Journal of Indian School of Political Economy

Vol. V, No. 3
July-Sept. 1993

A Journal devoted to the Study of Indian Economy, Polity, and Society

INDIAN SCHOOL OF POLITICAL ECONOMY

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JOURNAL
OF INDIAN SCHOOL
OF POLITICAL ECONOMY

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Indian Economy, Polity and Society

Vol. V | July-September 1993 | No. 3

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FOREIGN TECHNOLOGY IN PUBLIC ENTERPRISES

Sunil Mani

The purpose of this paper is to analyse the economic conditions under which Indian Public Sector Enterprises purchase technology from abroad and second the efforts made by them to indigenise and develop local capabilities. The paper first develops a consistent series of data on direct cost of technology import at aggregate and at thirteen subsector levels. The relationship between technology import and domestic R&D is then examined through a log-linear test. These results are then compared with those obtained from a similar exercise which employs an RBI data set.

One of the objectives of the country's planned economic development has been growth accompanied self-reliance, especially in industrial technological capability. State-owned enterprises have been assigned a major role in generating indigenous capabilities. This has led to a spurt in industrial activity, mostly in basic capital goods and certain intermediate goods sectors. The common nagging element in all these sectors was that the technologies for their industries were complex, and imperfect. The government, through its active participation in the technology transfer process, was believed to be able to obtain technologies in such critical areas on favourable terms and conditions and also to imbibe it into indigenous capabilities more effectively than what the private sector could do.

I

ORGANISATION OF THE STUDY

The paper is organised into five subsections. The first subsection analyses the issues that are normally researched into on the theme of technology transfer in Indian industries. The second section discusses the framework that is employed in analysing the issues. The third section analyses various dimensions of the trends in foreign collaboration in Indian Public Sector Enterprises. The fourth and the fifth sections analyse the relationship between technology import and in-house R&D efforts employing two different data sets: one developed by the RBI and the other one by ourself.

This goal of self-reliance in technology was sought to be achieved through a strategy of "import and adapt". The import of technologies was effectively controlled by a tight regulatory policy with respect to the mode and conditions of technology transfer. But, how far the policy of adapting new technologies and improving existing ones has affected the development and maturity of indigenous technological capability is subject to scrutiny. Available evidence portrays a mixed picture: certain areas of Indian industry, say, electronics, where technology is fast changing, remain technologically backward and become increasingly so; whereas there are cases where a number of Indian firms continue assimilating imported technologies and even effect improvements upon them[1]. In this context, we propose to survey the changing dimensions of technological dependence in Indian industries. To begin with, a brief survey is made of the government policy towards foreign collaboration and its evolution over the last four decades.

An evaluation of the policy reveals three distinct regimes. The first phase covers the first two decades after Independence till 1968, when foreign collaboration with equity participation was encouraged. This was considered to be the best mode of technology transfer because, by giving a chance to the collaborator to manage the host firm, the country could secure technologies for a variety of high technology areas which would otherwise have been difficult to obtain. Further, the increasing foreign exchange constraint on the import of capital goods, especially in the late fifties, encouraged minority foreign capital participation. The government extended a number of tax concessions to foreign collaborations and streamlined industrial licensing procedure to avoid delays in approval of foreign collaborations. The Indian Investment Centre was established in 1961 to forge a close link between Indian and foreign parties. But, this soon led to a flood of collaborations. It has been remarked by some commentators that the liberal policy with respect to foreign collaborations often led to the import of technologies which were inessential and

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This article is a summary of Chapters 1 to 5 of Foreign Technology in Public Enterprises by Sunil, Mani, Published by Oxford and IBH Publishing Co. Pvt. Ltd.

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Summarised by Mrs. Santoshree Rath.

inappropriate for the factor endowments of the country[2]. Apart from acquiring technology through financial participation, turnkey contracts with the foreign firm as the prime contractor, was another source. During the period 1957 - 1967, about 254 such agreements were entered into for plant construction, and a large proportion of these were in the public sector.

Against the growing criticism of such large scale reliance on foreign technology, the government, appointed the Mudaliar Committee in 1966 to examine the conditions under which indigenous know-how could be deemed commercially exploitable, and to suggest general guidelines on the type of cases in which foreign collaboration might be allowed. The Committee submitted its report in 1967. The government accepted the main recommendations which envisaged *inter alia* a stricter approach to the extension of existing collaboration agreements; favoured outright purchase of technology through drawings and designs, where technological obsolescence was rapid, rather than equity participation; deprecated repetitive import of the same technology; and suggested liberal treatment of foreign exchange provisions for import of essential instruments and equipment, for research laboratories.

On the basis of the Committee's report and government's decisions thereon, the Foreign Investment Board was established in December 1968. The Board was given the responsibility of approving foreign collaborations, except in cases where total investment exceeded Rs. 2 crore of equity capital and where foreign investment exceeded 40 per cent of issued capital.

During the second phase of government policy, the main accent was on the strong discouragement of technology acquisition via the mode of Foreign Direct Investment (FDI). In 1967, the stock of FDI in India was $1.5 billion as compared with $1.3 billion in Brazil, $78 million in South Korea and $1.8 billion in Mexico [Dahlman and Sercovitch, 1984, Table 5]. This showed the relative importance of this mode of technology acquisition, which, in view of its obvious adverse repercussion, had to be regulated. In accordance with this changed policy of regulation, government issued in January 1969 an illustrative list of industries where: (a) foreign investment might be permitted; (b) only foreign technical collaboration, but not foreign investment, might be permitted; and (c) no foreign collaboration (financial or technical) was considered necessary.

Moreover, in order to bring down the price of technology, the government imposed a pre-tax ceiling of 3 per cent on royalty for most products and 5 per cent for some with more complex technologies. Higher rates were allowed, only in exceptional cases where technology was difficult to obtain or when substantial exports were expected. In addition to these ceilings, actual royalty payments were subjected to a 40 per cent withholding tax, so that the collaborator could receive a maximum royalty of 3 per cent. The other important component of the explicit price of technology, namely, the lump sum payment, was subject to a withholding tax of 20 per cent.

Technology acquisition through licensing agreements was subject to the validity for a maximum period of 5 years, as opposed to about 15 years in the agreements contracted during the pre-1968 phase.

Careful screening of licensing agreements was employed through the Technology Evaluation Committee of the DGTD. As part of a strict policy towards FDI, the Foreign Exchange Regulation Act (FERA) was passed in 1973, whereby share ownership by foreigners was diluted to a maximum of 40 per cent of the total equity (except for wholly export-oriented enterprises or for those using "sophisticated technology"). Project engineering imports, in the form of turnkey plants and consultancy services, were allowed on a subcontracting basis, with domestic consultants in-charge of modifying, adapting and implementing the technologies from the basic design stage. The significance of this policy was that no turnkey contract was awarded to a foreign firm on a prime contractor basis between 1967 and 1981, while, as stated above, some 254 such agreements had been signed up between 1957 and 1967.

Finally, even the embodied technology import, in the form of the import of capital goods, was regulated through high tariff barriers, quota restrictions, and more often, through outright prohibition, depending on the local availability

and the ability of local manufacturers to produce and supply the capital goods within a given time-frame.

Commentators have opined that this strict regulatory policy, which the country adopted towards technology import, had been greatly inspired by Japanese experience.

However, the growing disillusionment with excessive bureaucratization which resulted in inordinate delays on collaboration approvals led to the government dismantling some of the controls. This liberalization was discernible from 1978 and was termed the 'new economic policy' of the government. This was imperative because of the restrictions on royalty rates and other payment-related aspects of the contracts, particularly in a market of limited economic size. This implied that, until then, Indian firms had been offered packages that were less than complete. Even when state-of-the-art designs were included, the packages offered were frequently the bare minimum to enter into a new line of production, thus employing only "average practice" technologies [Alam, 1985*a*]. This was especially so in industries where rapid technological changes took place. As part of the liberalization package, the government announced a technology policy statement in 1983. The main accent was on the technological upgradation of Indian industries, resorting to a judicious mix of indigenous and imported technology. While technology import was permitted, wherever necessary, emphasis was laid on adaptation through the in-house R&D. Some of the restrictions on royalty were relaxed, especially the withholding tax, which was reduced to 30 per cent. Turnkey contracts and equity participations were allowed, albeit on a selective basis. The procedure for screening applications for foreign collaborations was streamlined with the Secretariat of Industrial Approvals (SIA) (Ministry of Industry) acting as the nodal agency. To improve the data base, a National Register of Foreign Collaboration (NRFC) was set up in the Department of Scientific and Industrial Research. A greater need for strengthening the local research was also emphasised.

However, the basic conditions, under technology transfer took place, were retained. These could be summarised as follows:

1) The duration of an agreement should be for a period of eight years from the signing of the agreement or five years from the commencement of production.
2) Use of foreign brand names should not be generally permitted for internal sales.
3) The host firm should be free to sub-licence the technical know-how to another domestic company.
4) There should be no restriction on exports to any country by the host firm, except where the foreign collaborator already had existing licensing arrangements for manufacture.
5) In items of manufacture patented in India, the Indian company should be free to manufacture these, even after the expiry of the collaboration agreement without any further payments, and a separate clause to this effect should be inserted into the collaboration agreement.

How far had these regulations been beneficially transliterated into reality in terms of: (a) reduction of the price or the direct/indirect cost of technology imports, and (b) enhancement of the self-reliance of Indian firms? An attempt is made to answer this on the basis of some already existing studies on the theme [Subrahmanian, 1986, 1987]. The emphasis would be to analyse the behaviour of Indian firms importing technology during the three phases.

We begin with an analysis of trends in foreign collaboration approvals and the relative share and movement of various modes of technology acquisition during three phases.

One can identify four modes of technology transfer, namely, (i) turnkey contracts which encompass the entire gamut of establishing a plant, such as detailed engineering, procurement of services, fabrication of equipment, construction and commissioning of the plant; (ii) foreign direct investment involving majority capital participation; (iii) licensing agreement with purely domestic firms; and (iv) outright purchase of technology through drawings and designs.

Sufficient data are not available to precisely

map out the relative importance of these four modes. However, available data indicate that the acquisition of technology via licensing or technical collaboration agreements was by far the most important, accounting for about 80 per cent of the collaborations approved between 1948 and 1988. (See Table 1).

An interesting inference, which can be drawn from Table 1, is that financial-participation cases that had averaged at around 34 per cent during the period 1960 - 1968, nearly halved during the next decade, that is the period 1969 - 1978, clearly reflecting a tighter policy. They once again rose and formed an average of 19 per cent of the cases approved during the post-1978 period, reflecting the liberalized policy. Another evidence for the declining importance of FDI is indicated in Table 2. However it was once again on the increase since 1991.

TABLE 1. FOREIGN COLLABORATION APPROVALS: 1948 TO 1991

Total	Total number of cases approved	Cases involving foreign capital participation	percentage share of 3 in 2
(1)	(2)	(3)	(4)
1948-55	284	-	-
1956	82	-	-
1957	81	-	-
1958	103	-	-
1959	150	-	-
1960	380	-	-
1961	403	165	40.95
1962	298	124	41.61
1963	298	115	38.59
1964	403	123	30.52
1965	241	71	29.46
1966	202	49	24.26
1967	182	62	34.07
1968	131	30	22.90
1969	134	29	21.64
1970	183	32	17.49
1971	245	46	18.78
1972	257	36	14.01
1973	265	34	12.83
1974	359	55	15.32
1975	271	40	14.76
1976	277	39	14.08
1977	267	27	10.11
1978	307	44	14.33
1979	267	32	11.99
1980	526	65	12.35
1981	389	56	14.40
1982	588	113	19.22
1983	673	129	19.17
1984	740	148	20.00
1985	1,041	256	24.59
1986	960	256	26.66
1987	903	259	28.68
1988	957	289	30.20
1989	639	212	33.18
1990	703	201	28.59
1991	976	298	30.53
Total	15,165	3,435	22.65

Source: *Foreign Collaboration - 1991 A Compilation:* (National Register of Foreign Collaboration), Department of Scientific and Industrial Research, (Delhi, p. 1).

TABLE 2. STOCK OF FOREIGN DIRECT INVESTMENTS AS A PER CENT OF GNP AND GROSS DOMESTIC INVESTMENT (GDI) STOCK

	Argentina		Brazil		India		S. Korea		Mexico	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
1967	10.6	7.4	11.1	9.1	3.1	2.3	1.6	1.7	7.3	6.2
1977-78	408	2.6	6.6	4.2	2.1	1.1	3.1	2.4	5.6	3.3

Notes: 1. FDI as a percentage of GNP; 2. FDI as a percentage of GDI stock
Source: C. Dahlman and F. Sercovitch, *Local Development and Export of Technology. The comparative Advantage of Argentina, Brazil, India, The Rublic of Korea, and Mexico*, World Bank Staff working Paper No. 667, 1984, Table 5.

The literature on technology transfer hypothesises that the cost of technology imports is likely to be higher when the technology is imported through FDI, owing to transfer pricing and other imperfection than through other ways [Stewart, 1984, Pp. 67-110]. Besides, under *ceteris paribus* conditions, there can be a positive correlation between the cost and the policy of technology import. It would be of special interest to see if regulation reduced cost. A view is sometimes expressed that the control on certain components of the technology price (say, royalty) has influenced a shift in payments: while the share of royalty in remittances abroad by private corporate sector companies has come down, the share of lump sum payments has gone up, confirming the above proposition. However, in order to make inter-temporal and inter-firm comparisons about the cost of technology imports and its relationship with regulatory policies, one has to compare the trends in the ratio of the price of technology to the value added *via* the collaboration. If this ratio has gone down during the period of regulation and moved up during that of liberalization, it is possible to conclude that regulation reduced cost.

One such exercise has been done by Subrahmanian by using the RBI Survey on Foreign Collaboration in Indian Industry [Subrahmanian, 1986]. His results are presented in the following Table:

TABLE 3. COST RATIOS BY TYPE OF COLLABORATION DURING THE THREE PHASES

	Phase I 1960-61 to 1963-64			Phase II 1964-65 to 1972-73			Phase III 1977-78 to 1980-81		
	S	M	T	S	M	T	S	M	T
1. Direct cost as a per cent of value of production (Variant i)[2]	3.4	1.7	0.80	2.45	1.70	0.50	1.3	1.2	0.3
2. Direct cost as a per cent o value of production (Variant ii)[3]	0.50	0.60	0.30	0.40	0.30	0.25	0.10	0.20	0.10

Notes: 1. S - Foreign subsidiaries; M -Indian companies with Minority foreign equity participation; T - Technical collaboration
2. Direct cost (Variant i) = Dividend + interest + royalty + technical fees and other components like payments to foreign technicians
3. Direct cost (Variant ii) = Direct cost (Variant i) - (Dividend + interest)
Source: Subrahmanian, K.K. *Technology Import-Regulation Reduce Cost*, Mimeograph, Centre for Development Studies, Trivandrum, p. 21, 1986.

Table 3 clearly shows that there has been an across-the-board fall in cost ratios during all the three phases. Also, the direct cost by all the subsidiaries was remarkably higher than the other two types during all the periods but the third phase. On the other hand, cost ratios of the companies with purely technical collaboration were the lowest. Thus, he concludes that 'a regulatory policy influencing the choice of technology import in less packaged forms such as purely technical collaboration agreement is desirable for reducing the cost of technical import and the consequent outgo of resources' [Subrahmanian, 1986]. This finding has been corroborated by another study by Alam [Alam, 1985*b*].

However, these studies refer only to the beha-

viour of the private sector, neglecting the experience of the public sector altogether. So, a re-examination of these issues is needed to see if the same line of reasoning holds good even when the experience of the public sector is taken into consideration.

If one accepts the above reasoning that the regulatory policies have helped in bringing down the direct cost of technology, it is also equally important to weigh the level of the experience that the Indian firms gained in the assimilation of that technology and the adaptation of it to local conditions. In other words, we are interested in the track record of domestic companies towards technological self-reliance. For examining this proposition, we adopt a working definition of the term: self-reliance. An enterprise will be deemed self-reliant in technology over a period of time, if its expenditure on imported technologies decreases relative to its expenditure on in-house R&D [Katrak, 1985, Pp. 213-229].

Employing this definition, Subrahmanian applies log-linear regression equations to the RBI survey data of expenditures on R&D (R/N) and those on technology import (M/N) for 10 years with respect to foreign collaboration [Subrahmanian, 1987, Pp. 420-446]. The period of study was from 1964-65 to 1980-81[3]. The results have been presented in Table 4.

TABLE 4. LOG-LINEAR REGRESSIONS EXPLAINING R&D EXPENDITURE BY FOREIGN COLLABORATIONS IN INDIAN MANUFACTURING IN THE PRIVATE CORPORATE SECTOR 1964-65 TO 1969-70 AND 1977-78 TO 1980-81

Dependent Variable	Independent variable	Coefficients		R^2
		a	b	
R/N	M/N	0.2946	0.8942*	
		(0.9178)	(0.8392)	0.3235
R/N	M1/N	0.2542	1.4461*	
		(1.091)	(4.8864)	0.4603

Notes: 1. R/N = average expenditure on R&D.
2. M/N = average direct cost of technology import (dividend + royalty + technical fees).
3. M1/N = average direct cost of technology import (royalty + technical fees).
4. The t-values are shown in parentheses; coefficients of 'b' are significant at 1 percent level.

From the above exercise, it can be concluded that, even with two variants of the direct cost of technology import, the track record of the companies with foreign collaboration was good both in the direction and extent of self-reliance. In other words, this means that these firms have generally moved along a "technology dependence - independence continuum", primarily because of the greater emphasis laid on the in-house R&D.

As a corollary to the above, we analyse the trends in in-house R&D in the industrial sector.

From Table 1, it is clear that the number of approved cases of foreign collaborations averaged around 660 per annum during the period 1980 - 1985, as against nearly 230 per annum during the period 1948 - 1978. We have also seen that deregulation raised the cost of technology imports. It is very essential then to absorb the borrowed technology and also to develop the local capability. In this light, the role of in-house R & D in industry assumes greater importance now than ever before.

Secondly, the government has sought to develop an indigenous technological capability through the Council of Scientific and Industrial Research (CSIR). The CSIR has grown into a major institution with research laboratories, extension centres and regional stations spread throughout the country. A need for integrating these laboratories with in-house R&D units, especially those in the public sector, has been emphasized by successive governmental committees[4].

As seen earlier, the country's strategy for technological development has been guided by the goal of self-reliance, consistent with the emphasis on across-the-board import substitution. While substantially restricting the inflow of imported technology, government policies have consistently promoted the indigenous generation

of technological knowledge and allocated considerable resources for the purpose. These policies manifested themselves in providing recognition to in-house R&D units, a scheme that has been operative since 1973. One of the objectives of this scheme has been to provide liberalized import facilities to recognized R&D units for equipping their laboratories with equipment, components, raw materials, etc., necessary for the R&D work. Apart from this, in order to encourage the utilization of in-house R&D results for commercial exploitation, an entrepreneur (other than MRTP and FERA companies), who wishes to manufacture items based on indigenously developed technology, shall be exempted from industrial licensing. This latter provision has been made available since 1976 only. Thirdly, research within the industry has been encouraged by fiscal incentives, and certain provisions of the Income Tax Act have been specifically directed to encourage in-house R&D[5]. Fourthly, the National Research Development Corporation has been set up to license the technologies developed by the CSIR network of laboratories. Finally, in order that indigenous R&D efforts may culminate into successful commercial ventures, adequate term finances have been assured by the government through various schemes launched within its development banks like IDBI, ICICI, IFCI, and SFCs.

The combined effect of these numerous schemes was a manifold increase in the number of recognized in-house R&D units from about 100 in 1973 to about 900 in 1986, (by nearly 800 per cent). In terms of the share of the gross national product (GNP) devoted to R&D, India (0.96 per cent GNP in 1984-85) is second only to the Republic of Korea (1.1 per cent GNP in 1983) among the developing market economies and is ahead of such countries as Brazil (0.6 per cent GNP in 1982) and Pakistan (0.2 per cent GNP in 1977).

The next task would be to see certain indicators of selected technology expenditure. This is presented in Table 5.

TABLE 5. SELECTED TECHNOLOGY EXPENDITURES

(Rs in crores)

	1976-77	1977-76	1978-79	1979-80	1980-81	1981-82	1982-83	1983-84	1984-85	1985-86	1986-87
1. R&D expenditure	374	431	529	639	761	941	1,159	1,381	1,841	2,224	2,693
2. Payments for royalty of technology know-how[1]	54	48	69	54	114	287	298	342	329	391	399
3. Technical development Funds disbursements[2]	0.00	3.00	4.00	8.00	35	25	31	36	50	60	69
4. Capital goods imports (including precision equipment)	1,048	1,110	1,228	1,368	1,821	1,981	2,231	3,174	3,027	4,084	6,279
5. Technology expenditure as a proportion of gross domestic investment	9.2	8.9	8.1	8.8	9.2	9.3	9.0	11.0	11.0	11.0	15.0

Notes: 1. Refers to payment by private sector firms only; 2. This is for the import of drawings and designs, training of Indian technicians abroad, etc., administered by the IDBI; 3. This is taken as the payment for embodied technology imports.
Source: 1 and 2: DSIR, 3 and 4: IDBI.

Average technology expenditure amounts to about 1 1 per cent of the GDI - a significantly lower figure, as compared to other developing countries such as Brazil and Mexico for which it stands at around 14 per cent of the GDI. The comparable figure for South Korea is about 29 per cent.

Table 6 provides a break down of the expenditure incurred since 1976-77 for R&D in Indian industries from public and private sectors.

TABLE 6. DISTRIBUTION OF INDUSTRIAL R&D IN INDIAN PUBLIC AND PRIVATE SECTORS 1976-77 TO 1984-85

(Rs lakh at constant prices: 1970-71)

	Public Sector			Private Sector			Total Industrial Sector	
	Total		Average per firm	Total		Average per firm	Total	Average per firm
1976-77	1915.42	(40)	36.84	2920.03	(60)	7.70	4835.45	11.22
1977-78	2175.71	(39)	41.84	3377.57	(61)	8.91	5553.28	12.88
1978-79	3141.52	(42)	50.67	4319.27	(58)	9.19	7460.79	14.02
1979-80	3634.10	(44)	58.61	4561.49	(56)	9.17	8295.59	15.41
1980-81	3851.10	(42)	56.63	5381.58	(58)	8.97	9232.83	13.82
1981-82	4407.41	(42)	64.81	6023.91	(58)	10.04	10431.32	15.62
1982-83	4634.98	(38)	57.94	7455.34	(62)	9.14	12090.32	13.49
1983-84	5575.00	(44)	69.69	7167.37	(56)	8.79	12742.37	14.22
1984-85	7655.91	(50)	95.70	7688.12	(50)	9.42	15344.03	17.13
Point to Point Compound average annual growth rate (in per cent)			12.67					5.43

Note: Figures in parentheses indicate percentage share of the total.
Source: Adaptation of Table 1, *Research and Development in Industry, 1984-85*, Department of Science and Technology, New Delhi, p. 47, 1986.

A striking feature is the extremely low share of industrial R&D in the total national expenditure on R&D - about 26 per cent of the national R&D and 0.25 per cent of the gross national product. Within the industrial sector, on an average, the public sector accounted for 42 per cent and the private sector, 58 per cent for the period 1976-77 through 1984-85. Particularly noteworthy is the higher average expenditure per firm in the public sector, from nearly five times that in the private sector in 1976-77, became eleven times that in the private sector in 1984-85. It grew at an impressive rate of 13 per cent per annum. The relatively higher R&D expenditure per firm in the public sector can be attributed to the fact that public sector firms operate in high technology areas where heavy R&D investment is necessary. Moreover, it can also mean that the increasing research consciousness of Indian industries is mainly due to the public sector, which, as the instrument of state policy towards technological self-reliance, has the necessary mandate for developing indigenous technological capability. This is further corroborated by the higher research intensity of the public sector, defined as the ratio of expenditure on R&D to total sales turnover, which works out to be nearly 0.80 per cent as against 0.50 per cent for the private sector (in 1984-85).

Nevertheless, the volume and intensity of R&D efforts among Indian manufacturing firms remained low. Here, of course, the public sector was better in performance than the private sector. Organized in-house R&D was indeed concentrated in a few industrial groups like electrical and electronics, chemicals, drugs and pharmaceuticals and engineering goods. What is striking is the low research intensity of the private sector, especially in technology-intensive industries like electronics (see Table 7).

The level of technological competence is a function of not only the volume of resources allocated to technology development, but also how the technology is managed *per se* at the firm level. Subrahmanian's analysis of the private corporate sector revealed that there was a positive correlation between the expenditure on R&D and the cost of technology import, implying complementarity between the two. This was corroborated by another finding by Alam, showing that import of technology was often accompanied by a comparable expenditure on R&D activities by the technology importers [Alam, 1985, p. 11]. However, no one has analysed this proposition systematically for the public sector.[6]

Our proposed study is envisaged to fill this gap in literature. Moreover, in these days of economic liberalization when technological upgradation is given prime importance, the performance of the public sector with respect to (a) the conditions under which technology is being imported, and (b) the efforts that are being made towards technological self-reliance, warrants a closer look.

