	21.62	—	—	24.40
Production in quintals/hectare	11.59	14.15	16.32	—	—	17.65

the slack period: January-February—June-July accounts for the relatively much less use of hired labour, relatively lower wage rate and smaller wage bill for this region. On the contrary, jute being cultivated during the more busy period: April-May to August-September in the other regions, the requirement of hired labour becomes more, wage rate becomes higher and wage bill heavier for this region. This accounts for the relatively much less share of inputs purchased from agricultural source in zone I compared to that in other zones in the State. On the whole, purchased inputs in the aggregate constitute no less than one-fifth or one-fourth of the total cost of production of jute, except for zone I.

The values of multiple correlation coefficient between per hectare yield (Y) and the use of inputs from agricultural source (X) and the use of inputs from industrial source (Z) for paddy (1972-73) and jute (1973-74) for the different agro-climatic zones of West Bengal are presented in Table VI along with their respective values of R^2 and \bar{R}^2 .

In the case of paddy, the value of multiple correlation coefficient (R) is found to be high (0.88) in zone VI and low (0.49) in zone V. This indicates a positive and higher degree of association between the purchased inputs used and per hectare yield. This observation is reinforced by the fact that

TABLE VI.—MULTIPLE CORRELATION COEFFICIENTS BETWEEN PER HECTARE YIELD (Y) OF PADDY (1972-73) AND JUTE (1973-74) AND INPUTS USED FROM AGRICULTURAL SOURCE (X), AND FROM INDUSTRIAL SOURCE (Z) IN DIFFERENT ZONES OF WEST BENGAL

Correlation coefficients				Zone I		Zone II		Zone III		Zone IV	
				Jute	Paddy	Jute	Paddy	Jute	Paddy	Jute	Paddy
r_{yx}	..	..	..	0.65	—	0.64	—0.56	0.35	0.78	0.02	—0.20
r_{yz}	..	..	..	0.90	—	—0.48	—0.20	0.40	—0.77	0.02	0.48
r_{xz}	..	..	..	0.71	—	—0.02	—0.44	0.63	—0.65	0.42	0.27
R	..	..	..	0.90	—	0.41	0.75	0.42	0.85	0.02	0.59
R^2	..	..	..	0.81	—	0.16	0.56	0.18	0.73	0.0005	0.35
\bar{R}^2	..	..	..	0.61	—	—	—	—	—	—	—

Correlation coefficients				Zone V		Zone VI		West Bengal	
				Jute	Paddy	Jute	Paddy	Jute	Paddy
r_{yx}	—	0.17	—	0.20	0.25	0.31
r_{yz}	—	0.49	—	0.88	0.22	0.46
r_{xz}	—	0.44	—	0.16	0.19	0.25
R	—	0.49	—	0.88*	0.30	0.50*
R^2	—	0.24	—	0.78	0.09	0.25
\bar{R}^2	—	—	—	0.72	—	0.21

* Significant at 1 per cent level.

the R has been found to be significant for zone VI. The respective minimum and maximum values of R^2 are 0.24 and 0.78 ($\bar{R}^2 = 0.72$) indicating that a high proportion of variability in yield is explained by the purchased inputs. For the zones taken together, R has been found to be 0.50 and significant at 1 per cent level and R^2 0.25 for paddy. On the whole, purchased inputs from industrial source seem to be more closely associated with per hectare yield for paddy than inputs purchased from agricultural source, r_{yz} being higher at 0.46 than r_{yx} at 0.31, but no precise trend appears as to the relative impact of inputs purchased from industrial source and agricultural source on per hectare yield as between agro-climatic zones.

The maximum value of R for jute is obtained from zone I at 0.90 with R^2 at 0.81 ($\bar{R}^2 = 0.61$). The minimum value of R for jute is obtained from zone IV at 0.02. R for jute for all the zones taken together stands at 0.30. On the whole, purchased inputs bear a positive relation with per hectare yield of jute, but for the zones taken individually, no definite association is found between these variables.

The relationship between farm size and the use of purchased inputs in the districts of Surat and Bulsar in Gujarat for the year 1968-69 may be seen from Table VII.