TABLE 7. RESEARCH INTENSITIES IN VARIOUS INDUSTRIAL GROUPS 1980-81 - 1984-85

(per cent)

	1980-81 to 1984-85	
	Private Sector	Public Sector
1. Electronics and Electrical Equipments	0.72 - 1.06	2.00 - 2.16
2. Chemicals	0.87 - 1.66	0.43 - 0.79
3. Drugs and Pharmaceuticals	1.72 - 2.26	1.54 - 3.05
4. Industrial Machinery	1.03 - 1.30	0.35 - 0.68
5. Machine Tools	0.30 - 2.44	0.42 - 0.97
6. Telecommunications	1.33 - 2.75	6.96 - 8.40
7. Metallurgical Industries	0.19 - 0.53	0.24 - 1.21
8. Rubber Goods	0.42 - 0.51	2.05 - 2.05

Source: *R&D in Industry*, Department of Science and Technology, 1982-83 and 1984-85.

II

THE FRAMEWORK FOR ANALYSIS

For this purpose, we have distinguished two components of the cost of technology imports: the direct cost which is quantifiable in money terms and the indirect cost which is non-quantifiable in money terms. The latter stems from the various kinds of restrictions imposed on the host company, like the direction of exports, prevention of sublicensing the technology to a third party or R&D and improvements on the borrowed technology. However, owing to limitations of data, the enumeration of these costs has been difficult.

We have analysed the cost of public sector collaborations in terms of both the direct and indirect components, only on the basis of the RBI survey data. Since the data on restrictive clauses were not available, our own estimates of the cost were solely in terms of the direct one. We define the direct cost (IDC) as follows:

IDC = Royalty + technical know-how fees + Cost of payments to foreign technicians + training cost on Indian technicians + interest on deferred credit.

In short, we are basically concerned with an examination of the explicit price of technology.

The determination of the price of technology is largely dependent on the relative bargaining power of the buyer and the seller and on the given market availability [Vaitsos, 1974]. However, in countries such as India, the price of technology is somewhat controlled by regulatory policies. Moreover, owing to the backing of the state, the price of technology to a public sector firm ought to be lower than that to its counterpart in the private sector, for comparable technologies. However, the non-availability of comparable data rendered a comparative study impossible.

The process of technology transfer in underdeveloped countries can be characterised in two phases. The first phase, called "the phase of introduction and incorporation" or "the phase of acquisition", relates to the general conditions under which technology is transferred or imported from abroad. The second phase, called "the phase of technological learning" relates to the process of local inventive activities which have taken place to improve upon or adapt the technologies after import. Much of the recent work on "technological dependence" in underdeveloped countries has been devoted to the analysis of the first phase. The second phase has received much less attention. We will examine both the phases and analyse the relationship between them.

For analysing the second phase, we need to operationalize the concept of 'technological self-reliance' for a newly industrializing country like India. When the level of technology in the rest of the world is constantly advancing, technological self-reliance here can be taken to imply an improvement in the technological capability of enterprises over those in other countries. In short, an enterprise will be considered to be moving towards the goal of self-reliance over a period of time, provided its expenditures on imported technology decrease relative to its expenditures on R&D.[7]

The nature of the relationship between domestic R&D and technology import has to be spelt out for a developing country. We shall elaborate this

below:

The technological level of any country is a function of technology import, domestic R&D and the relationship between the two.[8] In a developed country, this relationship can be one of substitution while in a developing country, this relationship is expected to be complementary in nature. This line of reasoning is based on the following hypothesis.

Technology is location-specific. So, the borrowed technology, especially from advanced countries, needs to be adapted to the local conditions. Analytically, we can split the process of adaptation into one or more of the following categories:

i) changes in the product in accordance with local market conditions;
ii) adaptation of the product and/or the process to take account of the special features of local raw material supplies;
iii) adaptation of the process to local physical conditions (climate, temperature, etc.);
iv) modifications of the technological process to take account of the relative price of various factors of production.

The process of adaptation is usually done in the in-house R&D units of the firms that have imported technology. Thus, the expenditure on R&D can be taken as that on the adaptation of imported technology. One would then expect a positive correlation between the cost of technology import and the expenditure on R&D. This implies that the relationship between the two is complementary. In fact, this proposition has been empirically substantiated for the Indian Private Corporate Sector by Desai, Alam and Subrahmanian [Alam, 1985].

Alam's study of nearly 200 Indian firms for the period 1975 - 1984 found that ".....there is a close and positive relationship between technology imports and R&D activities by Indian firms. Firms, which import technology, also more often undertake R&D..... The amount of R&D expenditures is also found to be directly related to technology payments; firms with large technology payments are found to spend large sums on R&D." This finding clearly suggests that the import of technology is often accompanied by a comparable expenditure on R&D activities, by the technology importers.

The logical sequence of this is that the more R&D a firm does, the more knowledgeable it becomes, so that the next time the firm goes to borrow a technology it is in a much better position. Therefore, given the fact that technology transactions depend largely upon the relative bargaining power of the buyer and seller, the buyer can now bargain and bring down the cost of technology imports under *ceteris paribus* conditions.

Following Katrak, we can transliterate this economic hypothesis into a statistical one. On the basis of the above arguments, we define the following two concepts [Katrak, 1985, Pp. 213-229].

The first one, the "propensity to adapt", is defined as the ratio of expenditures on adaptive R&D to payments for imported technology. An increase in propensity will mean that the firm is becoming more self-reliant in technology.

The concept of "propensity to adapt" is a static one. Therefore, it is important to define another concept, "the elasticity of R&D with respect to technology import". This is given by the relative change in adaptive R&D to a proportionate change in the cost of technology import. If the coefficient of elasticity is greater than unity, we can say that the firm is becoming more self-reliant. If it is less than unity, we can interpret the performance of the firm, in respect of technological self-reliance, as poor. It needs to be emphasized that the technology-importing enterprise moves along a technology dependence - independence continuum, i.e., that it never reaches the status of absolute self-reliance.

If we denote IDC as the cost of technology import and RAND as the expenditure on adaptation, then the

Average propensity to adapt = RAND/IDC
Marginal propensity to adapt = δRAND/δIDC

$$\text{Elasticity of RAND with respect to IDC} = \frac{\text{MPA}}{\text{APA}} = \frac{\delta\text{RAND}/\delta\text{IDC}}{\text{RAND/IDC}}$$

A practical way of estimating this relationship is to run a log-linear regression of the form:

$$\log \text{RAND} = a + b \log \text{IDC}$$

with RAND as the dependent variable and IDC as the independent variable, and then to interpret both the sign and magnitude of the coefficient of the independent variable. The sign would indicate whether the relationship between the two variables is complementary or substitutive, and the magnitude would indicate the degree of self-reliance.

It is important to highlight three aspects of the definition of technological self-reliance. First, as mentioned earlier, technological self-reliance does not imply that the country, sector or firm ceases to import any technology. Secondly, the definition implies how far the experience gained by assimilating and adapting previously imported technologies may affect the firm's bargaining power during the subsequent import of technology. Thirdly, the definition of technological self-reliance is solely in terms of cost. Desai mentions four components of indigenous technological capability, namely,

a) price of technology: quality of technology, as judged by its operation, cost and quality of product.
b) plant operation: productivity of inputs.
c) duplication and expansion: unassisted expansion or duplication of plant, transfer of concomitant technology.
d) innovation: modification of received technology, marketable innovations of product or process.

Although the above classification is comprehensive, it is too 'data demanding' to be operationalized, except at a specific enterprise level [Desai, 1984, Pp. 245-261].

The scope of the study will be the entire Indian Public Sector, that is, the firms that have imported technology over a 12-year period (1973-74 through - 1984-85). The analysis is conducted both at the aggregate level and at the sectoral level, using the Bureau of Public Enterprise classification scheme.

As a corollary of the above, we shall analyse the dependence of the public sector firms on imported technology. This warrants a closer look, because it is sometimes said that there is an inverse relationship between technology import and net foreign exchange inflow. To facilitate intersectoral comparisons, we define the concept of "Net Foreign Exchange Inflow Ratio" (NFIR) as follows:

$$\text{NFIR} = \frac{\text{Exports} - (\text{Imports of goods} + \text{Imports of technologies})}{\text{Exports}}$$

Data Sources

(I) A list of public sector enterprises with foreign collaboration was drawn using the *Directory of Foreign Collaborations* released by the Indian Investment Centre. This was supplemented by the information contained in the document entitled *Foreign Collaborations* released by DSIR. In this process, a complete list was made of all the public sector enterprises that have/had foreign collaboration during the period 1948 to 1986.

(II) These enterprises numbered 79, which were then divided into 13 sectors. Our study is restricted to the enterprises solely under the management of the Central Government. (There are a few state-owned public sector enterprises, which have imported technology but, which have not been covered in the present study).

(III) These enterprises were then classified into 13 industrial groups, based mainly on the Bureau of Public Enterprise Survey classification system. For instance, 'electronics' enterprises were differentiated from "medium and light engineering sector"; "pharmaceutical" enterprises, from the "fertilizer, chemical and pharmaceutical" sector; and "shipbuilding", from the "transport equipment" sector. The resultant 13 sectors are listed below in an alphabetical order.

Sector-wise Classification of Public Sector Enterprises with Foreign Collaboration

Sr.No.	Sector
1.	CONSULTANCY AND CONSTRUCTION (Cand C).
2.	CONSUMER GOODS (Consu).
3.	ELECTRONICS (Elect).
4.	FERTILIZER AND CHEMICALS (Ferch).
5.	HEAVY ENGINEERING (Heavy).
6.	MEDIUM AND LIGHT ENGINEERING (Medium).
7.	METALS AND MINERALS (Mine).
8.	PETROLEUM (Petro).
9.	PHARMACEUTICALS (Pharm).
10.	SHIPBUILDING (Shipb).

11. STEEL (Steel).
12. TRADING AND MARKETING (Tranm).
13. TRANSPORT EQUIPMENT (Trans).

IV) Data on the direct cost involving technology imports, imports of capital goods, raw materials, spares and components, etc., and total exports, were acquired from the profit and loss accounts of the enterprises. These data were available only from 1973-74 to 1984-85.

V) Expenditure on R&D for these firms was obtained from the Department of Science and Technology publications entitled *R&D Statistics* and *R&D in Industry*. Unpublished data were collected from the DST itself and from the DSIR publication entitled *Compendium on In-House R&D Centres*.

VI) The major secondary source considered was the successive RBI Surveys on Foreign Collaborations and the COPU Reports.[9]

Limitations

It must be explicitly stated that we have employed a very narrow framework for analysing technological self-reliance, because of data constraints. If one had adopted the framework proposed by Desai, the analysis would certainly have been richer, but it was extremely difficult to obtain adequate data, even for a specific firm, leave alone, for the entire public sector.

III

TRENDS IN FOREIGN COLLABORATION IN INDIAN PUBLIC SECTOR: 1948 TO 1986

We shall start with the survey of the trends in foreign collaboration in the Indian public sector. As per the Industrial Policy Resolution of 1956, certain areas of strategic importance or the areas where the technology was complex and the investments were lumpy, were reserved for the public sector. For establishing such units, given the technological base of the country, reliance was placed on a foreign source of technology. However, some amount of care was exercised as not to go in for an across-the-board reliance on foreign sources. The trends in collaboration approvals since 1948 are presented in Table 8.

TABLE 8. NUMBER OF CASES OF FOREIGN COLLABORATIONS APPROVED IN INDIAN PUBLIC SECTOR ENTERPRISES (1948 TO 1988)

Year	Total Number of cases approved	Of which involving public sector	Percentage share of public sector cases in total
1948 to 1959	700	18	2.57
1960	380	10	2.63
1961	403	5	1.24
1962	298	3	1.01
1963	298	4	1.34
1964	403	6	1.49
1965	241	11	4.56
1966	202	10	5.84
1967	182	8	4.40
1968	131	7	5.34
1969	134	11	8.21
1970	183	10	5.46
1971	245	15	6.12
1972	257	16	6.23
1973	265	20	7.17
1974	359	16	4.46
1975	271	23	8.12
1976	277	22	7.94
1977	267	29	10.86
1978	307	26	8.47
1979	267	21	7.87
1980	526	46	8.75
1981	389	31	7.97
1982	588	42	7.14
1983	673	50	7.43
1984	740	49	6.62
1985	1,041	53	5.09
1986	960	40	4.17
1988	957	58	6.06
1948 to 1988	11,944	660	5.14

Source: Column 2: Foreign Collaboration - 1986 (*A Compilation: National Register of Foreign Collaboration*, Department of Scientific and Industrial Research, New Delhi, 1987 p. XVI)
Column 3: Compiled from *Directory of Foreign Collaborations*, Indian Investment Centre, New Delhi, various issues.

An analysis of the Table reveals that in the early period (that is, up to the mid-sixties), the relative share of the public sector had increased to nearly 5 per cent, but a few years thereafter (for instance, in 1977), it accounted for nearly 11 per cent. The effect of economic liberalization since 1978 is clearly seen in the number of approved cases of collaborations averaging at nearly 39 cases per annum (during the period 1978-1986) as against a low figure of 12 cases per annum in the pre-1978 phase). The number of approved cases thus registered a compound average annual growth rate of nearly 6 per cent for the public sector. The corresponding growth rate for the industrial sector as a whole was 4 per cent.

Bulk of the collaboration agreements in the public sector were purely technical collaboration agreements, though there were a few with foreign equity participation. The particulars of such enterprises are given below (Tables 9 and 10).

TABLE 9. PUBLIC SECTOR ENTERPRISES WITH FOREIGN EQUITY PARTICIPATION (AS ON 31/3/1986)

(Rs in lakh)

Sl.No.	Name of the enterprise	Foreign equity	Total equity	Percentage share of foreign equity
1.	Balmer Lawrie	1	287	0.35
2.	Biecco Lawrie	8	117	6.84
3.	Cochin Refineries	185	700	26.43
4.	Ferro Scrap Nigam	80	200	40.00
5.	HMT Bearings	24	295	8.14
6.	I.B.P. Co	5	290	1.72
7.	Lubrizol	192	480	40.00
8.	Madras Fertilisers	669	1,365	49.01
9.	Madras Refineries	334	9,825	3.40
10.	Maruti Udyog	883	5,720	15.44
11.	Rashtriya Ispat Nigam*	4,041	2,20,078	1.84
12.	Triveni Structurals	147	750	19.60

Note: * Unit under construction; the foreign participation is mainly by NRIs.
Source: *Public Enterprise Survey, 1985-86*, Volume 1, Bureau of Public Enterprise, Government of India, New Delhi, 1986, Pp. 135-143.

TABLE 10. INDUSTRY WISE DISTRIBUTION OF FOREIGN COLLABORATION APPROVALS IN THE INDIAN PUBLIC SECTOR (CUMULATIVE FOR 1960 TO 1986)

Industry	Total Number of approvals	
1. Consultancy and Construction	34	(6.01)
2. Consumer Goods	18	(3.11)
3. Electronics	49	(8.48)
4. Fertilizer and Chemicals	53	(9.17)
5. Heavy Engineering	195	(33.74)
6. Medium and Light Engineering	113	(19.55)
7. Metals and Minerals	24	(4.15)
8. Petroleum	22	(3.81)
9. Pharmaceuticals	9	(1.56)
10. Shipbuilding	12	(2.08)
11. Steel	26	(4.50)
12. Trading and Marketing	9	(1.56)
13. Transport Equipment	14	(2.42)
Total	578	(100.00)

Note: Figures in parentheses indicate percentage share of the total.
Source: Compiled from the *Directory of Foreign Collaborations*, Indian Investment Centre, New Delhi, various issues.

Foreign equity participation ranges from as high as 49 per cent in the case of Madras Fertilizers to as low as 0.35 per cent in the case of Balmer Lawrie. Equity participation in some of the companies is explained by the fact that they were essentially sick private sector firms which were nationalised. One sector, which accounts for the maximum number of enterprises with foreign equity participation, is petroleum – a sector which was essentially in the hands of the private sector before the mid-seventies.

We now look at the industry-wise distribution of public sector enterprises with foreign collaboration between 1960-1986. This is presented in Table 10.

It is seen that the heavy engineering sector tops the list, with medium and light engineering occupying the second position. What is striking is the relatively high share of consultancy and construction sector. This sector, which was specifically established as an indigenous source to deal with foreign turnkey agreements, was itself dependent on foreign sources of technology. It will be interesting to see its relative share in the total direct cost of technology imports.

The number of foreign-collaboration enterprises in each industry till 1985 is shown in Table 11. We find that in all major sectors, especially in the manufacturing sector with the sole exception of pharmaceutical industry, roughly more than half the number of firms have/had foreign collaborations. Table 12 presents the 10 largest importers of foreign technology in terms of the number of collaboration approvals.

TABLE 11. INDUSTRY-WISE DISTRIBUTION OF PUBLIC SECTOR ENTERPRISES WHICH HAVE/HAD FOREIGN TECHNICAL COLLABORATION

	Industry Group	Total Number of enterprises within each industry group[1]	Number of enterprises within each group with foreign collaboration[2]	
1.	Consultancy and Construction	15	9	60.00[3]
2.	Consumer Goods	15	5	(33.3)
3.	Electronics	5	5	(100.00)
4.	Fertilizer and Chemicals	14	6	(42.86)
5.	Heavy Engineering	13	10	(76.92)
6.	Medium and Light Engineering	14	11	(78.57)
7.	Metals and Minerals	13	9	(69.23)
8.	Petroleum	11	9	(81.82)
9.	Pharmaceuticals	12	2	(16.66)
10.	Shipbuilding	6	4	(66.66)
11.	Steel	2	2	(100.00)
12.	Trading and Marketing	19	4	(21.05)
13.	Transport Equipment	6	3	(50.00)
	Total	145	79	(54.48)

Note: 1. As on March 31, 1985; 2. Total Number of enterprises with approved foreign collaboration agreements between 1948 and 1985; 3. Figures in parentheses indicate percentage share of total.

TABLE 12. THE 10 LARGEST IMPORTERS OF FOREIGN TECHNOLOGY IN THE INDIAN PUBLIC SECTOR (in terms of collaboration approvals)

Rank	Name of enterprise	Year of incorporation/ takeover	Total number of collaboration approvals, 1950 to 1986	
1.	BHEL	1964	89	(15.00)
2.	HMT	1953	58	(10.00)
3.	HEC	1956	34	(6.00)
4.	IPCL	1969	24	(4.00)
5.	MAMCO, SAIL	1965, 1973	23	(4.00)
6.	BEL	1954	20	(3.00)
7.	ECIL	1967	15	(2.50)
8.	Instrumentation	1964	14	(2.35)
9.	ITI	1950	12	(2.01)
10.	EILC, Andrew Yule And Praga Tools	1965, 1979 1959	11	(1.85)
	Total (for the top 10)		345	(57.89)

Note: Figures in parentheses indicate percentage share of each firm in total public sector collaboration approvals. (See Table 1)

The Table shows that 13 enterprises account for nearly 57 per cent of the total collaboration approvals and, among them, BHEL alone accounts for nearly 15 per cent, suggesting a highly skewed distribution of collaboration approvals.

After analysing the distribution of collaboration approvals industry-wise and firm-wise, we now turn to the sources of foreign technology in the Indian public sector.

In the initial period, the main source of foreign technology was the "Soviet Bloc". In fact, the major steel plant (Bhilai) and important engineering firms like BHEL, HEC, etc., have come up with Soviet and other East European technology. This reliance on East European technology was prompted, primarily by the availability of deferred credit facility from these countries [Kidron, 1965, p. 225]. To illustrate, the first major credit agreement with the USSR was signed in 1955 for the Bhilai Steel Plant. This was followed by seven other agreements with the Soviet Union till 1968, thereby making India the largest recipient of Soviet economic aid. Similar credit agreements were also signed with other East European countries like Czechoslovakia, East Germany, Hungary, Poland and Rumania. Second, there was also reluctance on the part of some Western Block countries to associate themselves with the state-owned industrial projects in a developing country like India. However, Kidron notes that it is the capital barrier that prompted the country to turn to the Eastern block [Kidron, 1965, p. 226]. He observed that, had the Western aid agencies and governments been more flexible doctrinally or had the Western collaborators been able to offer better terms, the public sector might have put on a different colour [Kidron, 1965, p. 227]. In fact, the major machine tool manufacturer, HMT, came up through a turnkey arrangement with a Swiss firm, and the leading telecommunication equipment manufacturer, ITI, was established through an equity participation with an English firm. Finally, most of the public sector enterprises with equity participation have the Western block and Japan as their collaborators (see Table 9).

Currently, about 80 per cent of the public sector collaborations are contracted with Western and Japanese companies (see Table 13).

TABLE 13. COUNTRY-WISE DISTRIBUTION OF FOREIGN COLLABORATION APPROVALS IN INDIAN PUBLIC SECTOR
(in per cent, cumulative for 1974 through 1986)

Source of technology	Percentage share
1. West Germany	25
2. U.K.	14
3. Other Western European Countries	21
4. USA	16
5. JAPAN	10
6. USSR	4
7. Other Eastern European Countries	7
8. Others	3
Total	100

Source: Complied from the *Directory of Foreign Collaborations in India*, Indian Investment Centre, New Delhi, various issues.

We find that, among the various sources, West Germany seems to be the major exporter of technology to the public sector. Japan also occupies an important position. The share of the USSR and other East European countries appears to be quite low. This is mainly due to the type of technology being imported now.

We turn to the direct cost of technology imports by the public sector during the period 1973-74 to 1984-85. The period of study, the sources of data and the definition of terms have already been explained. The direct cost is presented in Table 14.

TABLE 14. DIRECT COST OF TECHNOLOGY IMPORT: PRIVATE VERSUS PUBLIC SECTOR

(Rs in crore)

Year	Private sector		Public sector		Total industrial sector
1973-74	95.98	(75.51)	31.13	(24.49)	127.11
1974-75	83.37	(62.82)	49.35	(37.18)	132.72
1975-76	106.00	(68.27)	49.27	(31.73)	155.27
1976-77	146.65	(73.92)	51.74	(26.08)	198.39
1977-78	148.71	(64.01)	83.62	(39.99)	232.33
1978-79	118.50	(67.38)	88.01	(42.62)	206.51
1979-80	144.00	(69.36)	63.60	(30.64)	207.60
1980-81	168.30	(57.64)	123.69	(42.36)	291.99
1981-82	398.90	(71.88)	156.06	(28.12)	554.96
1982-83	468.00	(80.96)	110.07	(19.04)	578.07
1983-84	NA	-	95.04	-	-
1984-85	NA	-	110.60	-	-
Average percentage share		(68.18)		(31.82)	

Note: 1. Figures in parentheses indicate percentage share of the total; 2. Public sector includes only those units under the ownership of the Central Government.

It is seen that, during the 12-year period (1973-74 through 1984-85), the public sector accounted for an average of 32 per cent in the total outgo, though there were year-to-year variations. During the same period, it had a share of about 7 per cent in the total number of collaboration approvals. In other words, seven per cent of the collaboration approvals accounted for one-third of the cost of technology imports. There was thus a wide scope and coverage in public sector collaboration agreements that essentially focussed on sophisticated areas of technology like heavy engineering. Of late, the share of public sector has come down, though, owing to data constraints no definite inferences can be drawn. However, during the period 1973-74 to 1982-83, the cost of technology imports by the private sector registered a higher compound average value (19 per cent) in the annual growth rate. The corresponding growth rate for the public sector was 15 per cent and, for the industrial sector, as a whole, it was 18 per cent.

The industry-wise distribution of the direct cost during the period 1974-85 is presented in Table 15.

TABLE 15. INDUSTRY-WISE DISTRIBUTION OF DIRECT COST OF TECHNOLOGY IMPORT BY INDIAN PUBLIC SECTOR ENTERPRISES

(Rs in lakh)

	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
C & C	61.20	130.47	267.16	364.13	722.13	932.26	1,005.62	1,698.81	1,523.72	1,251.74	1136.56	975.64
Consu	47.40	1809.97	26.69	7.15	5.31	8.82	50.85	9.86	2.96	2.84	1.93	201.82
Elect	40.40	22.01	36.34	80.34	69.48	68.50	58.78	80.22	142.81	1,103.40	573.19	698.16
Ferch	1,300.79	1,666.32	1,834.04	1,527.53	1,901.68	1,077.99	659.11	555.07	804.87	671.37	94.47	1,981.19
Heavy	448.90	600.13	748.98	1,370.68	2,588.35	3,860.87	3,364.00	5,637.09	5,579.11	3,053.62	2,485.73	2,281.11
Mediu	59.05	49.42	78.47	156.15	194.14	510.88	116.30	110.75	207.85	251.71	668.30	704.18
Mine	52.52	50.61	90.64	497.53	1587.64	888.63	391.02	759.60	2783.47	1,180.16	59.68	203.32
Petro	47.72	66.97	1085.44	857.33	1091.71	836.57	469.95	578.33	625.54	517.14	1,490.54	1,724.45
Pharm	0	0	0.26	22.56	6.94	9.73	10.49	1.50	0.73	1.87	0.38	5.46
Shipb	132.64	514.81	733.80	153.60	159.28	81.04	98.24	38.40	241.67	2,231.99	2,756.13	1,287.46
Steel	0	0	0.27	2.23	7.65	466.65	0	2835.22	3492.43	519.11	0.39	0.39
Tranm	0	0.12	0	0.46	0.57	0.31	0.55	0.00	0.66	0.93	0.39	0.00
Trans	22.28	24.29	24.54	33.86	26.95	58.82	135.04	64.30	200.03	221.84	136.15	97.18

Source: See Table 9.

Table 16 presents the sector-wise ranking in the cost of collaborations as well as in the number of collaboration approvals for the same period.

There does not seem to be a positive, rank correlation between the share in cost and the number of approvals. The consultancy and construction sector, as noted before, accounts for a large percentage in the share of the total direct cost. Care should be exercised in interpreting such average shares, because, as seen in Table 16, there were sharp year-to-year fluctuations in some of the sectors like consumer goods, fertilizer and chemicals, etc.

TABLE 16. RELATIVE SHARE OF VARIOUS INDUSTRY GROUPS IN THE TOTAL DIRECT COST OF TECHNOLOGY AS WELL AS THE NUMBER OF APPROVALS (AVERAGE PERCENTAGE SHARE DURING 1973-74 TO 1984-85)

Rank industry group	Average percentage share in	
	Direct cost	Number of collaboration approvals
1. Heavy Engineering	29	34
2. Fertiliser & Chemical	19	9
3. Pertroleum	10	4
4. Shipbuilding	9	2
5. Consultancy and construction	8.97	6
6. Metals and Minerals	7	4
7. Consumer Goods	6	3
8. Steel	5	5
9. Medium and light Engineering	3.5	18
10. Electronics	2.5	9
11. Transport Equipment	0.92	2.5
12. Pharmaceutical	0.07	2
13. Trading and marketing	negligible	9
Total	100.00	100

In the foregoing, we have seen the broad trends in foreign collaboration in the Indian public sector. The major conclusion that can be drawn is that the public sector having 7 per cent of the approvals accounts for one-third of the total payments made for technology. The industry-wise distribution of the cost of collaboration shows that five sectors, namely, heavy engineering, fertilizer and chemicals, petroleum, shipbuilding and consultancy and construction, account for nearly three-fourths of the total cost. The medium and light engineering and the electronics, though having a significant proportion of the number of collaboration approvals account only for a small share in the total cost. But, when one considers the year-wise percentage share, the picture is entirely different: these sectors possess a relatively higher share.

We shall analyse the relationship between technology imports and R&D activities of the public sector to examine technological self-reliance, using the RBI survey data and subsequently using our own estimates.

IV

TECHNOLOGICAL DEPENDENCE IN INDIAN PUBLIC SECTOR: AS SEEN THROUGH THE RBI SURVEYS

The RBI survey is the only published source of data on foreign collaboration in government-owned companies.

Table 17 presents the number of public sector enterprises and agreements covered in the successive RBI surveys.

TABLE 17. NUMBER OF PUBLIC SECTOR ENTERPRISES AND AGREEMENTS COVERED

	Survey periods		
	First Survey 1960-61 to 1963-64	Second Survey 1964-65 to 1969-70	Fourth Survey 1977-78 to 1980-81
1. Number of enterprises covered (of which number of enterprises with technical collaboration)	24 (24)	41 (39)	26 (22)
2. Number of agreements	70	163	93
3. Average number of collaborations per enterprise	3	4	4

From the Table, it is clear that the coverage of public sector enterprises in the RBI surveys is quite limited, especially in the fourth survey. There is also a gap in the data, as there is no information available for the period 1970-71 to 1976-77. Nevertheless, foreign collaboration agreements have registered an average increase of about 33 per cent between the first and the fourth survey.

In Table 18, we analyse the country-wise source of technology.

TABLE 18. COUNTRY-WISE SOURCE OF FOREIGN TECHNOLOGY: RBI SURVEY
(in per cent of the total number of collaboration agreements)

	1960-61 to 1963-64	1964-65 to 1969-70	1977-78 to 1980-81
U.S.A.	20	16	27
UK	23	21	12
West Germany	9	15	12
Other Western European countries	11	12	16
USSR	7	6	12
Other Eastern European countries	7	7	
Japan	11	9	17
Others	12	14	4
Total	100	100	100

The Table confirms our earlier finding: the Western-bloc countries provided the major source of technology in both the sixties and the seventies, while the share of the Communist block was stagnant (see Table 13). However, one cannot make a firm conclusion about the country-wise source, probably because the results are sensitive to the differing coverage in the successive surveys.

The industry-wise distribution of the number of collaboration agreements is presented in Table 19.

TABLE 19. INDUSTRY-WISE CLASSIFICATION OF AGREEMENTS

Industry	1960-61 to 1963-64		1964-65 to 1969-70		1977-78 to 1980-81	
Mining and Petroleum	12	(17)	15	(9)	7	(8)
Manufacturing	58	(83)	148	(91)	86	(92)
Transport equipment	4	(6)	14	(9)	4	(4)
Machinery and machine tools	16	(23)	39	(24)	19	(20)
Metals and metal products	8	(11)	16	(10)	4	(4)
Electrical goods and machinery	15	(21)	54	(33)	18	(19)
Chemicals and chemical products	10	(14)	20	(12)	33	(35)
Miscellaneous	5	(7)	5	(3)	5	(5)
Services	-		-		3	(3)
Total	70	(100)	163	(100)	93	(100)

Note: Figures in parentheses indicate percentage of the total.

From the above, it is evident that more than four-fifths of the agreements were concentrated in the manufacturing sector. Within the manufacturing sector, many changes seemed to have taken place. For instance, in the first survey period, the machinery and machine tools attracted the maximum number of agreements, while in the second survey period, it was the electrical goods and machinery and in the fourth survey period, it was the chemicals and chemical products. This apparent shift may perhaps be a simple reflection of the number of companies surveyed under each sector. The RBI surveys[10] did not specify the latter.

We now analyse the trends in both direct and indirect costs of collaboration agreements. Table 20 presents the direct cost of technology imports.

TABLE 20. DIRECT COST OF TECHNOLOGY IMPORTS

(Rs in crore)

Industry	1960-61 to 1963-64	1964-65 to 1969-70	1977-78 to 1980-81
Royalty	0.66	5.00	6.82
Technical fees	12.28	18.02	9.56
Payments to foreign technicians	8.98	14.49	13.07
Expenditure on trainees sent abroad	1.32	1.26	NA
Total costs	23.24	38.77	29.45
Value of production	NA	3,758	5,842
Cost as a percentage	NA	1.03	0.50
of value of production	(1.73)	(1.02)	

Note: 1. Only expenditure in foreign currency included; 2. Figures in parentheses indicate the corresponding ratios for the private corporate sector.

The technical fees constituted the largest share of 53 and 46 per cent in the first and second surveys respectively, while this share was reduced to 32 per cent in the fourth survey. Another important feature is that the royalty accounted for the lowest share. This is to be seen in the context of a sizable amount of technologies being purchased outright through lump sum payments. An important segment of the cost, that is, the payments to foreign technicians, increased from an average of 38 per cent in the first two surveys to about 44 per cent in the fourth survey, thus evolving into a single largest cost item. This heavy dependence on foreign technicians is perhaps a reflection of the willingness of the public sector in effecting the technology transfer much better.[11]

The cost of technology imports, as a percentage of the value of production arising out of the collaboration, has fallen to nearly one-half, despite the economic liberalization in 1979. This is because the survey has covered foreign collaboration agreements that came in force on and after April 1, 1977. In other words, the data reflected the characterization of cases approved during the phase of regulation. Therefore, the "cost reduction" effect of regulation might have been offset by the "cost raising effect" of deregulation. This has been extensively investigated by us with the help of a detailed set of data for a reasonably longer period covering the liberalization phase.

The ratio for the public sector compares favourably with that for the private corporate sector.

Another component of the cost – the indirect or non-qualifiable one – arises from the various restrictive clauses inserted into the collaboration agreement by the foreign partner (See Table 21).

Finally, we analyse the net foreign exchange balance (NFIR) as defined earlier (See Table 22).

TABLE 21. INDIRECT COST OF TECHNOLOGY IMPORTS: PRIVATE SECTOR VERSUS PUBLIC SECTOR: RBI SURVEY

(Number of restrictive clauses)

Particulars	1960-61 - 1963-64		1964-65 - 1969-70		1970-71 - 1972-73		1977-78 - 1980-81	
	Private	Public	Private	Public	Private	Public	Private	Public
1. Export clauses	455	35	956	104	874	NA	594	73
2. Tied purchase of raw materials and capital goods	240	5	235	6	232	NA	91	1
3. Conditional payment clauses and other restriction	55	7	94	5	170	NA	31	39
4. Total (1 to 3)	750	47	1285	115	1276	NA	716	113
a. Total no. of agreements with restrictive clauses	527	38	654	88	633	NA	376	58
b. Total no. of agreements	1051	70	1098	163	1010	NA	580	69
c. 'a' as a percentage of 'b'	50	54.29	60	54	63	NA	65	62

Notes: 1. The fourth survey gives data on various other kinds of restrictive clauses like restrictions on productive capacity, etc. for the first time; 2. The total number of agreements with restrictive clauses would be less than the total number of restrictive clauses since one agreement may have more than one restrictive clause.

TABLE 22. NET FOREIGN EXCHANGE BALANCE OF COLLABORATION AGREEMENTS

(Rs in crore)

	First Survey 1960-61 to 1963-64	Second Survey 1964-65 to 1969-70	Fourth Survey 1977-78 to 1980-81
1. Total Direct cost	23.24	38.77	29.45
2. Imports	NA	741.80	1859.80
3. Foreign Exchange outflow(1+2)	NA	780.57	1889.25
4. Exports	NA	172.20	183.00
5. Net Foreign Exchange inflow(4-3)		(-)608.37	(-)1706.25
6. NFIR (5/4)		(-)3.53	(-)9.32

The NFIR has registered a nearly 6 percentage point increase, meaning that the import dependence of public sector firms has increased. However, much of the public sector imports were in the form of petroleum products for refineries and for fertiliser production [Bagchi, 1986, p. 917]. This will be analysed in detail by studying the relative share of various sectors on the export front.

After having analysed the cost aspect, the next task is to find out the relationship between technology imports and R&D using the log-linear regression method.

Since the results of the third survey are not available, we have pooled together the relevant data for the second and fourth surveys. To normalize for the differing coverage of firms in the latter two surveys, we have computed the average direct cost/R&D per firm (Table 23) and obtained the average propensity to adapt (Table 24).

TABLE 23. DIRECT COST OF TECHNOLOGY IMPORTS AND EXPENDITURE ON R&D IN INDIAN PUBLIC SECTOR: RBI SURVEY

(Rs in lakh)

Year	Royalty	Technical Fees	Payment to foreign technicians	Total direct cost	Average direct cost per firm	Total R&D expenditure	Average R&D expenditure per firm
1964-65	24	99	288	411	9.79*	282	6.71*
1965-66	45	221	371	637	15.17*	460	10.95*
1966-67	80	356	580	1,016	24.19*	587	13.98*
1967-68	101	247	627	975	23.21*	983	23.40*
1968-69	118	393	639	1,150	27.38*	983	22.93*
1969-70	132	486	693	1,311	32.21*	1,097	26.12*
1977-78	140	204	308	652	25.08**	1,042	40.08**
1978-79	93	246	631	970	37.31**	1,190	45.77**
1979-80	217	263	499	979	37.65**	1,754	67.46**
1980-81	232	243	128	603	23.19**	1,731	66.58**

Note: * Number of firms covered = 42; ** Number of firms covered = 26.
Source: 1. RBI, *Foreign Collaboration in Indian Industry, Second Survey Report*, 1974; 2. RBI, *Foreign Collaboration in Indian Industry, Fourth Survey Report*, 1985.

TABLE 24. AVERAGE PROPENSITY TO ADAPT IN INDIAN PUBLIC SECTOR: RBI SURVEY

(Rs in lakh)

Year	Average direct cost of technology import	Average R&D expenditure	Average propensity to adapt
1964-65	9.79	6.71	0.69
1965-66	15.17	10.95	0.72
1966-67	24.19	13.98	0.58
1967-68	23.21	23.40	1.01
1968-69	27.38	22.93	0.84
1969-70	31.21	26.12	0.84
1977-78	25.08	40.08	1.60
1978-79	37.31	45.77	1.23
1979-80	37.65	67.46	1.79
1980-81	23.19	66.58	2.87

TABLE 25. LONG-LINEAR REGRESSIONS EXPLAINING R&D EXPENDITURE BY FOREIGN COLLABORATIONS IN INDIAN PUBLIC SECTOR (1964-65 TO 1980-91 RBI SURVEY)

Department variable	Independent variable group	Coefficients		R^2	Industry
		a	b		
$\frac{RAND}{N}$	$\frac{IDC}{N}$	-1.51 (1.30)	1.50	0.64**	All

The "average propensity to adapt" shows a clear-cut increase, meaning thereby an increasing level of research consciousness in the public sector. The log-linear regressions were run to explain the variations in R&D expenditure as effected by the cost of technology imports. The results are presented in Table 25.

The "focus variable" has the correct positive sign, thus confirming our hypothesis of complementarity between R&D and technology import. The magnitude of elasticity of R&D relative to technology import is greater than unity, implying a good performance by the public sector on the assimilation of imported technologies. This finding is at variance with the common belief that, since the public sector is operating in a sheltered environment devoid of a profit motive, it lacks the necessary drive to assimilate the imported technologies and to make any improvements thereupon. Again, our results on the basis of RBI survey data indicate that the performance of the public sector is not only good but even better than that of the private corporate sector (see Table 4).

V

TECHNOLOGICAL DEPENDENCE IN INDIAN PUBLIC SECTOR: AS SEEN THROUGH OUR ESTIMATES

We now propose to subject this proposition to further empirical scrutiny, using a more detailed, comprehensive and consistent set of time series data as developed by us.

Table 26 shows the total and average direct cost per firm.

TABLE 26. TOTAL DIRECT COST AND AVERAGE DIRECT COST PER FIRM IN THE INDIAN PUBLIC SECTOR, DURING 1973-74 TO 1984-85

(Rs in lakh)

Year	Direct cost	
	Total	Average
1973-74	3,112.96	67.67
1974-75	4,935.12	107.29
1975-76	4,926.63	107.10
1976-77	5,173.55	112.47
1977-78	8,361.83	181.78
1978-79	8,801.07	191.33
1979-80	6,359.95	138.26
1980-81	12,369.15	268.89
1981-82	15,606.05	339.26
1882-83	11,007.72	239.30
1983-84	9,503.84	206.61
1984-85	11,060.00	240.43
Average direct cost for the period		
(a) 1973-74 - 1977-78	5,302.02	115.26
(b) 1978-79 - 1984-85	10,672.54	232.01

The IDC has grown at an average compound growth rate of about 12 per cent per annum during the period 1973-74 to 1984-85.

We have found earlier that in the private corporate sector, regulation reduced the cost of technology imports. From Table 26, we find that this trend holds good even for the public sector, more so, when we have a large enough series of data, covering the early part of the liberalization phase. Nevertheless, to draw this inference on a firm-wise basis, we must know the duration of collaboration agreements and the value added as a result of foreign collaboration; but these data are not readily available. Moreover, our population also includes a number of firms which are not manufacturing units but are engaged in trading, marketing and consultancy activities. These firms do not have the concept of value addition, which renders a relative comparison difficult.

However, subject to these caveats, we find that the direct costs (albeit in the absolute sense) had registered nearly a 100 per cent increase during the post - 1978 liberalization phase, although they were showing a declining trend after 1982-83.

We shall now analyse the trends in IDC for the various industry groups. Since the industry-wise data on costs were already presented (Table 16), the relative share of each industry group in the total direct cost has been worked out. This is given in Table 27.

TABLE 27. SECTORAL SHARES IN TOTAL DIRECT COST OF TECHNOLOGY IMPORTS, (1973-74 TO 1984-85)

(per cent)

	Industry Group	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	Average
1.	C & C	1.97	2.64	5.42	7.04	8.64	10.59	15.81	13.73	9.76	11.37	11.97	8.82	8.97
2.	CONSU	30.48	36.68	0.54	0.14	0.06	0.10	0.80	0.08	0.02	0.03	0.02	1.82	6.00
3.	ELECT	1.30	0.45	0.74	1.55	0.83	0.78	0.92	0.65	0.92	10.02	6.03	6.31	3.00
4.	FERCH	41.79	33.76	37.23	29.53	22.74	12.25	10.36	4.49	5.16	6.10	0.99	17.91	19.00
5.	HEAVY	14.42	12.16	15.20	26.49	30.95	43.87	52.89	45.57	35.75	27.74	27.21	20.62	29.00
6.	MEDIU & LIGHT ENG.	1.90	1.00	1.59	3.02	2.32	5.80	1.83	0.90	1.33	2.29	7.03	6.37	3.00
7.	MINE	1.69	1.03	1.84	9.62	18.99	10.10	6.15	6.14	17.84	10.72	0.63	1.84	7.00
8.	PETRO	1.53	1.36	22.0	18.50	13.06	9.51	7.39	4.68	4.01	4.70	15.68	15.59	10.00
9.	PHARM	-	-	0.01	0.44	0.08	0.11	0.16	0.01	-	0.02	-	0.05	0.03
10.	SHIPB	4.26	10.43	14.89	2.97	1.90	0.92	1.54	0.31	1.55	20.28	29.00	19.78	9.00
11.	STEEL	-	-	0.01	0.04	0.09	5.30	-	22.92	22.38	4.72	-	-	5.00
12.	TRANM	-	-	-	0.01	0.01	-	0.01	-	-	0.01	-	-	Negligible
13.	TRANS	0.17	0.49	0.50	0.65	0.32	0.67	2.12	0.52	1.28	2.02	1.43	0.88	0.92

Source: See Section II.

As expected, the heavy engineering sector accounted for the highest share with an average of nearly 30 per cent, followed by the fertilizer and chemical group. In fact, much of the cost in the latter sector was accounted for by just one enterprise, namely, the Fertilizer Corporation of India (FCI). However, since 1979, costs are showing a downward trend, because in that year, the FCI was bifurcated[12]. In 1985, the costs rose again due to the diversification programmes undertaken by FACT and IPCL. The consultancy and construction sector, consisting of various engineering consultancy enterprises, has been a major importer of foreign technology. This raises questions about the capabilities of our indigenous consultancy organizations to execute projects independently.[13]

Since 1983, the shipbuilding sector has been showing very high costs, surpassing the heavy engineering sector. This can be attributed primarily to the large scale diversification programmes undertaken by these firms to ward off the severe recessionary trends in their main line of activity. To cater to the increasing demand for oil exploration, some of the firms diversified their activity. For instance, the Hindusthan Ship-Building Co. diversified into the manufacture of oil rigs, off-shore and on-shore structures, etc., while Gardenreach Shipbuilders and Engineers went into the manufacture of diesel engines.

Each of the two industrial groups, namely, medium and light engineering and electronics,

has accounted for 3 per cent of the total payments for technology. Both the sectors have increased their share tremendously from less than 1 per cent to about 10 per cent since 1983.

We shall now analyse the expenditure incurred by these groups to generate local capabilities through their in-house R&D activities.

Table 28 shows the absolute and relative shares of each industry group in the total expenditure on research activities of public sector enterprises that have imported foreign technology.

TABLE 28. ABSOLUTE AND RELATIVE SHARE OF EXPENDITURE ON IN-HOUSE R&D BY PUBLIC SECTOR ENTERPRISES WITH FOREIGN COLLABORATION

	Industry Group	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
1.	C and C	0	6.30	8.00	14.35	18.42	320.03	316.86	346.66	360.00	526.74	663.86	1221.86
		(0)	(0.37)	(0.39)	(0.54)	(0.69)	(6.95)	(6.95)	(4.70)	(4.37)	(5.24)	(4.89)	(6.49)
2.	CONSU	3.05	8.35	115.09	41.78	38.05	38.97	45.32	69.90	50.23	100.22	113.52	219.20
		(0.33)	(0.48)	(5.61)	(1.59)	(1.40)	(0.85)	(0.89)	(0.95)	(0.61)	(1.00)	(0.84)	(1.16)
3.	ELECT	210.94	504.32	474.97	460.88	575.44	672.68	136.02	1096.63	1159.87	1224.99	1452.14	2752.55
		(22.98)	(29.28)	(23.13)	(17.3)	(21.41)	(14.61)	(14.41)	(14.86)	(14.08)	(12.19)	(10.69)	(14.63)
4.	FERCH	212.85	330.98	354.03	398.97	73.35	241.40	192.06	267.23	243.00	292.52	313.56	486.76
		(23.18)	(19.22)	(17.00)	(15.00)	(2.73)	(5.24)	(3.76)	(3.62)	(2.95)	(2.91)	(2.31)	(2.59)
5.	HEAVY	39.56	115.16	264.50	464.50	624.89	1015.67	1535.50	2188.56	2129.76	2236.81	2913.71	3733.75
		(4.28)	(6.69)	(12.88)	(17.47)	(23.25)	(22.05)	(30.05)	(29.66)	(25.85)	(22.26)	(21.46)	(19.84)
6.	MEDIU & LIGHT ENG.	209.50	246.07	304.07	627.47	553.38	959.82	933.01	1383.07	1579.64	1678.85	2105.32	2271.86
		(22.82)	(14.29)	(14.82)	(23.60)	(23.59)	(20.84)	(16.30)	(16.74)	(19.17)	(16.71)	(15.50)	(12.07)
7.	MINE	10.59	27.51	31.21	51.64	57.47	211.70	110.00	180.45	186.00	184.85	184.42	200.95
		(1.15)	(1.60)	(1.52)	(1.94)	(2.14)	(4.60)	(2.31)	(2.45)	(2.26)	(1.84)	(1.36)	(1.07)
8.	PETRO	150.05	260.03	280.00	229.90	269.92	496.96	306.88	761.68	1132.90	1772.08	3488.25	5297.75
		(16.34)	(15.10)	(13.64)	(8.65)	(10.04)	(10.79)	(9.92)	(10.32)	(13.75)	(17.64)	(25.69)	(28.15)
9.	PHARM	59.51	96.16	78.16	150.06	130.99	146.61	110.96	197.56	298.00	535.08	274.59	169.28
		(6.48)	(5.58)	(3.81)	(5.64)	(4.87)	(3.18)	(3.35)	(2.68)	(3.62)	(3.50)	(2.02)	(0.09)
10.	SHIPB	3.49	3.36	22.00	29.40	83.00	59.00	60.25	60.10	55.30	60.48	75.13	63.05
		(0.38)	(0.20)	(1.07)	(2.23)	(3.09)	(1.28)	(1.18)	(0.81)	(0.67)	(0.60)	(0.55)	(0.34)
11.	STEEL	2.02	89.00	76.60	76.90	150.00	311.28	407.00	535.98	900.00	1395.32	1554.53	1466.28
		(0.20)	(5.17)	(3.73)	(2.89)	(5.58)	(6.76)	(7.97)	(7.26)	(10.92)	(13.89)	(11.45)	(7.29)
12.	TRANM	0	0	0	0	0	0	0	0	0	0	0	
13.	TRANS	16.83	35.09	44.27	83.23	113.27	131.29	187.22	290.72	145.24	222.70	438.95	936.86
		(1.83)	(2.04)	(2.16)	(3.13)	(4.21)	(2.83)	(3.66)	(3.94)	(1.76)	(2.22)	(3.23)	(4.98)

TABLE 29. RESEARCH INTENSITY IN PUBLIC SECTOR ENTERPRISES WITH FOREIGN COLLABORATION

(in per cent)

	Industry Group	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
1.	C and C	0.00	0.52	0.89	1.23	1.04	11.91	8.18	9.68	8.05	12.20	15.34	15.34
2.	CONSU	7.62	0.65	1.88	0.62	0.61	0.59	0.99	0.95	0.57	0.69	0.63	2.71
3.	ELECT	3.85	7.05	4.60	4.00	4.05	3.90	3.78	6.15	3.64	3.76	3.28	50.16
4.	FERCH	0.59	0.99	0.96	1.15	0.78	1.06	0.75	0.80	0.66	0.69	0.43	0.62
5.	HEAVY	0.24	0.28	0.24	0.77	0.59	0.60	0.69	1.00	0.90	0.79	0.79	1.10
6.	MEDIU	1.27	2.08	2.34	3.09	2.66	2.89	2.69	3.16	2.98	3.01	3.09	3.95
7.	MINE	0.34	0.44	0.37	0.63	0.53	1.55	0.54	0.59	0.50	0.50	0.38	0.41
8.	PETRO	0.66	0.56	0.50	0.11	0.08	0.13	0.14	0.26	0.17	0.43	0.43	0.54
9.	PHARM	2.18	2.89	2.07	2.13	2.29	2.46	3.23	2.68	2.71	2.68	2.43	0.54
10.	SHIPB	0.20	0.09	0.64	0.95	3.41	3.11	5.15	1.57	1.18	1.16	1.28	0.45
11.	STEEL	3.74	35.32	19.34	9.10	9.18	0.20	0.00	0.24	0.34	0.68	1.53	0.41
12.	TRANM	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
13.	TRANS	0.37	9.38	0.38	0.76	1.04	0.94	0.85	1.72	0.38	0.40	0.91	1.53

Source: Same as in Table 27.