TABLE VII—FARM SIZE AND PURCHASED INPUTS IN SURAT AND BULSAR IN GUJARAT: 1968-69

Operational size of farms (hectares)	Agricultural source		Industrial source		Common source		Total		Cost C (Rs.)	Gross value of output (Rs.)
	(Rs.)	Per cent of cost C	(Rs.)	Per cent of cost C	(Rs.)	Per cent of cost C	(Rs.)	Per cent of cost C		
Below 2.50	112.83	8.65	30.76	2.35	26.10	2.00	169.69	13.00	1,303.70	1,153.96
2.51—5.00	114.20	11.93	47.19	4.93	32.69	3.41	194.08	20.27	956.46	1,207.88
5.01—7.50	112.79	11.69	62.41	6.47	37.98	3.93	213.18	22.09	965.17	1,188.07
7.51—10.00	100.63	11.21	52.46	5.84	22.62	2.52	175.71	19.57	897.76	1,013.78
10.01—above	125.28	12.06	55.64	5.35	20.52	1.97	201.20	19.38	1,039.12	1,238.06
Overall	113.91	11.55	51.15	5.19	28.99	2.94	194.05	19.68	986.10	1,172.49

Source: Studies in the Economics of Farm Management in Surat and Bulsar (Gujarat), 1968-69.

It appears from the table that the farmers belonging to the operational size-group of 10.01 hectares and above purchased 12.06 per cent of the total inputs from agricultural source, while the farmers in the lowest size-group of below 2.50 hectares purchased a minimum proportion of the total inputs (8.65 per cent) from agricultural source. The share of inputs purchased from industrial source was maximum at 6.47 per cent of the total cost for the farmers in the size-group of 5.01-7.50 hectares while it was minimum at 2.35 per cent for those belonging to the lowest size class. The share of inputs purchased from common source was maximum for the farmers in the size-group 5.01-7.50 hectares while it was minimum for those belonging to the highest size class. For inputs purchased from the three sources taken together, the share was maximum for the farmers in the size-group 5.01-7.50 hectares and minimum for those in the lowest size-group. Although one-fifth of the total cost is composed of purchased inputs for the farmers taken together, no precise relationship evolves as between farm size and use of farm inputs.

It appears from other studies conducted on the relationship between farm size and the use of hired labour and other purchased inputs and resulting yield, particularly, for the period beginning with the early 'sixties that the traditional inverse relationship between farm size, on the one hand, and the use of inputs and per acre productivity, on the other, has been yielding place to a new and direct relationship between the two, technological changes encouraging the bigger farmers to use costly inputs more and more while res-

tricting the use of such inputs on the part of the smaller ones due to severe limitation of their investible surplus.¹

One may conclude from the foregoing analysis that the importance of purchased inputs in the cost structure of farm products is quite high. Among the different sources from which farm inputs are purchased, agricultural source still predominates, but in technologically advanced regions, industrial source seems to be quite important.

The fact that the share of purchased inputs from both agricultural source and industrial source in the total cost of production is quite high bears significantly on the formation of policies with regard to fixation of prices for inputs and output. The chief input purchased from agricultural source being labour, minimum wages may not be fixed without due consideration of its impact upon cost of cultivation and resulting price of output. Similarly, prices of industrial inputs like fertilizer and pesticides have to be fixed with due consideration of their impact upon costs and price of farm product. Specifically, the case of West Bengal in respect of minimum wage fixation may be mentioned. The proportion of purchased inputs from agricultural source given above was estimated on the basis of lower wages prevalent in the State and in some cases fixed by the Government.² Minimum wages recently fixed by the Government of West Bengal at Rs. 8.10 are much higher than the previously fixed wages as well as wages prevailing in the State. The proportion of inputs purchased from agricultural source will be much higher once the wage structure is adjusted in consonance with the newly fixed minimum wages. In respect of industrial inputs, it may be suggested that should it be essential to maintain prices of farm products at a moderate level for arresting the rise in the general price level and in the cost of living indices without curtailing prices of inputs purchased from industrial sources, then it is necessary that due subsidies are channelised through proper means such as farmers' co-operatives under due vigilance. Small farmers may be offered special facilities, e.g., relief from the scope of minimum wages act, wherever permissible.

1. A. K. Dasgupta: *Agriculture and Economic Development in India*, Associated Publishing House, New Delhi, 1973, p. 34.

2. Bagchi and Sain, "Minimum Wages for Agricultural Labourers in West Bengal," *Indian Journal of Agricultural Economics*, Vol. XXIX, No. 3, July-September, 1974.