The Table presents an interesting picture. The heavy engineering sector (as in the case of direct costs) accounts for the largest share in R&D expenditure. We find that the share of consultancy and construction sector, (which was less than 1 per cent till 1978), has increased tremendously after 1978. This is because the PDIL, which was the R&D wing of Fertilizer Corporation of India, was made into a separate consultancy organization in 1978. Though the sector consists of nine enterprises, only three of them are engaged in R&D activities, namely, EILC, ETTDC and

PDIL. Among them, a lion's share of the expenditure is due only to PDIL.

However, for a meaningful interpretation of the R&D expenditure, one has to consider the ratio of the R&D expenditure incurred by each firm to its respective sales turnover. These research intensities and their sub-groups are given in Tables 29 and 30 respectively.

TABLE 30. DISTRIBUTION OF INDUSTRIAL GROUPS ACCORDING TO RESEARCH INTENSITY

Size classes (Research Intensity in per cent)	Industrial Groups
0.00	Trading and Marketing
0.01 - 1.00	Fertilizer and Chemical, Heavy Engineering, Metals and Minerals, Petroleum
1.00 - 2.00	Consumer Goods, Shipbuilding, Transport Equipment
2.00 - 3.00	Medium and Light Engineering, Pharmaceutical
3.00 and above	Consultancy and Construction, Electronics and Steel

Source: Table 29.

The research intensities range from as low as zero in the case of the trading and marketing sectors to as high as 7.9 per cent in the case of the electronics group. The high research intensity, as registered by the consultancy and construction sectors, is mainly due to the inclusion of PDIL. Similarly, in the electronics sector, much of the R&D expenditure has been contributed by Central Electronics Ltd. Incidentally, Central Electronics depended upon its own R&D for the entire technology input till 1985; then in the ninth year, it went in for a foreign collaboration for the first time, since its inception in 1974.

A rise in the amount spent on in-house R&D in itself is not indicative of a firm's efforts towards self-reliance. What is more important are the relative changes in the amount spent on technology import.

The "average propensity to adapt" has been worked out and presented in Table 31. This was approximately 17 per cent growth rate (point to point compound) during the period.

TABLE 31. AVERAGE PROPENSITY TO ADAPT IN INDIAN PUBLIC SECTOR (1973-74 TO 1984-85)

Year	Total direct cost	Total expenditure on adaptation	Average direct cost per firm	Average expenditure on adaptation per firm	Average propensity to adapt
1973-74	3112.96	918.09	67.67	19.96	0.29
1974-75	4935.12	1722.33	107.29	37.44	0.35
1975-76	4926.63	2053.13	107.10	44.63	0.42
1976-77	5173.55	2659.08	112.47	57.81	0.51
1977-78	8361.83	2688.18	181.78	58.44	0.32
1978-79	8801.07	4605.41	191.33	100.12	0.52
1979-80	6359.95	5109.08	138.26	111.07	0.80
1980-81	12369.15	7378.54	268.89	160.40	0.60
1981-82	15606.05	8239.94	339.26	179.13	0.53
1982-83	11007.72	10047.64	239.30	218.43	0.91
1983-84	9503.84	13578.28	206.61	295.18	1.43
1984-85	11060.00	18820.16	240.43	409.13	1.70

Note: Expenditure on R&D is taken to be the expenditure on adaptation on the basis of the assumption discussed in the text.
Source: Table 26 and Table 28.

Log-linear regressions results are presented in Table 32.

The elasticity for the entire public sector is found to be greater than unity, indicating a good management of imported technology and corroborating the finding on the basis of the RBI data. The magnitude of elasticity is higher, probably because of the more comprehensive and consistent nature of the data set than the previous one. However, the situation within the public sector presents an entirely mixed picture, with only the Heavy Engineering showing an elasticity greater than unity. Since this sector accounts for the largest share in both R&D activities and technology imports, it has pulled the aggregate elasticity. In fact, a study on one of the leading heavy engineering firms, BHEL, reveals that the company over the time "has demonstrated its

technical capacity to produce sophisticated equipment" [Ramamurti, 1987, Pp. 77-128].

TABLE 32. LOG-LINEAR REGRESSIONS EXPLAINING R&D EXPENDITURE BY FOREIGN COLLABORATION IN THE INDIAN PUBLIC SECTOR (1973-74 TO 1984-85)

S.No.	Dependent variable	Independent variable	Coefficients		R^2	Industry Group
			a	b		
1.	RAND/N	IDC/N	-3.83	1.65 (1.40)*	0.73**	All
2.	- do -	- do -	-4.01	0.42 (1.53)*	0.63**	Elect
3.	- do -	- do -	-3.69	1.46 (1.33)*	0.77**	Heavy
4.	- do -	- do -	2.27	0.76 (1.48)*	0.68**	Medium
5.	- do -	- do -	0.98	0.98 (1.58)*	0.93**	Trans

Note: (1) RAND/N = Average expenditure on R&D. (2) IDC/N = Average direct cost of technology import. (3) * t-ratios are shown in parentheses; all coefficients significant at 10 per cent level of significance. (4) ** R^2s are all significant at both 5 per cent and 1 per cent levels.

On the contrary, the performance of the other sectors has not been all that 'good'. In the case of medium and light engineering and transport equipment, the magnitude of the elasticity is closer to unity, while for the electronics sector, it is quite low (0.42). The low elasticity registered by the electronics sector is perfectly understandable, as would be the case for most of the firms (irrespective of ownership) operating in underdeveloped economies, where the technology market is fast changing and is highly oligopolistic.

The elasticity for the fertilizer and chemicals sector is extremely low, and this can be attributed to the regression of R&D wing to form PDIL, which, on the contrary, is a consultancy organization. So, we re-ran the regression by clubbing PDIL with the Fertilizer and Chemicals sector, only to find a marginal improvement in the elasticity. This may be because, once PDIL was made into an independent consultancy organization, the expenditure on in-house R&D could no longer be construed as being for adapting imported technology. It is then for generating new technology itself. Since in our framework, all the expenditure on R&D is treated for adapting imported technology, it is not surprising that the elasticity is quite low. Moreover, the Fertilizer and Chemicals sector is very heterogeneous because there are firms like IPCL, which are entirely dependent on foreign technology for the manufacture of a host of petrochemical products.[14]

In all the other sectors, the coefficient of the elasticity is very 'low' indicating poor performance with respect to the management of imported technology. The high elasticity, as registered by the heavy engineering sector, can also be interpreted to mean that, the more complex is the imported technology, the greater is the required expenditure on adaptive R&D. Applying the same yardstick, one would have expected a higher coefficient for the electronics sector too, as the technology involved is even more complex than the heavy engineering sector. But, as stated before, the expenditure on adaptive R&D has not kept pace with the technology imports, because the CKD/SKD kits require minimal technical skills to unpackage the technology bundle. Secondly, government policy itself has greatly favoured this kind of technological dependence, though policies like "phased manufacturing programme" have sought to hasten the process of indigenization.[15]

Our empirical finding, which corroborates the RBI estimates, negates the hypothesis by Katrak that "the economic pressures for increasing efficiency *via* adaptive R&D may be weaker for public enterprises, because in the event of their making a loss, they are more likely to be subsidized by the government" [Katrak, 1985, p. 219]. In fact, all the findings point to a better

performance on the part of public sector enterprises in R&D activities.

Of late, the public sector has emerged as a major supplier of technology to other firms in both the public and private sectors. This can be taken as another indicator of the technological competence of this sector.

This horizontal transfer of technology has been confined to the heavy engineering and electronics sectors. In the heavy engineering sector, it is BHEL that has emerged as a major supplier of technology. This is mainly due to its in-house R&D. Details are given in Table 33. The Table shows that a majority of the recipients are from the private sector. One recipient was even a subsidiary of MNC. The overriding considerations for choosing BHEL's technology was its suitability to local conditions and its reasonable price.

TABLE 33. HORIZONTAL TRANSFER OF TECHNOLOGY: BHEL

S.No.	Product for which technical know-how has been transferred (1)	Recipient firm (2)	Nature of ownership of (3)
1.	Steam generators of up to 200 tons per hour for industrial purposes	BHPV	Central Public Sector
2.	Special purpose pipes	Orissa Industrial Development Corporation	State level public sector
3.	Mica Papers using thermochemical process	Mica Trading Corporation	Central public sector
4.	Coal fired, shell type atmospheric fluidized bed boilers for stationary use of up to 15 tons per hour	(a) Deccan Machanical and chemical industries	Private sector
		(b) Kaveri Engineering	Private sector
		(c) Industrial Boilers	Private sector
5	Tungsten Carbide Thermowells	Sandvik Asia, Pune	Private sector
6.	Welding Electrodes	(a) RCK Electronics	Private sector
		(b) SK Electronics	Private sector
7.	Magnetic Laminates	Asian Laminates Industry	Private sector

Note: This list is incomplete as it covers only the technologies that have been transferred in the last two years i.e., during 1986-87 and 1987-88.
Source: (1) Department of Public Enterprises, *Annual Report*, 1987-88, p. 45.
(2) *Business Standard*, (July 1), 1988.

TABLE 34. HORIZONTAL TRANSFER OF TECHNOLOGY: BEL

	Product for which technical know-how has been transferred (1)	Recipient firm (2)	Nature of ownership of (3)
1.	Television Picture Tubes	(a) Suchitra Tubes	Private sector
		(b) Beltron	State level public sector
		(c) Chinar Tubes	Private sector
2.	Language labs	Acoustics Ltd.	Private sector
3.	Studio-type amplifiers for AIR-/Doordarshan	WEBEL	State level public sector
4.	Non-directional beacons	Marine communication and Electronics	State level public sector
5.	Exciters for Television transmitters	(a) GCEL, (b) ECIL, (c) Keltron	State level public sector
6.	VHF omnirange equipment and distance measuring equipment	GCEL	State level public sector
7.	Television deflection components	Orissa State Electronics Development Corporation	State level public sector
8.	PCM Multiplexer	APEL, GCEL, Meltron	State level public sector
9.	Silver Paste composition	JV Electronics	
10.	TO-92 transistors packages	Sikkim Time corporation	State level public sector
11.	Voting machines	ECIL	Central level public sector
12.	Low Power transmitters for Televisions	GCEL	State level public sector

Source: *Telematics India*, Vol. 1, p. 13, Number 9, 1988.

Another firm, which has been successful in horizontal transfer of technology, is BEL. However, most of its recipients have been other public sector enterprises. Table 34 summarizes the main technologies transferred by the company. This shows that BEL has acquired a certain amount of capability in the sphere of design/manufacture of equipment for radio communication, sound and television broadcasting, radars and components.

In the electronics sector, the Central Electronics Ltd. preferred in house R&D activities to foreign sources of technology. It has successfully transferred know-how for large solar photovoltaic (SPC) modules to another public sector concern, Rajasthan Electronics and Instruments Ltd., has also signed similar deals with two other state electronics development corporations.

After having seen the efforts made by the public sector towards self-reliance, we shall now analyse the extent of import dependence in the public sector. We assess its degree, both temporally and across-the-sector by employing the concept of "Net Foreign Exchange Inflow Ratio (NFIR)".

It is contended that much of the foreign exchange outflow in the public sector is attributed to the imports of oil and other petroleum products for refineries, which, in itself, is a highly import-intensive enterprise. But one should not draw the inference that the public sector is highly import dependent, because the petroleum products account for a large proportion of the exports by the public sector as well. The import and export by the refineries nearly cancel out each other. In order to test the above proposition quantitatively, we present in Table 35 the percentage share of each sector in the total public sector imports/exports during the 12-year period 1973-74 to 1984-85. The petroleum sector accounts for two-thirds of the imports, while its share in exports is roughly one-half. Since in both import and export, it has the highest absolute share, we exclude it from the discussion. Secondly, one should also exclude the trading and marketing sector, since most of the units in it are engaged solely in channelised international trade.

TABLE 35. PERCENTAGE SHARE OF IMPORTS AND EXPORTS, SECTOR-WISE: 1973-74 TO 1984-85

Industry		1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	Average
C and C	Imp	0.02	0.27	0.17	0.29	0.44	0.07	0.52	0.26	0.56	2.10	3.21	3.67	0.97
	Exp	0.42	0.38	1.19	5.66	20.59	2.77	21.45	2.75	2.63	7.93	1.45	41.00	9.02
CONSU	Imp	0.55	1.34	0.71	0.60	1.08	0.59	0.38	0.47	0.55	0.42	0.53	0.86	0.67
	Exp	0.36	0.03	0.00	0.41	0.29	0.25	0.02	0.07	0.02	0.01	0.08	0.04	0.13
ELECT	Imp	1.39	1.52	0.73	0.69	2.28	0.75	1.12	0.86	1.00	1.06	1.08	1.99	1.21
	Exp	2.59	0.76	1.88	4.30	5.00	6.94	2.45	1.28	1.40	0.52	0.33	0.43	2.32
FERCH	Imp	13.45	11.13	9.99	7.83	6.85	3.33	1.71	1.68	1.22	1.53	2.16	4.09	5.41
	Exp	0.84	0.18	0.57	0.46	0.54	0.41	0.36	0.29	0.18	0.08	0.06	0.42	0.37
HEAVY	Imp	27.10	27.78	14.96	10.02	14.67	10.90	6.90	5.66	5.48	6.48	3.20	10.24	11.95
	Exp	2.93	1.51	13.83	2.55	19.82	5.26	19.26	13.74	8.01	2.86	2.11	6.47	8.20
MEDIU	Imp	0.99	1.50	2.43	2.31	4.53	2.71	2.15	1.66	1.84	1.44	2.08	2.68	2.19
	Exp	4.97	3.45	5.94	5.25	6.71	6.29	5.08	3.04	2.65	2.11	1.46	7.38	4.53
MINE	Imp	0.57	1.36	1.44	2.16	6.53	5.72	0.78	1.00	0.97	1.32	0.63	1.31	1.98
	Exp	82.30	59.11	1.39	34.37	7.43	16.08	3.64	3.63	3.31	1.66	0.53	8.55	18.52
PETRO	Imp	47.97	46.80	64.61	71.94	57.57	67.99	68.94	82.04	74.32	70.07	82.56	66.68	66.79
	Exp	1.10	23.14	51.04	28.67	32.66	30.53	33.20	53.99	76.53	82.48	92.42	25.20	44.25
PHARM	Imp	0.11	0.08	0.23	0.24	0.61	0.41	0.25	0.06	0.16	0.16	0.12	0.18	0.22
	Exp	0.23	0.02	0.40	0.29	0.00	0.43	0.25	6.27	0.04	0.04	0.08	0.46	0.71
SHIPB	Imp	3.86	4.98	3.29	2.45	4.71	1.43	12.02	1.14	1.77	1.55	2.23	4.20	3.64
	Exp	4.13	7.82	7.83	7.26	5.85	3.80	8.05	0.80	1.02	0.33	0.07	1.33	4.02
STEEL	Imp	0.00	0.00	0.00	0.03	0.25	5.12	4.41	4.77	10.95	12.42	0.33	0.34	3.21
	Exp	0.00	0.00	0.00	0.00	0.00	24.75	4.68	8.00	3.47	0.98	0.31	0.67	3.57
TRANM	Imp	0.00	0.04	0.00	0.00	0.01	0.00	0.12	0.09	0.04	0.02	0.02	0.02	0.03
	Exp	0.00	0.00	14.42	9.97	0.79	0.58	0.29	5.51	0.22	0.94	1.02	6.12	3.32
TRANS	Imp	3.98	3.20	1.44	1.45	0.46	0.96	0.72	0.31	1.13	1.42	1.86	3.75	1.72
	Exp	0.13	3.61	1.52	0.61	0.32	1.91	1.28	0.63	0.52	0.08	0.08	1.91	1.05

Notes: (1) EXP = Exports; (2) IMP = Imports.
Source: Computed from Annual Reports.

In order to measure the import dependence in a comprehensive manner, we have considered both the import of commodities and the import of technology in the concept of NFIR. We trace the trends in NFIR in Table 36. The import dependence, as measured through the direction of NFIR, shows higher outflows than inflows throughout the period under consideration. The magnitude of NFIR is greater than unity, except in 1976-77. However, after 1978-79, it registers a rise. After a dip in 1982-83, it rises again. Thus, on the basis of this measure, it is not easy to draw precise inferences about whether import dependence is increasing or decreasing. However, the average NFIR for the post- 1978-79 (that is for the liberalization phase) is higher at (-)5.46 as compared with (-)3.26 for the earlier period. This shows that the import dependence is on the increase during the liberalization phase.

TABLE 36. TRENDS IN NFIR FOR INDIAN PUBLIC SECTOR ENTERPRISES WITH FOREIGN COLLABORATION*

Year	NFIR
1973-74	-1.52
1974-75	-1.51
1975-76	-9.96
1976-77	-0.29
1977-78	-3.02
1978-79	-2.38
1979-80	-3.42
1980-81	-9.69
1981-82	-11.04
1982-83	-3.58
1983-84	-3.92
1984-85	-4.17

Note: *Excludes Petroleum and Trading and Marketing Sectors.

Much of the NFIR is contributed by the heavy engineering and the fertilizer and chemical sectors. The latter sector, being naphtha based, is highly import intensive. With these qualifications, one could say that the import dependence in the Indian public sector enterprises with foreign collaboration is increasing.

To sum up, we have analysed the relationship between technology imports and in-house R&D activities of the public sector enterprises that have depended on foreign sources of technology. We used, for the purpose, the log-linear test and a comprehensive data set developed by us. The results, thus obtained, reinforced those obtained on the basis of the RBI data set. These also indicate that the public sector, as a whole, has attempted to manage the imported technology well, although the performance of individual sectors vary considerably. The need for more firm-specific studies was felt in order to understand the technology assimilation process better.

NOTES

1. For instance in the engineering industries, India has built up considerable technological capabilities. In manufacturing power equipment and allied products (including thermal boilers), non-electric machinery for cement, sugar and chemical industries, and in setting up coke ovens and rolling mill areas of steel plants and in medium-sized power stations. India has demonstrated relatively high levels of technological competence.

2. The problem of over-import of technology was first systematically analysed by Micheal Kidron, [1965]. This phenomena was subsequently highlighted by K. K. Subrahmanian, [1972] and by NCAER, [1971].

3. Hitherto four RBI Surveys have been published. The first survey covers the period 1960-61 through 1963-64. But this survey has not collected data on R&D by firms importing technology. The second, third and fourth surveys cover the periods 1964-65 to 1969-70, 1970-71 to 1972-73 and 1977-78 to 1980-81 respectively. The third survey has not been published and so to overcome the problem of small number of observations, Subrahmanian pools together the data for the second and fourth surveys.

4. The very recent committee under the chairmanship of Abid Hussain to review the functioning of CSIR has once again reiterated this. See G.O.I., [1986].

5. For a detailed survey giving the various schemes which these development banks have in promoting the commercial exploitation of indigenously developed technology, See DSIR, [1986, Pp. 22-29].

6. There is of course a recent study on this theme, by and large based on the RBI surveys. See [Deolkar and Sundaram, 1989, Pp. 73-138].

7. This proposition is based on the implicit assumption that the two main sources of technology for a firm are its in-house or internal R&D and technology licensing agreements that it has especially with foreign firms. But there can be other sources like acquisition of innovative firms, joint ventures especially in R&D, contracted R&D and technology scanning exercises which include legal and illegal forms of acquiring technological know-how from the outside without any direct purchase from its original source.

8. This is one of the first attempts to quantitatively test the relationship between technology import and domestic R&D across six developed countries using cross-section data. See [Blumenthal, 1979, Pp. 303-306].

9. See Committee On Public Undertakings, *Foreign Collaboration in Public Undertakings*, Eighty-Ninth Report, Fifth Lok Sabha, Lok Sabha Secretariat, New Delhi, 1976, and Report of the Comptroller and Auditor General of India, Union Government (Commercial), *Electronics Corporation of India Limited*, Controller of Publications, Delhi, 1982.

10. What we mean here is that a lop-sided coverage of firms can bias any kind of disaggregated analysis. The percentage of coverage is not mentioned anywhere in the report. And this seems to be one of the limitations of this data set.

11. See Pillai, 1978. This seems to be the only study which analyses the public sector collaborations covered by the RBI survey. The study, of course, is based only on the first two surveys.

12. In 1978, the Fertiliser Corporation of India has been recognised and now comprise Sindri, Gorakhpur, Ramagundam and Talcher units.

13. We do not, of course, mean that all the consultancy organisation in the public sector are technologically stagnant in all branches of project execution. For instance, Engineers India Ltd., has a well-developed technological capability in providing engineering services to the petroleum, petrochemical and pipe line sectors. But its equipment design activity has relied mainly on imported know-how, and seems likely to continue to do so. For details see, Lall [1987, Pp. 183-188].

14. For a fairly detailed account of the role of foreign collaborations in IPCL, See Khanna [1984, Pp. 1319-1340].

15. A view is sometimes expressed that the target for "phased manufacturing programme" needs to be fixed after giving due concern for the availability of indigenous sources of intermediate, finished and semi-finished components. This is especially significant as the electronic components industry in the country is still in its infancy stage.

ABBREVIATIONS

APEL	Andhra Pradesh Electronics Development Corporation Ltd.
BEL	Bharat Electronics Ltd.,
BHEL	Bharat Heavy Electricals Ltd.
BHPV	Bharat Heavy Plates & Vessels Ltd.
BELTRON	Bihar State Electronic Development Corporation Ltd.
COPU	Committee on Public Undertakings
CSIR	Council for Scientific and Industrial Research
DSIR	Department of Scientific and Industrial Research
DGTD	Directorate General of Technical Development
ECIL	Electronics Corporation of India Ltd.
ETTDC	Electronics Trade & Technology Development Corporation
EILC	Engineers India Ltd. Corporation
FCI	Fertiliser Corporation of India
FACT	Fertilisers and Chemicals (Travancore) Ltd.
FDI	Foreign Direct Investment
FERA	Foreign Exchange Regulation Act
GCEL	Gujarat Communications and Electronics Ltd.
IPCL	Indian Petrochemicals Corporation Ltd.
ICICI	Industrial Credit and Investment Corporation of India
IDBI	Industrial Development Bank of India
IFCI	Industrial Finance Corporation of India
KELTRON	Kerala State Electronics Development Corporation Ltd.
MELTRON	Maharashtra Electronics Corporation Ltd.
MRTP	Monopolies and Restrictive Trade Practices
MNC	Multi National Corporations
NCAER	National Council of Applied Economic Research
NRFC	National Register of Foreign Collaboration
NFIR	Net Foreign Exchange Inflow Rate
PDIL	Projects and Development (India) Ltd.
R & D	Research and Development
SIA	Secretariat of Industrial Approvals
SPC	Solar Photovoltaic
SFC	State Finance Corporations
WEBEL	West Bengal Electronic Industrial Development Corporation Ltd.

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TECHNOLOGICAL SELF-RELIANCE IN INDIAN INDUSTRY

V.M. Gumaste

A constant lament about Indian industry, and the Indian economy in general, is the absence of successful R&D. Although the total stock of scientific and technical personnel rose from 1.88 lakh in 1950 to 17.82 lakh in 1980 and the expenditure on R&D rose from 0.17 per cent of GNP in 1958-59 to 0.89 per cent in 1990-91, "inadequate 'development' thrust is the basic limitation of Indian R&D", according to Parimal Mandke, among others. She continues. ...."There is a clear need to increase the 'development' type of research at every level of the national R&D system inclusive of industry both in the public and private sectors. The role of Indian industry in funding R&D is far from satisfactory when compared with that of its counterpart in developed countries. The growth of Indian industry, so far, has been without industry investing in its own R&D. The R&D system cannot gain strength unless there is a sizeable in-house R&D by the industry" [Journal of Indian School of Political Economy Vol. IV, No. 3, p. 440].

Why is this so? V.M. Gumaste suggests answers to some of these questions in his book based on a detailed investigation of R&D in 60 vehicle and ancillary units. These have been extracted below:*

TECHNOLOGY DEVELOPMENT; COSTS AND DIMENSIONS

Technology is generally the result of human effort and material resources. Since both can be put to uses other than the creation of knowledge, it becomes necessary to investigate the costs of creating technology *vis-a-vis* its benefits. But creation of technology is characterised by extreme uncertainty both on the cost and benefit side. Efforts to create technology may or may not be successful.

Cost of Technology Creation

Till the Industrial Revolution, technology meant 'arts and crafts' which were largely based on skills of hand and eye and on practical experience which was transmitted from generation to generation by some sort of apprenticeship or 'learning by doing'. In such cases technology creation and transmission were costless. Modern technology flows out of the research and development laboratories set up exclusively for the purpose of creating technology. R&D is at the heart of the complex process. A large proportion of new and improved materials, products, processes and systems come out of R&D activities and most of the technological progress now made may be traced and development work performed in specialised laboratories or pilot plants by full time qualified staff. What is distinctive about modern industrial R&D is its scale, its scientific content and the extent of specialisation. Freeman [1982] identifies three characteristics of modern technology. They are:

1. Its increasingly scientific character.
2. Its growing complexity and cost.
3. The general trend towards division of labour, with each laboratory or unit specialising in a small portion and component of the whole system, and having its own highly trained manpower, information services and scientific apparatus.

Technological innovation is often long and painstaking. As Fracasti [1984] says, innovation is much more than a new product or process. It is the result of a long series of operations requiring more time and involving more risk than other productive activities. It results in the transformation of an idea into a saleable product or a new or improved usable process.

Prerequisites of Successful Innovation

Innovations do not grow out of thin air. Their introduction presupposes certain favourable factors. Piatier [1984] lists the following as the favourable factors required for the introduction of innovations.

1. Large demand
2. Possibility of large scale production
3. Availability of funds
4. Availability of data
5. Possibility of direct application

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* The Article is extracted from *Technological Self-Reliance in the Automobile and Ancillary Industries in India* by V.M. Gumaste, published by Institute for Financial Management and Research , Madras 1988.

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6. Multiple uses
7. Mobility of qualified staff
8. Confidence in the possibility of solving problems

Since each of the above aspects is self-explanatory, there is no need to labour on their elaboration. It must be stressed, however, that some factors are exogenous to a firm undertaking innovations, while others are internal to it. Obviously, a firm has no control over the exogenous factors and can hardly influence them. Many Indian industrialists attribute lack of innovative activities in Indian industry to these exogenous variables.

Market-Pull or Research Push?

Innovations are triggered by research push or market-pull factors. There have been attempts to study the relative importance of the two on innovations. From available evidence it seems that market-pull exerts greater influence on them than research-push factors. Marquis [1969] for instance, found that 75 per cent of innovations are due to them. Haeffner [1973] assigns even greater importance to market-pull factors. According to him, research-push accounts for only 3 per cent of innovations. The greater influence of market-pull factors is easily explainable, because no head of an enterprise would embark upon a course of innovation merely on the basis of advice from his R&D engineers, without studying the market demand. Indeed, most failed innovations may be traced to a failure to monitor the market demand for the potential products or processes[1]. However, we should not underestimate the research-push factors in the innovation process. Schmookler [1966] feels that innovation is essentially a two-sided or coupling activity. On the one hand, it involves the recognition of a need, or more precisely, in economic terms, a potential market for the new product or process. On the other hand, it involves technical knowledge which may be generally available, but may also include new scientific and technological information, which results from original research activity. Experimental development and design, trial production and marketing involve a process of 'matching' the technical possibilities and the market. The professionalisation of industrial R&D represents an institutional response to the complex problem of organising this 'matching', but it continues to remain a groping in the dark, a searching for an uncertain future. The possibility exists of being overtaken by faster-moving or more efficient competitors or by an unexpected twist of events - either in technology or in the market.

Magnitude of R&D Expenditure

An idea of the magnitude of investment made in creating technology can be had from the R&D expenditure of the firms in industrialised countries (See Table on the following page). Over time expenditures are escalating exponentially. A company like the ITT of U.S.A., for example, spent $ 30-40 million to develop the pentaconta telephone exchange switch in the sixties. By the late seventies it spent $ 300-500 million to develop its 1,240 analogue of electronic exchanges and over $ 1 billion to develop its latest digital exchange 'System 12'. It is currently spending close to $ 100 million (Rs. 130 crore) a year just to adapt System 12, to US standards. It will require $ 14 billion for ITT to recoup its initial investment on System[12][2].

Halrid Corporation (later named Xerox Corporation) expended $ 4 million between 1950 and 1953 and a further $ 16 million between 1953 and 1959 on R&D to develop and perfect the xeroxing copier. RCA, another U.S. company, is said to have spent more than $ 65 million on colour television R&D, before anything resembling a mass market materialised[3]. On a more general canvas, available evidence points out that in the U.S., firms with 5000 or more employees originated 46 per cent of all value, added in manufacturing, but accounted for 88 per cent of the all expenditure on R&D incurred by manufacturing companies in 1958. Of the 378 firms with 5000 or more employees 350 or 93 per cent had formal R&D programmes[4].

Even a relatively 'minor' innovation requires large sums of money and considerable lead time and becomes viable only with a large downstream market. For instance, General Broach and Engineering Co., Mt. Clements, U.S.A., a relatively

obscure automobile ancillary unit, spent $ 0.5 million and 3 years to develop an 80 ton 275 h.p. broaching machine which will turn out 380 car, truck and other internal combustion engine fly wheels per hour[5].

Whose Business is R&D Any Way?

Available evidence unmistakably indicates that R&D is the province of large and giant organisations. A large organisation with enough market power can expect to cover development costs before the technology becomes obsolete. Small and fragmented markets are a big disincentive to R&D work. As development costs rise and product lives contract, it becomes even harder to recoup investment in a single national market[6].

Owing to these characteristics of high development costs and long development time required[7] and the scale of investment necessary, Freeman argues that only large enterprises can undertake innovation in most cases. He observes:

"In many key branches of industry the innovative process is dominated by giant corporations, often American-owned... Their strength is derived from the cumulative experience of R&D and scientific and technological services (STS) which established a technical and market know-how lead and is reinforced by static and dynamic scale. These assume increasing importance in these industries where technological complexity imposes high development costs for successive generation of equipment" [Freeman, 1982, p. 146][8].

COMPANY FINANCED R&D EXPENDITURE OF SELECT U.S. AND JAPANESE FIRMS

	Company	R&D Expenditure	R&D Expenditure as % of Sales
U.S. Firms (1980) ($ Million)			
1.	General Motors	2224	3.9
2.	Ford	1675	4.5
3.	I.B.M.	1520	5.8
4.	American Telephone & Telegraph (AT&T) (including Bell & Western Electric)	1338	0.8
5.	General Electric	760	3.0
6.	Du Pont	484	3.5
7.	Chrysler	278	3.0
Japanese Firms (1979) (Billion Yen)			
1.	Toyota Motor	104.0	3.7
2.	Hitachi	98.7	5.8
3.	Nissan Motor	90.0	3.3
4.	Matsushita Electrical Industries	50.0	2.9
5.	Honda Motor	38.0	3.6
6.	Toyo Kogyo	20.5	2.5
7.	Isuzu	18.6	2.9

Source: Freeman [1982] Table 4.5 a and b, p. 94.

Cost and time naturally keep this kind of research outside the scope of most firms, particularly in developing countries. Freeman cautions that a romantic policy which relies on encouragement of the small investor - entrepreneur would be hopelessly naive and ineffective in coping with most of the contemporary problems of industrial innovation. Large enterprises are very well suited to undertake vast R&D expenditure due to their ability to cross the threshold below which there is little possibility that innovations will be made. Galbraith has emphasised this aspect as far back as 1956 when he said:

"There is no more pleasant fiction than that technical change is the product of the matchless ingenuity of the small man forced by competition to employ this with that to better his neighbour; unhappily, it is a fiction. Technical development has long since become the preserve of the scientist and the engineer. Most of the cheap and simple inventions have, to put it bluntly and unpersuasively, been made. Not only is development now sophisticated and costly, but it must be on a sufficient scale....

Because development is costly, it follows that it can be carried on only by a firm that has the resources which are associated with considerable size" [Galbraith, 1956, Pp. 100-101].

Large establishments (not necessarily monopolistic organisations) have certain built-in advantages for undertaking R&D activities, *vis-a-vis* small units. Small firms place themselves in a dangerous position when they invest all their resources in a single innovative project whose technical and commercial prospects are far from guaranteed. Hence organised R&D is disproportionately the domain of the larger corporations.

Large corporations can afford to maintain a balanced portfolio of R&D projects letting the profits from those which succeed counterbalance the losses from those which fail. Yet another advantage of large units in undertaking R&D activities is the economies of scale in the conduct of R&D itself. A big laboratory, a variety of instruments and equipment, and the employment of specialists are investments which have a high degree of indivisibility. A large corporation can not only afford these expenditures but also can make use of these resources more optimally. The usual technical, financial, and marketing economies which large units enjoy help them in R&D as much as they do in their production activities. The large volume of their output enables them to give thought to cost cutting production technologies. Thus in R&D, only large is beautiful and profitable.

Threshold

In the light of what has been said above one can hazard some guesses regarding the threshold levels of R&D expenditures which have a good chance of being carried through and obtaining meaningful results. One can also calculate the threshold levels of sales turnover of companies which can make reasonable sums of money available for R&D. A rough idea of the threshold of sales turnover can be had from F. M. Sherer who observes, "A little bit of bigness - upto sales levels of roughly $ 75 million to $ 200 million in most industries - is good for invention and innovation" [Sherer, 1971, p. 36]. These threshold levels are at 1971 prices. Extrapolating them at 1986 prices, one may say that threshold sales levels could be somewhere between $ 125 million and $ 350 million. Only companies with these levels of sales turnover are likely to make effective allocation of sums for R&D.

This may be contrasted with the Indian industrial scene, where 75 per cent of the factories had an output of Rs. 20 lakh or under in a typical year, 1983-84[9]. They could not have undertaken any research at all[10]. Even companies with an average output of Rs. 20-25 crore or more cannot set apart the large sums required for R&D. As to the threshold levels of R&D expenditures, Maddock, former Controller (Industrial Technology), Ministry of Technology, U.K. has given some idea of the threshold level expenditure of certain technologies. Failure to reach this usually means complete failure - as opposed to partial success in more traditional fields of industry. The thresholds are set mainly by the scale of operation of large enterprises in the field. It is a folly therefore to attempt a technology which has a threshold which is beyond reach, unless it can be attacked on a very narrow front where the critical level can be reached. Many of these thresholds have been set by countries which have a large economic technological base - particularly U.S.A. and U.S.S.R. In descending order some rough figures for the thresholds are: space 10^9 U. S. dollars per annum, nuclear energy 10^8, microelectronics 10^7, computers 10^7, telecommunications-radio-radar 10^7, machine tools 10^6, industrial machines 10^5, and instruments 10^4. (These estimates are for the late 1950s. They will have to be extrapolated to 1986 prices to get an idea of the present threshold figures of R&D).

A point which is frequently missed in considering thresholds is the progressively growing costs throughout the innovatory process. Taking R&D costs as a unit of 1, the relative costs in many industrial technologies are:

(a) R & D	1 Unit
(b) Engineering prototypes, production planning, initial manufacturing facilities, market preparation specifications, inspections, staff training, etc.	10 Units
(c) Mass production, facilities, packaging, transport, marketing, post sales services and maintenance, write-off or previous products, etc., up-dating, etc.	100 Units

It is a common error to consider only the costs of the first (and the cheapest) stage and to overlook the much larger costs ahead. Lord Blackett, in his Jawaharlal Nehru Memorial Lecture describes this as the "Innovation Chain". A high level of research and development alone is not sufficient to ensure successful innovation. The industrial and commercial elements of the chain are equally vital. Actually R&D claims only a small part of the total costs of successful innovation - as shown above. For instance, the British textile material 'Terylene' was invented in a research laboratory running at less than $60,000 a year. When Imperial Chemical Industries obtained the U.K. commercial rights for this invention, it spent around $ 11 million on pilot plant development; and for the first major commercial production, the new plant cost around $ 40 million[11]. The economics of the innovation chain therefore needs to be clearly borne in mind if the investments on R&D are to be profitable, and not lead to frustration. Another important point to consider is that for each high threshold subject not attempted or abandoned, several lower threshold projects may be within reach. This calls for shrewd judgement of the efforts against the returns.

'Offensive' and 'Defensive' Strategies of Innovation

Since R&D activity is expensive, time consuming, and uncertain it is doubtful whether many firms can undertake it. Therefore, economists distinguish between those firms pursuing offensive strategy of innovation and those content with defensive strategies. The firm with an offensive strategy of innovation will normally be highly research intensive. It will aim at being first, or nearly first, in the world and hope for substantial monopoly profits to cover the heavy R&D costs which it incurs and the failures with which it has to live. Only a small minority of firms in any country is willing to pursue the offensive strategy. Most others pursue a path of defensive strategy of innovation. They consciously choose not to be first in the world, but do not wish to be left behind. But even defensive research cannot be undertaken for a song. The defensive research has to be near the threshold levels set by offensive research firms. To do that the 'defensive' firms have to set high levels - comparable to 'offensive' firms - R&D capacity. It may be noted that the threshold levels of R&D expenditures are absolute levels of research expenditures, not a ratio to sales. The 'threshold' figures can be turned into an estimate of the annual R&D expenditure required by dividing it by the lead times and making some adjustments for supporting research in materials, etc. This annual level of expenditure would be the minimum needed to maintain a defensive position in the market.

Several studies [Nelson *et al*, 1967, Schott 1975 and 1976, Sirilli 1982] indicate that most industrial R&D in many countries is defensive or imitative in character. Most of the firms indulge in 'technological gate keeping' i.e. they keep a constant watch on the new products and processes coming in the market. They incorporate the good or convenient parts of these innovations by small changes in their own products and processes. Thus they are mainly concerned with minor improvements, modifications of existing products and processes which have a short-term time horizon. In a monopolistically competitive market the process of product differentiation takes the path of defensive strategy of innovation.

TECHNOLOGICAL SELF-RELIANCE WITH REFERENCE TO THE AUTOMOBILE INDUSTRY

Since Technological Self-Reliance (TSR) has been defined by us as that stage of a country's technological capability which enables it to (i) obtain technology at least cost (ii) decompose the technology and progressively reproduce technology from the constituent parts and (iii) reduce

the country's reliance for technology from abroad, we thought it desirable to address ourselves to the following specific questions.

(i) Has the unit tied-up with any foreign source for its technological needs?
(ii) How frequently does the unit go to its collaborator for its technological needs?
(iii) How far has the unit been able to meet its technological requirements by its own efforts?
(iv) What changes has the unit introduced in its products or processes?
(v) How far have these changes enabled the unit to raise its profits and/or reduce its cost per unit?
(vi) What import substitution has the unit been able to effect in either raw materials or sub-systems?
(vii) In the case of vehicle manufacturers, what precise R&D activities have they undertaken to enhance the fuel efficiency and improve the utility of the vehicles in terms of greater ease of operation, reduction of driver fatigue, etc.?
(viii) What changes has the unit introduced in making the vehicle more suitable to Indian conditions, such as weather, climate, roads, driving and overloading habits?

Our investigation focussed on the R&D activities of firms: their size, nature, specific results, as well as the difficulties and problems faced in undertaking R&D. Of the units covered all vehicle manufacturers had a formal R&D department[12]. Most of the units manufacturing components, particularly the large ones, did R&D work on a regular basis. Small component manufacturers, however, did not have a formal R&D department. Their R&D activities were either sporadic or non-existent. Some of them engaged freelance consultants, some sought help from the IITs, the National Productivity Council, or the Automotive Research Association of India. Thus, R&D seems to be the business of large units in the automobile industry. The level and magnitude of R&D activities undertaken has to be assessed in order to know the intensity of their work. The one reliable measure of this is the annual R&D expenditure[13] although the number of R&D personnel engaged could also be a measure of extent of R&D work. We shall take R&D expenditure first.

Expenditure on R&D

In terms of absolute R&D expenditure, vehicle manufacturers spend more than ancillary units. The largest R&D expenditure was as high as Rs. 7.5 crore per annum in the vehicle sector and Rs. 2.84 crore in ancillaries. The lowest was Rs. 1 lakh for vehicle and a mere Rs. 20,000 for ancillaries. Surprisingly, ancillaries spend proportionately more on R&D than vehicle manufacturers (Table below). In relative terms, the R&D expenditure as a percentage of turnover works out to 1.46 for ancillary units, compared with 0.76 per cent for vehicle manufacturing units. This may be explained in terms of two factors, viz. (i) R&D expenditure has certain built-in indivisibilities and thresholds. Due to the high unit value of vehicles the proportion for these units appears smaller than for ancillary units and (ii) a portion of the development expenses incurred by ancillary units is shared by vehicle units. Thus a part of the R&D efforts of component manufacturers is really borne by the vehicle manufacturing units.

ANNUAL R&D EXPENDITURE

(Rs lakh)

	Average	Maximum	Minimum	R&D expenditure as % of turnover
Vehicles	83.4	750.0	1.0	0.76
Ancillaries	37.0	284.0	0.2	1.46

R&D EXPENDITURE AND INTENSITY

	Average R&D Expenditure (Rs. Lakh)	R&D Expenditure as a % of Sales Turnover
MRTP companies	114	0.71
Non-MRTP Companies	14	1.42
Companies with foreign collaboration	56	0.79
Companies without foreign collaboration	78	0.98

An attempt was made to find out if the fact that a firm was an MRTP company, or has foreign collaboration, had any bearing on the intensity of its R&D activities. Some of the findings are shown in the Table above.

From the information presented in the Table it appears that MRTP companies, with their large assets and turnover spend more on R&D compared with non-MRTP companies. It is possible that one of the provisions of the MRTP Act covering R&D expenditure aimed at productionising the technology developed, may have acted as an incentive for spending more money in absolute terms. However, in relative terms, non-MRTP firms spend nearly 1.42 per cent of their sales turnover on R&D while MRTP companies spend only 0.71 per cent. The normal expectation that firms without foreign collaboration spend more money on R&D is amply borne out by our study[14]. Firms without foreign collaboration spend nearly one per cent of their sales turnover on R&D in contrast with 0.79 per cent by firms with foreign collaboration. In absolute terms also, firms without foreign collaboration spend more (Rs 78 lakh, on an average), on R&D than firms with foreign collaboration (Rs 56 lakh).

A possible explanation for the greater dynamism of firms without foreign collaboration is that since they do not have technical help from outside and have to fend for themselves, they spend proportionately more on R&D than those which get such help. An UNCTAD study felt that, "in their (firms with foreign collaboration) case, it seems that the benefits of centralised R&D at their headquarters outweigh the advantage derived from the lower cost of local research personnel". For the two major CV manufacturers in India, this explanation comes closest to facts. The firm without foreign collaboration is technologically highly dynamic. The other firm which is still a subsidiary of a multinational has not shown much technological dynamism.

R&D Personnel

The other measure of R&D intensity is the number of R&D workers in a given firm. Some large firms employ a fairly large number of R&D personnel. The successful CV manufacturer mentioned earlier has an elaborate R&D set up employing nearly 1000 persons. A tractor unit covered by us engaged nearly 250 persons in its R&D centre. Others are more frugal. On an average 30-35 persons are employed by reasonably large concerns in their R&D units. Smaller ones employ between 15-20.

The ratio of R&D personnel to total employees is used to denote the extent of R&D activities. In the units we covered the average ratio was 2 per cent, i.e.,for every 100 workers there were 2 R&D workers. However, in a few units, there were 6 to 7 R&D workers for every 100 employees. Many units had a ratio of below 1. These statistics, however, need to be looked into with care. The exact line that divides R&D employees from production and other workers is not quite clear. Departments like quality control, product performance etc., are often clubbed with the R&D giving a higher ratio of R&D employees to total employees. Nevertheless, the overall low ratios of R&D to total workers in the Indian automobile and ancillary industry suggest that the R&D culture has not penetrated the industry.

Status of R&D Chief

It is felt that the status of the chief of R&D in the corporate hierarchy of a unit has an impact on the quality of R&D work done. If a fairly high status is accorded to him, his ego is satisfied and this has an impact on R&D work.

Also, when the R&D chief has a reasonably high status, communication between him and his unit and the No. 1 of the concern, and inter-face with the rest of the departments in the concern improves vastly. Since optimum flow of management information has an important bearing on the health and growth of the firm, good communication between the chief of R&D and the heads of the different departments would greatly affect the financial fortunes of the firm, particularly in the long-run. On the other hand, if R&D is considered to be of mere decorative or cosmetic value (mostly to gain a number of fiscal and other concessions) to the unit, the R&D chief would be obviously a low ranking man. It follows that if a unit wants to take up R&D with seriousness and wants to contribute to the unit's growth, then it will accord a fairly senior position to the R&D chief.

Our findings reveal that in many of the units engaged in R&D, the chief has either the third or fourth rank in the hierarchy, i.e. there are at least two other persons above him to whom he has to report. This we feel is a rather low status. However, in about 20 per cent of the units covered, the chief of R&D enjoyed the second position, i.e., he was directly accountable to the No. 1 in the unit. These were the units which have an ongoing R&D centre and meaningful R&D programmes before them. TELCO, the No. 1 commercial vehicle manufacturing unit has gone even further and accorded the membership of the Board of Directors to the chief of their R&D centre. This is ample testimony to the importance the unit gives to R&D activities. A number of R&D chiefs, however, were of the view that the R&D unit is considered the 'Harijan' of the concern and a person found inconvenient in some other department is dumped on the R&D departments in many cases[15], and that they are regarded as cost centres and the R&D personnel as parasites of the unit. Such an approach and culture, strongly militate against meaningful R&D.

Recruitment and promotional prospects in R&D units also leave much to be desired. All R&D units felt that it was very difficult to get qualified and talented persons for R&D departments. This is because while R&D has many challenges, there are no commensurate rewards[16]. While sales and production personnel get fast promotions for their work, those in R&D departments do not.

Does this have any impact on technological dynamism? The status of R&D persons even in advanced countries such as the U.S. and the U.K. is much the same as in India. Wolif (1979) and Gunz (1980) speaking of the status of R&D persons in the U.S. and the U.K. bemoan the same "low status" and "second-class citizenship" in those countries as well. Thus offering status, promotions and rewards could at best be of peripheral value in getting the best out of the R&D manpower resources in India.

Competition and R&D

The Indian automobile industry has been sheltered by effective protection. An absolute ban on import of cars, scooters and CVs has given Indian producers of these items complete protection from foreign competition, though a mild degree of internal competition exists due to rivalry amongst different producers of the same item. Whether this is strong enough to stir them to innovations and R&D activities is difficult to say. Schumpeter felt that the process of technical change comes about when a firm is "compelled" to change by the threat of cheaper and/or "better" products being made available by competing firms and failure to change results in reduced revenues, or revenues increasing at a slower rate than they might if changes were undertaken.

But threat or compulsion to change is in itself not enough for technical change to actually take place. Rosenberg [1976] has suggested that besides the threat of losing money there must also be an incentive to make money if a technical change is to take place. If both pressure and incentive, exist simultaneously then technical change is most likely to come through. There is reason to believe that due to a variety of policy

measures such as restricted entry, price and distributive controls, capacity restrictions, MRTP regulation etc., the incentive for technical change has been seriously eroded by the Government of India. Thus limited competitive threat and poor incentives for gain have frozen technical change in the Indian automobile industry.

Incentive as a carrot is not measurable, but a threat due to rivalry (competition) is. We can measure the degree of competition within the various segments of the industry through two indices. There are the so-called 'H' index and 'E' index. The former index provides a good understanding of the average size of firm in relation to industry. The latter shows the degree of market power and the index stands for inequality of the firm size. The two indices are:

$$(i) H = n\sigma^2$$

$$(ii) E = \frac{\sigma}{m}$$

Where n is the number of firms, σ^2 the variance of the size distribution of firms, σ the standard deviation and m the mean size of firms. If all firms are equal in size then the H index will be equal to zero. If firms are highly unequal in size then the H index will be a positive number whose value depends on the degree of inequality and the number of firms in the industry or its demarcated segment. The E index will tell the likely control over market supply and price. The higher the value of E the more will be such control and vice versa. We give below the value of the H and E indices for different segments of the automobile industry and the corresponding percentage of R&D expenditure.

Segment	H index	E index	R&D Expenditure as % of sales turnover
HCV	0.8	0.52	0.65
LCV	0.8	0.52	0.35
Cars	0.8	0.52	0.72
Scooters	0.021	0.36	0.27
Motor Cycles	0.05	0.45	0.64
Mopeds	0.03	0.41	1.81

Ancillaries: Number of firms 216, products assorted, difficult to work out H and E indices.

The data above suggests that the Schumpeterian dictum may not hold good in the Indian context. There appears to be very little correlation between the degree of competition and the R&D expenditure as a percentage of sales turnover i.e., intensity of R&D expenditure does not increase with the increase in the degree of competition. Amongst four wheeler manufacturers (cars, LCVs, and HCVs) although the H index is the same, the R&D expenditure varies from as low as 0.35 per cent of turnover to as high as 0.72 per cent. Among two wheeler manufacturers, the Schumpeterian dictum has some validity. Motor cycles and mopeds which are relatively more competitive, show somewhat higher R&D intensity compared with scooters. The E index stands for control and influence over market supply and has to be seen through its ability to control prices. In the Indian situation where market supply and prices are under regulation by the Government, there is hardly any room for such control of prices.

Rosenberg's hypothesis seems to have greater validity as far as the intensity of R&D in the Indian automobile industry is concerned. He is of the view, as we saw above, that incentive is a more powerful drive for greater activities in the R&D departments. Since Indian automobile manufacturers have very little or no incentives, thanks to a number of trade, industrial and other regulatory policies, and as they are also operating behind high protectionist walls, they find R&D expenditure unproductive.

In comparison with the absolute sums of R&D expenditure in the automobile industries in developed countries, Indian R&D expenditures

are like eddies against giant tidal waves. However some units, particularly among vehicle manufacturers, do have ambitious R&D programmes and earmark sums of money that are substantial by Indian standards for R&D. Whether Indian R&D expenditures are above the threshold barriers[17] has to be judged in the light of the nature of R&D in the Indian automobile industry.

Nature of R&D

R&D in the Indian automobile industry has two main features. In most cases it provides support to production departments and quality control. Secondly, it is involved in achieving incremental innovations, like adapting imported technology to suit Indian conditions. Our investigations reveal that the principal activity of R&D in the Indian automobile and ancillary industry is product design, process innovation and adaptation of imported technology. The relative significance of these different activities of R&D is shown in the Table below.

NATURE OF R&D IN THE INDIAN AUTOMOBILE INDUSTRY

R&D Activity	Percentage in units surveyed
1. Product design	68.85
2. Process innovation	58.54
3. Adaptation	58.54
4. Modification	51.22
5. Basic research	14.63

As the Table above suggests, basic research is undertaken by very few firms. This is understandable, in view of the fact that they have neither the time nor the resources needed to undertake this activity. Among the companies surveyed, one company manufacturing brake systems reported that it undertakes basic research in heat treatment and heat transfer.

Product design and adaptation were of prime importance in R&D in the companies surveyed. The two large commercial vehicle manufacturers were observed to have done reasonably good R&D work to make their vehicles suitable for Indian roads and the overloading habits of truck operators.

Units with ongoing foreign collaboration seem to have somewhat different priorities in their R&D activities compared with units without foreign tie-ups. Of the units which responded to our questionnaire on the nature of R&D, three out of every five units had ongoing collaboration and the remaining two were on their own. The Table below presents the nature of R&D in units with and without foreign collaboration.

NATURE OF R&D (IN PER CENT)

Nature of R&D	Units with foreign collaboration	Units without foreign collaboration
Product design	52	93
Process innovations	49	73
Adaptive work	78	67
Modificatory	65	73
Basic research	4	27
Import substitution	43	66
Material substitution	8	

While nearly all firms without foreign collaboration were engaged in product design, only half the number of units with foreign collaboration did so. Similarly while three quarters of the former also undertook process innovation, slightly less than half of the latter did so . Thus for almost all categories of R&D work units without collaboration addressed themselves to a larger number of activities than those with foreign collaboration. This could be interpreted as loss of autonomy for firms with foreign collaborations.

Specific Results of R&D

A large number of incremental innovations have been reported, both by vehicle manufacturers and ancillary units. ..... How far are these innovations significant and how far do they enable the country or firms to achieve TSR? Most of the innovations, it must be stressed, are adaptive and modificatory. This is important in as much as technology obtained from abroad, particularly in the automobile and ancillary industries has to be greatly modified, downgraded and adapted to the specific conditions in India. Adaptation often takes the form of material substitution, import replacement and cost cutting. There is evidence to believe that this objective of R&D - which contributes a great deal to TSR has been accomplished by the industry reasonably well. But these R&D activities have not enabled the firms to introduce new products and processes, by themselves - excepting in the case of some units. Nor have they pushed forward the technology frontier. One knowledgeable R&D functionary told us that these R&D activities have, at best, enabled them to stay where they are and not go under. Incremental R&D should have, over time, been cumulative but unfortunately this has not happened. For new technology, our automobile industry still has to go abroad scouting for new collaborators. Compared with the Brazilian and Korean automobile industries, the Indian industry has not shown technological dynamism.

Difficulties in Conducting R&D

Our investigations suggest that conducting R&D in the Indian automobile industry is not without difficulties. Only 27 per cent of the companies surveyed felt that they faced no difficulties in conducting their activities in the field. The relative importance of the various constraints on the smooth conduct of R&D is shown in Table below.

CONSTRAINTS ON CONDUCTING R&D

Nature of Difficulty	Percentage of responding units
1. Funds	14.6
2. Government policies	24.4
3. Personnel	14.6
4. Equipment	15.0
5. Size of Market	14.7

Nearly a quarter of the firms surveyed felt that Government policies are a positive drag on the conduct of R&D. Many Government procedures, regulations and restrictions were regarded as hurdles in the way of R&D work. It was stated that the rules and regulations of the Department of Science and Technology (DST) which accords recognition to R&D departments in the industrial units were not always conducive to such activity. It was argued that the teams visiting R&D units to accord recognition, more often that not, consisted of bureaucrats. As a result of this, recognition of R&D units has become a function of drawing boards and draughtsmen rather than the nature and intrinsic quality of the work being done.

R&D activity in any industry as technically complex as the automobile industry has become more and more equipment intensive. R&D engineers aided by right and adequate equipment would be much more productive than those working without such equipment. For instance, experience has shown that there is a direct saving in time to the extent of 35 to 50 per cent on sketching and design layouts, 60 per cent on bills of material and 100 per cent in inking and drawing by using computer aided design (CAD). The saving in overall product time can be three to four times as compared with conventional methods. Similarly computer aided engineering (CAE)

enables a product to be simulated, tested and evaluated by a computer before it is even physically built. This results in substantial time and cost reduction of the product development activity. But R&D functionaries in the Indian automobile industry face a number of difficulties in obtaining such facilities for their work. It was contended that import duties levied on the equipment needed for R&D are heavy. For example, even when a sample is sent free from abroad, a duty of 160 per cent is levied on it. R&D functionaries feel that the concessional duties applicable to imports of production equipment should be extended to R&D equipment as well. A number of R&D functionaries are of the view that there should be no duty on equipment needed for R&D.

The following policies and actions which specifically dampened innovation and R&D efforts were brought to our notice.

1. An effort made by a car manufacturing unit to develop higher combustion ratios and higher levels of thermal efficiency in their engines had to be given up as their demand for higher octane content in petrol was not conceded by the government.
2. Some tariffs levied by the government are a positive drag on indigenisation. Illustratively, an imported component would attract an import duty of only 45 per cent whereas inputs required to manufacture the same component indigenously would be liable for an import duty of over 160 per cent.
3. One car manufacturer had developed a totally new model sometime earlier. It required heavy retooling to productionise the prototype commercially and hence the investment cost was heavy. The unit requested a small price hike for the new car, but this was not given.

On the other hand, Government's restrictions and regulations are defended by some R&D functionaries. They feel that industry often misuses Government concessions and facilities. Equipment for R&D is, for instance, diverted to production, and tax concessions are grossly misused. Government restrictions, they argue, are necessary as long as there is no commitment to R&D.

In roughly 15 per cent of the firms covered other factors were regarded as problematic. They are dealt with below.

Funds, it appears, are not a severe constraint in most of the large organisations both in ancillary and in vehicle units[18]. However, an overall budgetary constraint is felt. One major tractor manufacturer felt that more funds for R&D are needed when a company's market share is declining, but it is precisely at this time that a company cannot spend more on R&D.

Most of companies feel that getting the right people for R&D work poses a serious problem. Many engineers shun R&D as the rewards - both pecuniary and non-pecuniary - are inadequate. A number of R&D persons are of the opinion that in R&D there are more challenges than commensurate rewards.

Equipment, particularly laboratory equipment of high sophistication, is not to be found in India to any significant extent. This mars the productivity of R&D engineers.

The attitude of management towards R&D is, by and large, anything but helpful. Managements have a very low tolerance level of failure. Since the probability of success in R&D is not high, it does not receive adequate encouragement. Most have little faith in the creativity of their R&D personnel. This seems to be a chicken and egg problem. Creativity cannot be developed unless there is a substantial amount of trial and error. The latter will not be permitted unless there is evidence of creativity.

One of the difficulties in conducting R&D, which is often ignored is vested business interests and business ties. They pose problems and retard the pace of innovation. For instance, an innovation to change from a leaf dynamo to an alternator in a defence vehicle was stalled for a few years as the supplier did not have the capacity to supply the new equipment. He argued that the contemplated change-over would be detrimental to the optimum functioning of the vehicle. He supported the change only when he set up the product line after 3-4 years.

Existing arrangements with foreign collaborators and ancillary suppliers also come in the way of innovation. Foreign collaborators normally do not give a free hand to their Indian partners to go

ahead with the introduction of new concepts and changes. Tie-ups with ancillary suppliers also play the same detrimental role in this regard.

General Constraints

R&D engineers need three kinds of support. They are:

1. Support from the workshop,
2. Support from the laboratory for evaluation of the work done at various stages; and
3. Support from the design office and from the library.

Due to lack of such support in adequate measure, the R&D engineer in India is in a disadvantageous position. The R&D engineer abroad has an extensive data base and fundamental information to fall back upon. For instance, if he wishes to make up a shopping list, he can look at the various catalogues and select the best and nearest possible component. Provided he knows roughly what he needs, he can be sure of getting the standard product. This facilitates his work immensely and raises his output and productivity. The Indian R&D man on the other hand lacks test data and can expect little standardisation. Therefore he cannot profitably go around shopping for the important and critical inputs that he needs.

HAS INDIA ACHIEVED TSR?

The answer to this question depends on how we define and understand TSR. If by TSR we mean the ability to identify sources of technology, effectively bargain and obtain technology on the most favourable terms, carry out modifications to the imported technology, improve it independently, introduce new products and processes through incremental innovations, we may say, with minor qualifications, that India has achieved TSR. But if by TSR is meant the introduction of radically new products and processes, breakthroughs on the technology frontier or a level of competence which will enable the country to be completely self-sufficient in its technology requirements, and export products competitively in international markets,[19] then we have to concede that India is still far from TSR, and may not achieve it. This is especially worth pondering over in view of the fact that technological development requires huge sums of money and resources in men and time. Perhaps in such areas it is desirable that the principle of comparative advantage is allowed to work than attempt to achieve the goal of autonomous technology.

TSR as visualised by the GOI was aimed at fashioning of a mix of imported and indigenous technologies in which the proportion of the latter must increase with time'. *Ipso facto* TSR was thought of as a strategy which will reduce the proportion of imported technology. How far has this materialised with respect to the automobile industry? Reduction of imports of technology can take place either through forced reduction or through voluntary reduction. Forced reduction of imports of technology is imposed by the Government, while voluntary reduction of imports of technology comes through the country's ability to indigenously generate all the technology it wants particularly if there is a comparative advantage in doing so.

Available evidence suggests that in the Indian automobile industry, there has been a forced reduction of technology, which has resulted in technology in the country remaining static. The imported technology has been assimilated and adapted to suit Indian conditions. But technological dynamism which will enable the country to push forward the technology frontier does not appear to have been achieved. Two factors can be identified as causes for this state of affairs. The pace with which the technology frontier moves forward in the automobile industry is too fast for the Indian industry to keep up or overtake. The other is that India simply does not have enough resources to do it.

As far as the areas of power pack (the engines) and transmission (gears, clutches, etc.) are concerned we are absolutely nowhere near the goal of TSR. This is no reflection on the capacity of Indian engineers and scientists. The whole area of engine improvement, is devoid of easy and quick solutions. R&D resources the world over are pooled to make inch-by-inch dents in it. It consists of basic research in areas such as metallurgy, designing, fuel-injection, etc., and has to be a combined effort which requires prodigious

sums of money and frustrating length of time. To think that India would be able to attain TSR in such areas is being unduly optimistic.

Of course working out progressively different configurations of power pack, transmission, weight shedding, precision engineering etc., may yield some marginal results in fuel economy. As of now India is capable of achieving good results in this area provided that conducive industrial and technology policies are pursued to hasten the work. But there are many areas where technology development abroad is of little use to us.

Relevance of Advanced Country Technology

Advanced countries are spending large sums of money on developing and improving automobile technology. Some of the main directions in which development activities are moving are weight-shedding, aero-dynamics (drag co-efficients), automatic transmission, alternative fuels, etc. Many of these developments and the technology involved in them are of little relevance to Indian conditions. An automobile, like food, has to be country specific. The Indian user of automobiles - be it a two or three wheeler, or a bus or a truck- has certain specific expectations from his vehicle. If he is a two-wheeler rider he expects it to carry him, his wife and children in reasonable comfort and safety. A lower weight of the vehicle by a few kilograms, perhaps by the use of plastics, does not excite or interest him. He basically looks for a rugged vehicle, able to run on roads of indifferent quality, a sari guard, a few attachments to enable him to carry his shopping items, etc., and a low initial cost price and subsequent ease of maintenance. Under such circumstances reduced weight of the vehicle could even be of negative value to him. A truck operator (or driver) looks at the capacity of the vehicle to carry maximum loads for long distance, and a smaller body weight of the vehicle by a few kilograms does not interest him. Since he loads the vehicle rather irregularly (depending on the merchandise he is required to carry) the technology of aerodynamics has often no relevance to his needs. Some other sophistications like automatic transmission, power steering, etc., may perhaps add to the ease of operation of the vehicle,; but their incorporation pushes up the price of the vehicle to prohibitively high levels. For instance, the technology of automatic gear changing in a vehicle is estimated to lead to an escalation in the price of a truck by atleast another Rs. 85,000 to 95,000. How many truck owners are prepared to buy a truck having such sophistication with a price tag higher by nearly a lakh of rupees?

Under such conditions one should not be carried away by the technology gap in the automobile industry between the developed countries and India. In India ruggedness, operability or rough roads, ability to carry maximum loads, lower initial price, ease of getting the vehicle repaired anywhere, etc., are at a premium. In this respect, the balance sheet of TSR in the automobile industry is not too unsatisfactory. Indian vehicles may lack sophistication but they run fairly satisfactorily with excessive loads on roads whose quality leaves much to be desired, using fuels that are not pure. A number of technology collaborations in the industry in recent times have failed, because what the Indian consumer wants is not what the supplier of technology offers. A collaboration for manufacturing commercial vehicles with a leading world manufacturer failed to click because of this.

This is not to say that India has reached the zenith of the technology frontier even in meeting its own specific requirements. A good deal needs to be done and substantial benefit can be derived from selectively chosen foreign collaborations for importing technology. The point, however, bears stressing that it would not be correct to measure the technology gap by the differences between the vehicles of advanced countries and the vehicles in India. The technology gap which needs to be closed is between the technology we want and the technology we have. This gap is really not so large as some would have us believe.

Comprehensive Effort

In order to close the technology gap, efforts will have to be made not only by the automobile industry, but by all others providing inputs, both directly and indirectly, to it. The following are three cases in point.

Steel is a major input in the automobile industry.

It is used in making engines, gears, transmission shafts, cylinders, bearings, chassis, body suspension, etc. as well as in fabricating fuel tanks, air tanks and tubings. The automobile industry consumes a variety of steel. Many of items in the engine are made of alloy steels with inputs of pig iron, scrap, black and bright steel, round and square bars. Other items are made out of low carbon steel flat products. The latter form the major chunk of the steel input. The estimated consumption of flat steel in 1985-86 was 530,000 metric tons or RS. 530 crore in value terms. Of this 320,000 metric tons were cold-rolled steel and 228,000 metric tons were hot-rolled steel. In cold rolled steel again, the automobile industry requires some Deep Drawn Steel (DD) and some Extra Deep Drawn (EDD) steel.

The industry gets only 44,000 metric tons or approximately 15 per cent from domestic sources and the rest has to be imported. The Bokaro Steel Plant (BSP) is the only source of supply of DD and EDD category of steel, and the quality of it is far from satisfactory. Inconsistency in chemical and mechanical properties, variation in thickness beyond acceptable limits, inadequate formability, and poor surface finish are some of its major defects. Besides, BSP's commercial practices also need to be improved. Hot rolled steel too has to be substantially imported. Since the lead time between placing an indent and getting imported steel is between 12-15 months, the quality of the imported steel deteriorates due to 'ageing'. These problems with the steel used in the automobile industry are reflected in the poor quality of the final product and the inability of the automobile industry to produce vehicles of international standards.

The automobile industry is also a major user of anti-friction bearings. It uses as many as 6000 types of bearings, of which only 650 are produced in India. In terms of aggregate quantities, of the 80 million bearings only 40 million bearings are produced indigenously. Although most of the 18 units producing bearings have foreign collaborations, the product is of inferior quality. The price of domestically produced bearings is however 6-times higher than those made abroad. It may be noted that the bearing industry also is the user of steel of a particular grade and quality.

Machine tools are extensively used in the automobile industry. But the industry's requirements of sophisticated and advanced machine tools are not met by domestic manufacturers. Most of it has to be imported. Numerically controlled machine tools and machining centres are new developments which promise to revolutionise productivity in the automobile industry. Unless Indian industry makes extensive use of them, the quality and performance of our vehicles will not match those produced in developed countries.

It would be futile to expect a flower to bloom in a desert. We cannot expect our automobile industry to produce vehicles of world standard unless technology upgradation and modernisation takes place in all the upstream industries. Technology development in an import restricted economy is a cumulative process. One cannot expect high levels of technology in one industry unless all other industries are also technologically up-to-date.

India could have done far better on the technology front. The levels of technological capability attained by countries much smaller and the time in which they have achieved it, begs the question whether India could not have done at least as well, if not more. The technology of our machine tools, and other engineering goods is way behind the technology of countries such as South Korea, Brazil and Taiwan. One conspicuous input which is missing in the case of Indian products appears to be the exposure of our products to international levels of technology[20]. Over-protection from international competition and technology is the principal factor behind the technological obsolescence of Indian industry.

The lack of technological dynamism in India has to be traced to imperfections on both the supply and demand side. On the demand side our markets do not appear to be sophisticated enough to necessitate continual technological change. Bell and Scott-Kemmis quote an Indian manager who says,

> "The market in India is not that sophisticated. Our economy is really very patchy.... There are many areas where technology is about 10 years behind the developed countries. But many firms

don't accept this, they don't accept the need to change and to learn" [Bell and Scot-Kemmis, 1985, p. 1991].

Quoting another manager of an Indian firm the above authors found,

"...There is very little pressure for technological excellence and little incentive for technical change" [Bell and Scot-Kemmis, 1985, p. 1990]

Our customers are not demanding and our markets are not competitive. Hence our firms operate in an atmosphere free of threat.

On the supply side, the Indian industrial milieu is not well developed as of now. In order to introduce technical change what is required is one that offers a shelf of technologies, opportunities and ideas. If this is present, there is reason to believe that technological dynamism will permeate the firms and the urge to change will become internalised in the firms' objectives. This will result in a constant search for improvements.

It must also be observed at this stage that since firms have limited R&D resources at their disposal, after involvement in adaptation, modification and material substitution there is little or nothing left for pushing the technology forward[21]. This perhaps explains why Indian firms are not innovative in the true sense of the term. As for new products or product designing, they often have to go abroad in search of new technology[22]. This however does not mean Indian industries are not comparable to their foreign counterparts. To fill the gap between what has been achieved and what could have been achieved some action oriented programmes both from the industry and from the Government must be undertaken. We suggest some possible lines of action on the Government side.

Response Expected from Industry

Barring a few exceptions in the vehicles and ancillary units, industrial units have not done well in absorbing the technology imported and hence require to go to foreign sources frequently. Our survey suggests that Indian industrialists do not have confidence in their R&D functionaries. This 'confidence gap' is a sore point with many R&D functionaries. Many of them are confident that given funds and reasonable time, they can develop the types and kinds of vehicles and components which India needs. But owing to lack of confidence in their capability industrialists go abroad in search of technology. Ashok Desai's views come close to our findings. He says:

"...a major reason for the lack of technological dynamism in Indian firms is management. Firms abroad often pay considerable compliments to Indian engineers and attribute the gap between their potential and achievements to managerial practices". [Desai, 1985, p. 1973]

Even the technology imported many times is hardly altered to reflect local conditions[23].

Many R&D functionaries strongly feel that import of foreign technology means trips abroad and ways to quick gains. Frances Stewart comments, "In the context of present day LDCs, there is the factor of foreign interests which can become so inter-twined with local interests that local decision-makers favour the use of foreign innovations as compared with the local ones. In trying to explain why some societies innovate effectively and others do not, the fundamental and underlying explanation seems to lie in the realm of history and interests rather than in particular policies.

Hence a major element in any work on indigenous technical change should be to trace how interests and rewards of major decision-makers relate to a static or dynamic environment and to local or foreign sources of technology" [Stewart, 1984, p. 88].

Although one may or may not fully share this view, it is nevertheless a fact that one of the reasons for frequent imports of technology is that it provides decision makers opportunities to go abroad, make money both in the purchase of technology and the attendant components and equipments. At the regulatory level too, government officials find it convenient to approve imports of technology for the same reason.

Above all, it is the glamour, prestige and better commercial prospects associated with foreign technology and brand names which induces Indian industry to go for foreign tie-ups, even at the cost of slighting domestic capability and

creating an artificial reliance on foreign technology. In the ultimate analysis, the overwhelming preference of Indian industrialists for foreign technology must be traced to its commercial prospects, which rests on the average Indian consumer's mania for foreign technology and brand names. One exception, the case of Punjab Tractors Limited (PTL) in productionising a domestically developed technology, is worth mentioning. An important factor which contributed to its success was that the potential users of the tractors viz., farmers were *tabula rasa* for technology. To them, it mattered little whether the tractor was designed in India or abroad as long as it functioned satisfactorily[24]. Until the Indian consumer comes out of his mania for foreign technology and brand names, there is very little prospect of overcoming this hurdle to TSR. But there are some bright spots in an otherwise gloomy picture. Some bold, continuous sustained and successful efforts have been made to overcome this. Surprisingly, successes have been achieved due to the determination of the units to do so on their own.

There is evidence to show that where an industry firmly and sincerely aims at TSR, is prepared to develop the technology indigenously and make genuine efforts towards it, worthwhile results have been achieved. TELCO is a case in point. Since it also operated under the same government policies and regulations, recruits its personnel from the same pool from where the rest of the industry obtains its manpower, it will be seen to have done extraordinarily well, through committed efforts in that direction of TSR.

Our study also indicates that industrial units where foreign control, in one form or the other, exists have not done as well as those which are free of it. MNCs, subsidiaries of foreign companies, companies having foreign collaborations have shown much less interest in both R&D activities and achieving higher levels of TSR. One reason for this is that foreign companies exercise close control over their Indian partners and leave very little or no freedom to them. Most of them assume a big brother [attitude] towards their Indian collaborators. This retards the process of TSR. This is not to say that units with foreign participation do not undertake R&D. They do. But their R&D may not be relevant to the immediate needs of the country. MNCs in particular treat the Indian units as mere outposts of their principal units. Their R&D therefore is geared to their world view of priorities and preferences. If their R&D activity is incidentally directed to Indian requirements it is by accident and default rather than by design. Hence greater Indianisation of the ownership of companies will further the goal of TSR.

Government Policies

After having closely seen and observed the R&D scenario in the Indian automobile and ancillary industry, one wonders whether Government can influence the tempo and direction of R&D efforts in the industry. Either way Government policies appear to have very little bearing on the R&D undertaken by industrial units.

Government has attempted to promote the goal of TSR through a variety of measures which can be broadly grouped into two categories. One set of policy measures seeks to regulate the influx of foreign technology and the second to support and promote indigenous efforts to generate technology. But a careful review of these policies and measures makes one wonder whether the government has any consistent programme of reaching the goal of TSR.

Its policy of restrictive imports of technology seem more an outcome of the dearth of foreign exchange than a measure to promote indigenous efforts of generating technology. To Government ministries, technology policy is a second order issue dependent upon the resolution of the more pressing first order problems of balance of payments, fiscal policy, employment and inflation. When the first order problems are tentatively resolved, the technology policy might receive recognition in the form of either a government plan or a minister's speech sermonising people to use appropriate or indigenous technology. In the day-to-day routine of administration, however, technology policies play a minor role.

To understand the behaviour of the technology policy, it is necessary to find the link between first-order and second-order issues, i.e., to

understand how first order decisions constrain and shape second order decisions and then how second order decisions in turn influence future first order decisions. In practice, for an analysis of technology policy, it is necessary that the overall economic environment be taken into account so that the growth of first order aggregates are specifically related to technological decisions. We have elsewhere made an attempt to identify such links between first order and second order policy issues.

The one first order issue which will have far-reaching positive impact on technology policy aiming at TSR, we believe, is the faster growth of the economy. A sluggish economy is a technologically dependent economy. Some contemporary economic developments do bear this out. Korea, Brazil and Taiwan which began on almost the same level as India have far outdistanced India in achieving higher levels of technological capability. A conspicuous feature of these countries is their higher growth rate. Faster moving economies have a built-in-tendency to move towards TSR. Higher levels of absolute investments, lower CORs, [Capital Output Ratios], a reasonably well provided infrastructure would take the economy on a faster track and the goal of TSR will be promoted without explicitly aiming at it.

We set out below some suggestions for short-term and specific government policies which are most likely to subserve the objective of TSR:

1) Expose Indian firms to a greater degree of international and internal competition to spur them to innovate.

2) Implement MRTP control more imaginatively. The present MRTP controls prevent natural exploitation of technological dynamism through growth in competitive manufacturing industries. The way MRTP regulations are translated into reality now cripple the growth of specialised firms of viable size.

3) FERA regulations too should be more technologically forward looking. The reduction of foreign equity participation has in many cases restricted the inflow of new technologies and/or has raised its costs.

4) The above argument has an obverse side. Indian industry has sometimes shown greater levels of innovative capability when foreign sources of technology were not available to it. HMT and Escorts tractors for instance were downgraded indigenously as such models were simply not available from the original collaborators. Hence whether greater ease of inflow of foreign technology promotes domestic innovations and thus closes the technology gap or whether greater difficulty in acquiring overseas technology helps in achieving TSR is rather difficult to say. In the circumstances, policies should be formulated according to the merits of each case.

5) Going out of the way to promote the SSI sector in the past has had high technological costs. SSIs may be promoted consistent with technological goal in mind.

6) Public sector undertakings need not be technological museum pieces. Technologically, they can be as dynamic as their private sector counterparts. Although huge funds are earmarked for R&D in the public sector undertakings, they have not proved their commercial mettle, as they are not put through the crucible of the market. Giving a more marked market orientation to public sector R&D activities, one can argue, is very necessary.

7) A battery of price control regimes, import tariff, sales tax rates, etc., have played havoc with domestic inventiveness. It is time that those measures are revised in the light of our past experience.

8) As with many other regulatory policies, a large area of discretion is left to the administrators. This introduces an undesirable degree of arbitrariness, delay, political interference and ultimately corruption. Foreign suppliers of technology feel that India remains a relatively difficult country to enter. A single point clearance is now under consideration as a remedial measure but whether bureaucratic red tape will be eliminated or even reduced still remains to be seen.

9) Ideological and historical factors seem to be exercising their weight on the government's and policy-makers' rigidities in responding to changed circumstances. Some social scientists, economists in particular, have been churning out literature and mustering suitably chosen data to build a scaffolding for their antiquated stands on

technological dependence, economic imperialism, monopoly houses, multinationals, merchant capital, poverty, etc.[25]. Their stand has done great harm to the goal of TSR - which they claim to be very dear to the hearts. These individuals and groups have been crying wolf to liberalisation, particularly with respect to the import of technology. If they were to cease looking at the obtaining situation through tinted glasses and observe it in the right perspective, a major reason for technological stagnation will have gone.

NOTES

1. The reason why Government research in India yields little that is commercially useful is that it is not market - oriented, see ESRF study [1966, p. 5].

2. See Pinto, [1986].

3. See F.M. Scherer [1971].

4. See F.M. Scherer [1971].

5. *Financial Express*, September, 19, 1985.

6. *The Economist*, December 4, 1984.

7. It took 13 years for Xerox, 11 years for nylon, 12 years for terylene and 23 years for television to commercialise the technology developed in R&D laboratories.

8. Edwin Mansfield [1969] also emphasised that the minimum size necessary to undertake and exploit an innovation is often greater than the average size of industrial enterprises. Schumpeter underlines the close relation between the size of the firm and research activity. He says "what we have got to accept is that (the large scale establishment or unit of control) has come to be the most powerful engine of (economic) progress". See his epochal work, *Capitalism, Socialism and Democracy* [1950, p. 106].

9. See *Annual Survey of Industries*, 1983-84, Summary Results for Factory Sector, Table 15.

10. It is unlikely that such units could have contracted foreign collaboration of any kind either. Desai found that foreign suppliers of technology prefer large firms [Desai, 1982, p. 117].

11. See Menon [1982, p. 5].

12. One two-wheeler unit, Mopeds India Ltd., however, did not have formal R&D - the unit is almost on the verge of closure.

13. See Desai [1980] for adopting similar criteria.

14. An UNCTAD Study bears us out in respect of machine tools manufacturers. However, Desai [1982] found that the companies which did R&D were also the ones which borrowed technology from abroad. According to him those which did not borrow technology, did not, by and large engage in R&D. Our study does not appear to support this.

15. Chakraborty and Bhaumik [1984] have shown that in other industries also the situation is no better. They cite the head of one of the largest and most prestigious R&D establishments of a public sector company bemoaning the fact that R&D personnel in his firm enjoyed a much lower status than line personnel even in the eyes of peons and other Class IV staff.

16. Chakraborty and Bhaumik [1984] also found that "in a transport vehicle manufacturing company vertical mobility was lesser for R&D people. Normally life in R&D was tougher".

17. The threshold level of R&D expenditure is the minimum quantum of resources which must be committed to the project in order to ensure its fructification - whether successful or otherwise.

18. Our finding regarding funds being not a severe constraint is corroborated by an ESRF Study [1966, p. 4].

19. It is doubtful whether the poor exportability of Indian goods could be traced to technological aspects. Some Indian and non-Indian authors have felt that the poor export performance of the Indian industries is due more to a large domestic market despite its proverbial poverty. Export opportunities are often neglected in favour of expanded penetration of local markets where ROIs [Returns on Investment] are higher than in export markets. See Eiseman [1984], Sanjay Lall [1984].

20. Edquist and Jacobson comparing the technological levels of Indian and Korean machine tools found the Indian machine tools inferior in quality. One of the important reasons they attribute this to is lack of foreign competition and exposure. [Edquist and Jacobson, 1985, p. 2,065].

21. Edquist and Jacobson [1985] analysing the technology in the machine tool industry in India endorse our view. They say, "The firms employ a very considerable number of design engineers, but on the whole do not seem to be using them to develop their own basic designs. The bulk of them are instead occupied with the design of special purpose machine tools, in absorption of the licensed technology and in indigenisation efforts".

22. See, Bell and Scott-Kemmis [1985] for similar views.

23. Bell and Scott-Kemmis [1985] refer to an Indian manager as saying "very few Indian firms do anything with the technology they import. Even though many are quite profitable they won't invest in R&D" [Bell and Scott-Kemmis, 1985, p. 1,991].

24. Chandra Mohan, Managing Director of PTL says, "It would perhaps surprise you that customer preference for brand names, etc., perhaps only exists in the mind of the educated elite... Farmer preference was solely dictated by performance reliability, servicing and spare parts" [see V.V. Bhatt, 1983, p. 118].

25. Desai [1985] thinks that an entire generation of economists has been raised on this folklore of parochialism. He says this is a fairy tale told by this specie of economists [Desai, 1985, p. 1,973).

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TECHNOLOGY ISSUES IN INDIA'S MACHINE TOOL SECTOR

P.I. Suvrathan

The technological state of the machine-tools industry in India is a product of the government policies permitting import of technology and its absorption and assimilation, the degree of competition in the industry and the absence of pressures from a demanding user industry to modernize and manufacture sophisticated products. The Indian machine-tools sector can be said to be lagging behind technologically as compared to other developing countries. Modernization of other sectors of the economy has not been followed by a similar development of the machine-tools sector. The initial dominance of HMT in the machine-tools sector has now given way to the rise of a number of smaller technologically enterprising firms. Apart from being non-competitive in terms of cost, Indian machine-tools are found to be deficient in the matter of marketing and after sales service. The reasons for the present state of technological backwardness seem to be the policies of the 1960's and 1970's which favoured a limited number of manufacturers producing machines based on outdated technology for an assured market which had not acquired the capacity to discriminate on the basis of quality and price.

The industry also has been spending a much smaller part of its total investment on research and development. The slow pace of development of micro-electronics and the absence of a cost-effective ancillary industry network have contributed to the machine-tools industry not being able to achieve international competitiveness.

Introduction

In this paper we take up for examination the machine tool industry in India which is a crucial and dynamic component of the engineering goods sector. By an analysis of the determinants of competitiveness of machine tools we hope to identify the variables which are amenable to policy and the prospects for improving the contribution of the sector to industrial growth.

The machine tool industry has a crucial role in industrial development. The basic logic underlying the Mahalanobis/Feldman model of economic growth, which was the basis of plan investments since the Second Five Year Plan, was the emphasis on machine building capacity as a source of future growth [Mahalanobis, 1951, p. 43]. Machine tools are in this sense 'mother machines' which provide depth and resilience to the industrial structure. However, the cyclical nature of machine tools production is the source of many difficulties in planning and investment in this sector. The primary reason for cyclicality in machine tool demand is what might be termed an accelerator effect regarding purchases of major capital equipment [NRC, 1983, p. 19]. It has been suggested that protected economies in general, have a greater tendency toward synchronous business fluctuations than do open ones. Developing economics can, therefore, minimise the adverse impact of domestic business fluctuations by exporting to countries with more buoyant demand. In this sense, a more open economy providing better access to imported raw materials and components, and a larger share of exports in total output, can contribute to more stable growth in the machine tools industry.

In 1991, India's machine tools industry had 161 firms in the organised sector and 300 in the small scale sector with a production of Rs 699 crore and employing over 1,25,000 persons. India ranks eighteenth in terms of production among 35 machine building countries and sixteenth among 25 leading machine tool consuming countries [CMTI, 1986]. While imports formed a dominant share of domestic availability in the fifties, this declined steadily through the sixties and seventies reaching the low level of 22 per cent in 1975. The above period could be seen as that phase of planned development when the nation was building up the domestic capital goods sector through heavy imports. Indigenous machine tool units were not yet in a position to meet the rising domestic demand for machine tools from the modernizing sectors. However, from the sixties we see a steady rise in the share of domestic

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This article is a modified version of a chapter from a Ph.D. thesis submitted to Himachal Pradesh University on the 'Export Competitiveness of India's Machine Tools Sector'. The guidance received from Dr. L.R. Sharma, Prof. V.M. Dandekar and an anonymous referee is gratefully acknowledged.

production indicating the coming of age of indigenous producers. The share of imports rose again in the eighties when the more liberal economic policies allowed larger imports to meet the more discriminating domestic demand. In 1990 the proportion of total consumption met out of imports was 32.9 per cent [Kothari, 1992, Pp.8.7-8.10].

According to an analysis carried out by the Central Machine Tool Institute, the technological status of the Indian machine tool industry is characterised by obsolescence. Of metal-cutting machines which constitute the bulk of machine tools, 63.5 per cent of imported machines were above 20 years old, while the corresponding percentage for indigenous machine tools was 28.78 per cent. For joining and assembly machines the figure for imported machine tools was as high as 73 per cent clearly pointing to the obsolete technology, due mainly to the protective umbrella under which domestic industry developed till recently.

World machine tool industry is characterised by a fast pace of technological change. General purpose machine tools have been replaced by highly specialised Numerical Control (NC/CNC) machines, not only in the OECD countries, USA and Japan but even in newly industrializing countries such as South Korea and Taiwan. In the case of the latter, for example, the share of CNC lathes in total outlays for lathes increased from about 7 per cent in 1978 to 20 per cent in 1981. While the market for traditional engine lathes has shrunk not only in relative but also in absolute terms, Indian machine tool industry still produces largely general purpose machine tools, heavy duty machine tools such as horizontal and vertical boring machines, jig mills, hydraulic and pneumatic presses, universal cylindrical and other types of grinders, automatic lathes and plane millers. In 1984 India produced just 42 units of NC/CNC machines. By 1990 this had gone up to 560 CNC machines with a value of Rs 137 crore. The incorporation of CNC technology and electronic componentry into machine tools has been slow and hesitant in India which accounts directly for the poor performance of Indian machine tools on the export front.

The growth rate of the domestic machine tool industry has fluctuated over the past 25 years. During the period 1956 to 1960 starting from an initial low base, the average growth rate was a phenomenal 57 per cent. But this came down to 23 per cent in the 1961-70 period and further 19 per cent in the period 1971-80. From 1982 onwards the decline has been steady except for an upturn in the years 1989 and 1990. In 1991 the rate of growth had come down to 11 per cent. What is clear is the inability of the industry to raise output on a sustainable basis.

Economic Aspects of Machine Tool Manufacture

Non-electrical machinery, the broad branch under which machine tools are included, is characterised by a varied market structure and length of production depending upon the type of product. Many types of machine tools are produced on specific orders from customers. Even in large establishments, multiple production runs for small batch production are common. In the case of parts and components, production is usually in small batches carried out by small and medium size establishments who are all in competition with one another. The concept of economy of scale is often not relevant for production of the machinery industry. A study by Howard Pack showed that in the USA, labour productivity in the agricultural machinery industry increased as firm size increased, but the reverse was the case for machine tools, dies, tools, jigs, and textile machinery [Pack, 1981, p.228].

Technological intensity is an important characteristic of the production of machine tools, which are research and development intensive and man-power intensive, but non-capital intensive [UNIDO, 1984, p. 5]. The low capital intensive and scale economy characteristics of the industry have encouraged a growing emphasis on the development of less sophisticated kinds of production in the developing countries. However, the low capability for research and development in this branch in the developing countries not only restricts the rapid expansion of the industry but also affects to some extent the efficiency of the entire domestic economy. Import substitution activities attach importance to cost reduction (process research) but not to design

improvement (product research). One consequence of the continuous design improvement in the developed countries, while developing countries continue to produce older versions of machines, is the technical dominance of the machines produced in the former which are also less expensive to use regardless of relative factor costs.

Technological Perspective of the Indian Machine Tools Industry

On the basis of the available information relating to the technology status of Indian machine tools industry it is reasonable to conclude that it faces a product technology gap. An indication of the gap could be had from the number of new product collaborations signed by Indian machine tool firms during the 1970s. Indian industry has been slow to adopt Computer Numerically Controlled machine tools, basically because of the high cost of the machines and the need to train personnel in new areas of servicing, maintenance, programming and tooling. Of the total population of around 300 CNC machines installed in India, CNC turning machines account for 26 per cent, CNC machining centres 20 per cent, CNC drill/mill 16 per cent, CNC milling machines 13 per cent, CNC wire cut EDMs, CNC punch press and CNC printed circuit boards/drilling machines 11 per cent, CNC jigs and bores 9 per cent and other machines 5 per cent. The current rate of import of CNC machines is around 100 machines per year, i.e. approximately 5 per cent of annual production by value. It has been estimated that CNC machines will account for at least 25 per cent of annual production by value by the year 1993 [Central Machine Tool Institute, 1983, p. 89].

Product Development and Innovation

Table 1 below gives data regarding machine tools newly developed in the country over the years. Though this does not mean that machines have been built from scratch right from the drawing board, their production signifies the domestic capability to produce new varieties of machine tools hitherto imported. It is however, very small.

TABLE 1. NEW VARIETIES OF MACHINE TOOLS DEVELOPED INDIGENOUSLY

Period	Number of Newly Developed Machine Tools	Percentage Growth of Production at Constant Value
1964-66	76	15.5
1967-69	289	6.0
1070-72	168	5.8
1973-75	137	9.9
1976-78	398	1.0
1979-81	218	5.7
1982-84	213	3.1

Source: Indian Machine Tool Manufacturing Association, *Annual Reports*.

Another aspect of this phenomenon is the low levels of innovativeness which characterise Indian machine tool industry. Data on India's patent registrations for metal cutting and metal working machine tools seem to show that the industry's performance in this regard has been negligible. However, it must be mentioned here that registration of patents does not clearly indicate innovativeness or the quality of patents. Ultimately it is only the ability to market new and technologically superior machine tools in a competitive market that can establish the innovativeness of an industry. By this standard, however, India's machine tool industry cannot be said to have fared much better.

The increasing proportion of imported machine tools in total consumption is another indicator of the technological sluggishness of India's machine tool sector. During the last decade there has been a dramatic increase in the production of such sectors as railways, automobiles and defence production which are heavy users of machine tools. Modernisation of these sectors has not triggered off a similar expansion in machine tools due to the inability of the latter to tailor its output to the requirements of the users. Substantial imports have been permitted by the Government through a liberalised policy to meet the demands of user industries for machines of modern technology. An indication that such a product technology gap was emerging could be had from the

distinct drop in the number of new product collaborations signed by Indian machine tools industry during the 1970's [Ministry of Science and Technology, 1987, Pp.2-3].

What is this gap due to? Why is Indian machine tool industry not able to advance technologically when even newly industrialised countries are able to do so? It has been argued that such progress is due to (i) greater competition among producers; (ii) greater competition among producers and users; (iii) greater external competition through imports as well as exports; and (iv) R&D on a substantial scale. We will examine these below, one by one, in the Indian context.

Market Structure of Machine Tool Industry

There has been a steady increase in the total installed capacity from $106 million in 1977 to $283 million in 1984. The number of firms rose from 115 in 1974 to 137 in 1983-84. Due to higher capacity utilisation, additions to capacity have been rapid from 1980 till 1983. With the loosening of licensing policy in 1983, production capacity increased by 36 per cent. A review of changes in the installed capacity shows that capacity utilization peaked in 1981-82 at 113 per cent and then declined to 78.8 per cent in 1983-84. During 1980-81 installed capacity nearly doubled while demand increased only by 76 per cent. There was a marked deceleration in growth rate from 5.7 per cent in 1978-81 to 3.1 per cent in 1981-84 despite the large capacity creation. During this period, the ratio of imports over apparent consumption increased from 17.9 per cent to 36.6 per cent explaining subsequently the decline in capacity utilization and growth in production.

According to a World Bank study there has been a significant change in the market structure of machine tool industry due to entry of newcomers. The share of the top eight companies peaked at 95.7 per cent in 1978-79 after which it declined to 76.3 per cent in 1983-84. The ability of new entrants to penetrate well-established markets can be explained in part by the lack of significant scale economies in the industry, especially in the area of special purpose machine tools *vis-a-vis* general purpose machine tools. There are also reasons to believe that the small firms are often better able to meet the user's needs than more established firms.

One significant finding from discussions with established large machine tool manufacturers and their smaller competitors is the spread effect of the larger ones in the promotion of smaller competitors. Skilled workers in established firms like HMT have tended to branch off on their own, first as ancillaries to the main producer and later as producers in their own right. The smaller producers have thus eaten into the market shares of HMT, Kirloskar, etc., in the more simple and less technology intensive products, forcing the former to move into the top end of the market. Table 2 below throws light on this phenomenon.

TABLE 2. MARKET SHARES OF LARGE FIRMS IN THE INDIAN MACHINE TOOL INDUSTRY

(Per cent)

	1964	1978-79	1980-81	1981-82	1982-83	1983-84
HMT Ltd.	43.59	51.84	36.61	45.16	41.56	44.06
Mysore Kirloskar	16.93	21.63	17.44	16.48	11.56	11.83
Cooper Engineering	4.39	6.87	7.41	6.29	-	6.20
Bharat Fritz Werner	3.75	2.84	-	-	2.28	2.30
Invest Machine Tools	3.49	-	-	-		-
Heavy Engineering Corporation	0.00	8.52	9.26	13.24	4.97	6.53
Praga Tools Ltd.	0.00	2.44	2.02	1.64	2.00	2.96
Kirloskar Brothers	0.00	1.59	2.74	2.55	2.35	2.33
Total (for large firms)	72.15	95.73	75.48	85.36	64.62	76.31
Total (for Industry)	100.00	100.00	100.00	100.00	100.00	100.00

Source: Kishore Jethanandani, 'Entrepreneurship, Market Structure and Technology Development in the Indian Machine Tool Industry', New Delhi, April 1986. Quoted in World Bank (1986).

We have seen in table 1 that greater competition among firms has led to a certain amount of technology development. But it can be seen that it is not enough because there has been no spurt ever after the domestic producers began to face greater competition from external sources due to a policy of liberalisation. Therefore, the reasons for the present state of technological backwardness of the Indian machine tool industry have to be looked for in the policies of the 1960s and 1970s that favoured a limited number of manufacturers producing machines based on outdated technology for an assured market which had not acquired the capacity to discriminate on the basis of quality and price. The licensing systems which gave each firm a virtual monopoly on the types of machine tool assigned to it for manufacture also contributed to the creation of an artificial pricing system based on monopoly power.

A United Nations study has found that industrial licensing, while regulating the haphazard creation of capacities, often conferred oligopolistic advantages to a few enterprises which had their designs frozen at the level which prevailed when domestic manufacture was initially undertaken, with the result that domestic production continues to be based on technologies that are becoming obsolescent and are characterised by low productivity. One of the largest machine tools manufacturers in India, Mysore Kirloskar Ltd., still produces the low powered (0.75 KW and 2.2 KW) cone pulley lathes which were developed 50 years ago. The HMT plant which was built on Swiss-German know-how was in accordance with the international technology of the time. However, to meet the growing demand for different types of machine tools HMT had to collaborate with many internationally recognised machine tool manufacturers rather than build them on their own. It has been estimated that in general, the status of process technology in the Indian machine tool industry is comparable to that of industrialized countries 15 to 20 years ago.

The fact that the machine tool market in India was dominated by HMT would seem to be a factor which blunted competition in the field. The limited and undemanding market for machine tools seems to have placed little demand on the capabilities of HMT which even now is able to market its products without much difficulty. However, in the meanwhile, possibly on account of the declining rates of profitability of machine tool manufacture, HMT has diversified its production base into tractors, watches, dairy machinery, etc. HMT has possibly the widest range of machine tools of any manufacturer in the world, more than 70 different types. Clearly such an industry and plant structure of production cannot have been conducive to the achievement of scale and specialisation effects nor for the creative generation of competitive pressures.

Interaction between Producers & Users

An important aspect of the technological backwardness of the Indian machine tool industry is the influence of domestic demand on the output of the industry. As Rosenberg has said, the importance of the growth in markets is not necessarily bigness but rather an increased division of labour among firms in the specific sense of a narrowing down of the product range and the ability to concentrate on a limited range of products possessing certain specified properties, performing specific functions and meeting highly specialized requirements [Rosenberg, 1976, p. 18]. The specific structure of user demand directly influences the competitiveness of a product. Watanabe had shown that a large and growing market was created for CNC machine tools in Japan by the structure of the motor car industry which is the major user of NC and CNC lathes, the extensive subcontracting network and the strong competition between motor car producers [Watanabe, 1983]. Responding to these 'environmental' conditions, Japanese machine tool producers, with the assistance of the suppliers of control systems, began to produce high performance, medium priced, standardised CNC machine tools. Only later, once their products had been developed for the domestic market, did Japanese producers enter more competitive export markets, particularly of the United States [Linder, 1967]. On the other hand, the user structure differed substantially in the USA where the motor car industry was a relatively smaller user of CNC machine tools and where the aerospace industry constituted the major user.

American producers, accordingly produced more specialized, heavier and higher priced CNC machine tools.

The main consumers of machine tools in India are the automobile industry, railway wagons and railway engines, bicycles, power generators, ordnance factories, etc. In fact there is a two-way relationship of the machine tool industry with these user industries. The stage of technological development in these user industries determines the quality and sophistication of the machine tool which they demand. Till recently, an inward looking industrial development strategy had built up an industry which emphasized technological self-reliance rather than competitiveness. The premium was on manufacture of items which were previously imported, so that foreign exchange could be saved. It was, therefore, natural that the demands placed on the Indian machine tool sector were for low technology, standardised items with price and cost effectiveness being considered as secondary features. This also explains the current difficulties faced by the machine tool industry when confronted with the demand for increasingly sophisticated machine tools to meet the needs of rapidly modernising user industries. It has been found that the rate of increase in machine tool production from 1965-66 onwards has no significant relationship with the growth of production of vehicles, railway wagons, diesel engines or bicycles [Bhattacharya, 1983]. The growth of machine tools must have provided a stimulus to the growth of other capital goods industries. However, at least statistically, not much of a stable relationship between output or growth of output of machine tool industry and other industries has been found [Shetty, 1978].

However, it may not be correct to trace all sources of technological development to the nature and composition of domestic demand. Competitive pressures in the external market are often greater than on the domestic market with the result that firms are forced to become more efficient in terms of price, quality, delivery time, service, etc. In world machine tool industry, users have often provided the most significant source of information for improvements and research and development, thus facilitating a process of 'learning by doing'. Domestic market which provided such an important source of growth for the Japanese machine tool industry, thus seems to have contributed little by way of making Indian machine tool industry more internationally competitive. In this connection, reference may be made to the hypothesis put forward by S. B. Linder that domestic market provides the training ground for a product before it makes its entry in the international market [Linder, 1967]. While it is clear that domestic production base is essential for an export thrust, Indian experience seems to show that without discriminating pressures to improve quality and technology, it is difficult to sustain a viable presence in the world market. The reasons for the weak linkages between the machine tool sector in India and the other sectors of industry, would be a fruitful area of research which, however, is beyond the scope of the present study.

There is another channel through which the limited technological demands of non-competitive industries appear to have influenced the growth patterns of the machine tool industry. Large users of machine tools such as railways and ordnance factories frequently award contracts on a cost-plus basis, with the result that the pressures and constraints are likely to be different as compared with the case of normal commercial user. Even in respect of industries such as automobiles the informal controls on prices tend to encourage discounting of prices of critical inputs which in any case would be covered by cost plus pricing. In such cases it might be that the quality-price trade off tends to be biased in favour of quality, whereas in the typical commercial case, relatively greater weight is given to price. An environment such as above could well have undermined the international competitiveness of machine tools produced in India.

Competitiveness of Indian Machine Tools

Competitiveness has an absolute and a relative dimension. In the absolute sense it refers to the cost and quantity of resources that have gone into the manufacture of the product and partakes of the elements of technological and engineering efficiency. Though the extent to which a product

is traded in the market depends on its attractiveness to the consumer *vis-a-vis* other products, the efficiency with which it is produced has a direct bearing on the quality and price of the product in the market. From this point of view it would be interesting to examine the cost of production of machine tools and the input costs which account for the final price of the machine tools.

Several studies have suggested price as the major factor responsible for the inability of India's machine tools to capture significant shares of the world market [Ministry of Industry, 1983, p. 167]. According to this view, for use in areas which are not precision critical, the marginal technical superiority of Indian machines does not seem to offer the necessary buying advantage. Though by no means decisive, what emerges from a comparison of product prices with countries such as South Korea and Taiwan is the price advantage enjoyed by the competitors *vis-a-vis* Indian machine tools. It has been suggested that on account of product unfamiliarity in Western markets, India's engineering goods exporters have to offer significant discounts to attract initial buyers. This, combined with the much higher transport costs and servicing expenses, would seem to explain the handicaps facing Indian machine tool producers in world markets.

Price, though the ultimate indicator of competitive strength, is a composite of several factors, only one of which is cost of production of the manufacturer. An examination of all factors that make up the attractiveness of machine tools is called for before a view is taken on the corrective measures called for. Several distinguishing features of Indian machine tool industry as compared with those of its main competitors can be suggested. Machine tool factories in a country like Taiwan specialise in the manufacture of one or two types of general purpose machine tools like lathes, drilling machines, milling machines, grinders, etc., which gives them a competitive edge in product pricing. It was observed earlier that scale economies are less important with machine tools than some other segments of the capital goods industry. The reasons could be two fold: (i) The share of capital in total production costs is generally low (5-7 per cent), thereby reducing an important source of scale economies. (ii) Capital goods in the machine tool industry are highly divisible.

In Taiwan and South Korea, machine tools are manufactured in small/medium sized firms each employing around 10-80 persons. Of the 200 odd machine tool factories operating in Taiwan, only about 25 employ more than 80 people. On the other hand, large manpower is a typical Indian problem, and a large proportion of the manpower is employed in non-productive operations.

It is interesting to note that scale economies become more important with exports because of the expense of world-wide marketing and the after sales network. It has been estimated that if scale with respect to overheads, like marketing and labour organisation, is taken into account, in the CNC lathe industry, economies approach 40 per cent as output increases from 100 units to 800-1,000 units a year. What this means is that a higher output distributes the overhead costs of marketing so widely that overall economies reach 40 per cent, with significant reduction in unit costs. The leading Taiwanese firms handle volumes ranging from 1,200 to 7,200 machines per annum. According to one estimate, cost of production could be reduced at the rate of 20 per cent with each doubling of production volume. It is apparent that low volumes of output must be regarded as an important factor inhibiting competitiveness of Indian machine tools. The experience of Taiwan, however, seems to show that though technologically neutral with respect to scale, a larger size enables a machine tool producer to devote greater resources and skill to marketing and servicing, both essential in the highly competitive western markets. Where India seems to have slipped up is in its heavily manned and low productivity manufacturing units which have the disadvantages of small volumes as well as of high cost.

It has been estimated that for a typical conventional machine tool, manufacturing costs account for 60 per cent of the total costs, the remainder being accounted for by overheads. A rough allocation of manufacturing costs would be as under:

		Per cent
Raw material	-	20
Bought out parts	-	35
Subcontracted parts	-	8
Machinery	-	20
Assembly	-	17

It will be seen that materials account for more than 60 per cent of the total manufacturing cost of a machine tool. The main raw materials used in machine tools are castings made out of grey cast iron and bar/stock forgings made out of plain carbon steels and alloy steels. A comparison of raw material costs with those in other countries shows that not only are raw material prices higher in India but also are of lower quality causing extra machining costs. In the case of sub-contracted parts, the small scale suppliers have to process a large variety of components in small lots thereby adding to cost. It is significant that in Taiwan and South Korea the parent firms in the machine tool industry concentrate only on the manufacture of high technology items within the factory while the remaining parts are obtained from ancillaries leading to the growth of a large network of supporting industries that offer even components like precision ground gears, ball screws, etc., at highly competitive prices. The inability of Indian machine tool firms to build up an efficient ancillary industry and base their production on the availability of competitive inputs from outside without adding to their own overheads could be seen as basically a management failure to source the components and identify efficient small producers. The shortage of efficient ancillaries has in turn encouraged the machine tool producers to be more and more self-reliant in order to avoid the risks of an uncertain supply of components, paying the price in terms of higher overheads and unit costs.

A study undertaken by the National Productivity Council showed that labour productivity increased only at 3-5 per cent in machine tools and their parts [Nair, *et al.*, 1988, Pp. 81-91]. Capital productivity seemed to have declined in the non-electrical machinery sector as a whole and in the machine tool industry at a moderate rate. Total productivity in the machine tool sector either remained stagnant or increased at negligible rates. The study suggests that the small size of the market and the impact of inadequate growth in the infrastructural sectors might have constrained the efforts of the industry to step up operations to levels at which the benefits of higher technology could be actually realised. Mere technical growth alone thus does not appear to be a sufficient condition for productivity growth.

While the rate of growth of labour productivity in machine tool industry has been low at 3.3 per cent, capital productivity has actually declined (-2.8 per cent). Total productivity grew at a rate of only 0.9 per cent. The capital/labour ratio is seen to have risen at 6.2 per cent over this period indicating that while the industry as such has become more capital intensive, the corresponding output has been low. The addition of new capital equipment has however succeeded in increasing labour productivity which, however, was inadequate in raising total productivity to competitive levels.

If we take machine tool manufacture as a whole, it will be seen that it is dominated by small factory operations. More than 65 per cent of all machine tool manufacturing firms employ between 10 and 50 workers. There are approximately 10 large scale manufacturing plants employing more than 200 workers [Little *et al.*, 1987, p. 139]. Large scale firms frequently produce other engineering products such as pumps, engines and precision instruments in addition to machine tools, while small scale firms tend to concentrate exclusively on the production of machine shop equipment. It may also be mentioned that most large scale firms have licensing and technical cooperation agreements with foreign machine tool manufacturers to obtain design for more sophisticated types of equipment, while small and medium size firms generally copy their designs from existing tools. According to a comparative survey of small manufacturing enterprises carried out by the World Bank, the production process employed in both small and large scale machine tool manufacturing firms are fundamentally similar. The degree of vertical integration, however, differs. The large scale firms generally have their own foundry for the casting of bodies and foundations, while smaller firms subcontract casting to specialised foundries. Indian machine tool manufacturers do not subcontract a significant portion of their production. The proportion subcontracted ranges generally between 15 per cent and 20 per cent of total production [RIS, 1987, p. 108].

Even in respect of choice of techniques there does not appear to be any sharp break in firms of varying sizes. Increase in size makes it possible to add specialised items of equipment such as gear hobbing machines, which make it possible to either manufacture, rather than purchase, inputs or to reduce manufacturing time on general purpose machines. Larger firms, however, tend to use more mechanized material handling methods. The machine tool industry is characterised by constant returns to scale. Capital and skilled and unskilled labour are all substitutes, but capital is in general more substitutable for skilled than unskilled labour. Studies have shown that substitution possibilities do not vary significantly with firm size. The vintage of the capital stock was associated with the level of total factor productivity; each year of additional age of the capital stock resulting in a loss of 2-3 per cent in total factor productivity.

While the basic price of raw material consumed accounts for a large part of the difference, this is often compounded by the duties paid on raw materials and components by domestic buyers, as given below [Ministry of Industry, 1987, p. 26].

TABLE 3. INCIDENCE OF DUTIES ON INPUT COSTS & PRICES

	Percentage of Domestic Selling Price			Total Duty as Percentage of Selling Price
	Import Duty & Excise on Raw Material & Components	Excise & Sales Tax on Final Product	Total Duty	
Machine Tools				
Radial Drill	2.54	15.84	18.38	34.3
Surface Grinder	2.55	15.84	18.39	34.8
Gear Hobber	5.46	15.83	21.29	41.6
CNC Lathe	13.58	15.83	29.41	69.8
Central Lathe	1.39	10.72	12.11	41.8

Source: C.P.Chandrasekhar (1987) "Investment Behaviour, Economics of Scale and Efficiency in an Import Substituting Regime: A Study of Two Industries". Paper presented at the Seminar organised by the Planning Commission, IDBI and CDS Trivandrum. p. 12, Table VI.

It has been found that just doing away with duties reduces the price differential between the domestic and the international market to between 16.51 per cent and 28.49 per cent in the case of machine tools.

The cumulative effect of all these factors is evident in the profitability record of the machine tool sector which is a proxy for its economic efficiency. Data on the profits of the machine tool industry during the crucial period 1960-74 show that for almost half the years under review the industry made negative profits [Mathews, 1986, p. 109]. According to some observers this is indicative of the high concentration of public ownership in the industry where losses could be subsidised either directly or indirectly by the tax payer [Katrak, 1985, Pp. 213-229]. The low rates of return on capital also imply that the ability of the industry to adequately replace capital was severely eroded.

Research and Development in the Machine Tool Sector

In a technology intensive industry like machine tools, the research and development undertaken by each unit could be regarded as an index of the efforts in the direction of adaptation and assimilation of imported technology. With the increase in the value of output, conditions become more conducive to an improvement in the technological capability of the industry. On the basis of empirical tests in terms of the ratio of expenditure on research and development and technology import, Subramaniam has concluded that a regulatory policy does help in promoting local

adaptation and incremental innovation on the basis of knowledge acquired from initial import of technology. He finds that the marginal propensity to invest on domestic research and development with respect to technology import is negative, which suggests that the relation between import and local generation of technology is one of substitutability. According to the above mentioned UN Study, the ratio of research expenditure to total value of production was 3.4 per cent in machine tools.

According to a survey conducted by the Department of Science and Technology, the research intensity (defined as the ratio of expenditure on research and development to total sales turnover) in the machine tool industry was 0.30 to 2.44 in the private sector as compared to 0.42 to 0.97 in the public sector. Average expenditure on Research and Development worked out to 0.8 per cent of sales of Indian machine tool firms. Only 7.4 per cent of the total staff employed are qualified engineers, a low percentage by any standard and especially in a technology intensive industry like machine tools [Trade Development Authority, 1983, p. 35]. As suggested by some earlier studies, even the little expenditure on research is devoted to adapting imported technology to local materials and work practices rather than original design work or innovation. This contrasts sharply with the heavy investment in research incurred by Japanese and US machine tool firms. According to an OECD Survey of trends in Research and Development the EEC countries, Japan and the United States spend 1.5 per cent to 3.5 per cent of the gross output on research in the non-electrical machinery sector [OECD 1979; RIS, 1987, p. 112]. It must however be borne in mind that an industry dominated by small firms and low profitability may not be in a position to provide a substantial volume of resources for R&D.

Conclusion

The technological state of the machine tool industry in India is a product of the government policies permitting import of technology and its absorption and assimilation, the low degree of competition in the industry and the absence of pressures from a demanding user industry to modernise and manufacture sophisticated products. The slow pace of development of microelectronics and its incomplete integration with the machine tool sector has further impeded the introduction of NC and CNC machines on any large scale. In the absence of a cost-effective ancillary industry network which has been further compounded by the comparatively high cost of basic raw materials, the machine tool industry has been unable to achieve international competitiveness and thereby an increasing share of the world markets.

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RELATIVE EFFICIENCY AND TECHNOLOGICAL CHANGE IN PADDY CULTIVATION: INDIAN EXPERIENCE*

V.N. Misra

The paper examines relative efficiency by adopting a different approach, under which differentiated groups of farmers on the basis of yield and unit cost (i.e. technical and economic efficiency) have been studied in cross sectional framework in each state. The influence of the technological change on relative efficiency is being captured through yield variations among different efficiency groups. The most technical efficient farmers had achieved the maximum yield at higher unit cost vis-a-vis the most economic efficient farmers; for, they appeared to be more interested in maximising yield rather than reducing unit cost. Whereas, the most economic efficient farmers had obtained higher yield, but unit cost happened to be much lower as compared to the least economic efficient farmers as well as to the most technical efficient ones. This suggests; (i) the influence of technological change on input use efficiency is more pronounced among the most economic efficient groups; (ii) there is scope to reduce unit cost among the most technical efficient farmers; and (iii) there is also scope to raise yield with lower cost of production, under which the technology would play an important role. The influence of the technological change on unit cost has come up sharply in time series analysis. The significantly negative regression coefficients of unit cost on yield during the entire period of study in most of paddy producing states give supportive evidence to the fact that technological changes, while raising yield, had reduced unit cost of paddy in the country. However, the process was not smooth in the sense that in the initial stage of technological development during early seventies, more yield was obtained at higher unit cost, but when the technology became well spread in terms of area coverage along with more use of purchased inputs like fertiliser, higher yield resulted in lower cost of production.

I. INTRODUCTION AND OBJECTIVE

Recognising the necessity for cost effective output growth of paddy[1] for raising foodgrain production in the country, so as to meet the basic needs of the poor, constituting about 30 per cent of the total population,[2] and academic interest in view of somewhat conflicting empirical evidence on cost of production,[3] the paper examines; (i) Changes in cost of production and important input use in real terms in the process of technological development during the period: 1970-71 to 1986-87 in major paddy producing states such as Andhra Pradesh, Assam, Bihar, Karnataka, Madhya Pradesh, Orissa, Punjab, Tamil Nadu, Uttar Pradesh and West Bengal, (these states account for about 88 per cent of the total rice production in the country[4]); and (ii) Relative economic efficiency in cross sectional framework in 1984-85 among differentiated groups of farms with emphasis on correlating efficiency differentials with the input use rather than measuring it. This analysis has been attempted with a view to highlight the scope for raising yield by effecting changes in input use, only in states of Andhra Pradesh, Tamil Nadu, Karnataka, Orissa and Punjab. These states have been selected mainly because of availability of data at household level. The study is based on the data collected under the *Comprehensive Scheme for Studying the Cost of Cultivation/Production of Principal Crops*, Directorate of Economics & Statistics, Ministry of Agriculture, Government of India (for details regarding sample design of the scheme and its comparability and representativeness over the period, see Appendix -I).

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* This paper is dedicated to the memory of late Dr. D.S. Tyagi, Chairman, Commission for Agricultural Costs and Prices, who initiated the study as collaborative research between the Ministry of Agriculture, Government of India and the International Food Policy Research Institute (IFPRI), Washington. The author is grateful to Dr. G.M. Desai, IFPRI for useful suggestions while preparing the draft report, "Efficiency in Technology Based Growth: A Study of Paddy Enterprize in Indian States" on which the paper is based, and to Shri M.C. Joshi, Dr. V.M. Rao and Prof. V.M. Dandekar for their critical and substantive comments, which provided several insights in focussing the issues in a better perspective. However, none is responsible except the author for the short comings that remain in the paper. The facilities provided by IFPRI during October and November 1992 are gratefully acknowledged.

II. ANALYTICAL FRAMEWORK AND SCOPE OF STUDY

Economic efficiency among differentiated groups of farmers in the Indian context has generally been examined on the basis of the Cobb-Douglas production function estimates, through which marginal productivities of various factors of production are equated with their acquisition costs. However, the various assumptions such as identical production technology characterized by a linear homogeneous function having perfectly competitive factor and product markets, etc., are highly restrictive and unrealistic [Rudra, 1970, Jodha & Anderson, 1973]. It has, therefore, been argued that "production function is the wrong trap for the purpose of capturing relative efficiency" [Yotopolous, *et al.*, 1970].

Since it is difficult to separate technical efficiency (i.e. farmers' ability to obtain the maximum output per unit of area at given levels of inputs and technology) from economic efficiency (i.e. to produce with the least unit cost at given input and output prices and technology), on the basis of production function analysis [Sampath, 1979], an attempt has been made to examine *efficiency in input use in a cross sectional* framework by classifying farmers in a particular group in each state. This approach in a way has employed the framework of theory of production to assess the differences in input intensity among differentiated groups of farmers on the basis of yield and cost of production. For this purpose, in each state, all paddy growing farmers have been arranged in a descending order on the basis of yield per hectare. Top 20 per cent and bottom 20 per cent of the farmers are categorized as the most and the least technical efficient ones respectively. It would provide the extent to which yield level could be raised by effecting some changes in input use. The holdings have been further rearranged with a view to assess economic efficiency on the basis of unit cost of production in an ascending order; top 20 per cent with the least unit cost and bottom 20 per cent with the highest unit cost have been categorized as the most and the least economic efficient farmers respectively. This is basically an accounting approach. It has been adopted for a limited purpose for correlating efficiency differentials with the pattern of input use. Further, the emphasis is more on comparative analysis among different groups within a state, so as to isolate the effect of other factors except technology, rather than explaining inter state efficiency differentials, under which other factors such as structural, institutional, etc., apart from technology enter into the picture.

The cost of production is a good indicator of economic efficiency, as it measures unit cost, using cost minimising input combination, when most of the inputs are variable and some (i.e. capital, land, entrepreneurship) are fixed [Sampath, 1979]. Further, by computing cost of production, prices of inputs enter into the analysis, which provide some idea about the economic efficiency.

For better integration of cross sectional analysis of efficiency in resource use with those of temporal changes in unit cost, comparable individual household data on cost of production are required at least at two points of time. Since it is difficult to trace such data for early seventies, cross sectional approach has been adopted. However, cross sectional and temporal analyses are broadly integrated in the sense that an attempt is made to capture the influence of technological development on both; unit cost changes over the period and efficiency in resource use at a point of time.

The wide variations in cost of production among states provide supportive evidence to the fact that unless the analysis is attempted at state level, it is difficult to get an insight into the cost effectiveness of technology based growth. It may be noted that only in some states the high yielding varieties referred to as the new technology has contributed to the output growth during the last two decades. In the eastern states like Bihar and West Bengal, the new technology has yet to become well spread; for, only 30-40 per cent of the area covered is under the new technology.[5] Keeping this in view, the technology has been referred to in relation to those states where it is well spread in terms of area coverage.

Technological change[6] has not been addressed in this paper, as has been done in other studies in measuring its contribution to output growth [Sidhu and Byerlee, 1992, Kumar and Mruthyunjaya, 1992]. However, it has been referred to as reflected in the growth of High Yielding

Varieties (HYV), irrigation, fertilizers, etc., raising thereby yield per hectare.

Adoption of the new technology obviously disturbed the equilibrium in resource use and the farmers' response has not been uniform. Punjab a wheat producing/consuming state adopted the new technology for paddy cultivation on a big scale following a favourable price regime and it became the first non-traditional paddy producing state. This may result in lower variation in unit cost in Punjab. Karnataka rose gradually from the traditional paddy producing state to a technologically developed one, which may result in higher variation in cost of production. At the bottom of the scale are states like Orissa, still in the grip of traditional technology, where the new technology has yet to make a dent on production. In such a situation, the variation in unit cost may turn out to be lower. Thus, even though Punjab and Orissa may show lower variations in unit cost, they do so for very different reasons. In between, fall the other traditional paddy states like Tamil Nadu and Andhra Pradesh where the new technology has found moderate response among farmers. The variations in unit cost have, therefore, been analysed by the broad categorization of states on the basis of a level of technology as reflected in their yield levels.

The new technology being in the nature of land augmenting and labour substituting[7] influences the input substitution[8] over the period. The changes in product and factor prices also play an important role in the substitution. To what extent these factors influenced the input substitution is quite important for policy purposes. Yet, such an analysis has not been attempted. Substitution among inputs over the period has, however, been examined by analysing the trends in the relative share of inputs in cost of cultivation.

Since the thrust of the study is on understanding the trends in cost of production in the process of technological development and scope for raising yield through efficiency in input use, the factors responsible for temporal changes and inter-state differentials in unit cost and yield have not been examined.

The temporal changes in cost of cultivation/ production and in input use over the period have been analysed at constant prices (i.e. 1972-73 prices), so as to isolate the effect of inflation on costs during the period of study. The methodology for converting inputs from current to constant prices is discussed in Appendix-II. Further, changes during early eighties over early seventies (for years included during early seventies and early eighties, see Appendix II-I) are examined along with the trend coefficients estimated for the period as a whole.

III. TECHNOLOGICAL CHANGE AND GROWTH PERFORMANCE; INTER STATE ANALYSIS

The main source of data used in this section is generated from the General Crop Estimation Surveys (GCES) in the country.

Changes in Area and Yield under High Yielding Varieties of Paddy

There seems to be steady growth in the area under HYV since 1966-67. It increased from 15.6 per cent in 1970-71 to 62.0 per cent in 1989-90 for the country as a whole. Percentage of irrigated area under paddy too increased from 38.4 per cent to 43.6 per cent during the same period. Andhra Pradesh, Tamil Nadu and Punjab, where coverage under HYV was more than 90 per cent, almost all the area was irrigated (Table 2).

The yield per hectare of HYV has generally shown an increasing trend over the period. However, in states like Bihar and Orissa, where the coverage under HYV had been considerably more than the irrigated area, yield per hectare is either stagnant or shows only a marginal increase over the period. This suggests that availability of irrigation has played an important role in raising yield of HYV of paddy (Table 3).

Output Growth

These changes have helped not only in raising the production of rice from 22 million tonnes during triennium ending 1951-52 to 37 million tonnes during triennium ending 1964-65 and further to 73 million tonnes during triennium ending 1990-91,[9] but also changed the sources of growth. During the pre-technology period, the area expansion contributed substantially to output growth, but in the post-technology period its contribution declined. It is the improvement in

yield, which became the main source of output growth during the post-technology period. The increased contribution of yield to output growth clearly suggests that technology based growth has taken place in paddy cultivation in the country during the post-technology period (Table 4).

During the period 1952-53 to 1964-65, Andhra Pradesh, Bihar, Tamil Nadu, Uttar Pradesh, Karnataka and Punjab had higher output growth than the growth rate for the country as a whole. In Assam and West Bengal the output growth was only marginal, being 0.74 to 1.38 per cent per annum respectively. After the new technology in all the states except Assam, Uttar Pradesh, West Bengal and Punjab, the output growth rates decelerated. The most striking situation is in the case of Tamil Nadu and Karnataka, where rice production during the post-technology period had stagnated; the growth rates work out to be only 0.7 per cent per annum. Similar is the case with Bihar and Orissa. In these states, yield increase that had taken place during the post technology period, was negated by a decline in the area under rice, pulling down thereby the output growth. For instance, in Tamil Nadu after the new technology, the yield increased at the rate of 2.17 per cent per annum, but area declined by 1.43 per cent. As a result, output growth turned out to be only 0.71 per cent per annum during the post-technology period (Table 4).

IV. TRENDS IN INPUT USE

This section attempts to examine changes in main inputs such as human labour, bullock labour, machine labour, manure, fertilizer, irrigation and rental value of owned land that had taken place in the process of technological development. These inputs accounted for most of the changes in the total cost of cultivation over the period (Table 5).

Utilization of Human Labour and its Association with Yield

Paddy being a labour intensive crop, there are wide variations in its utilization among states, as is evident from the following statement.

Human Labour days per hectare	States during	
	Early seventies	Early eighties
below 100	Assam, Bihar, Madhya Pradesh	Assam, Madhya Pradesh
100>125	Andhra Pradesh, Orissa, Uttar Pradesh, West Bengal, Punjab	Bihar, Karnataka, Orissa, Uttar Pradesh, Punjab
125 and above	Tamil Nadu, Karnataka	Andhra Pradesh, Tamil Nadu, West Bengal

The above statement indicates that the position remained more or less similar during early seventies and early eighties in most of the states except Andhra Pradesh and West Bengal, where because of sharp increase in labour use by about 48 and 29 per cent respectively over the period (Table 6), both the states moved up from middle level to the highest level of labour utilization. Similar is the case with Bihar, which moved up from the lowest labour use during early seventies to middle level during early eighties.

To account for yield differences, changes in labour use in days per quintal of paddy are also examined. It is clear from Table 6 that for producing one quintal of paddy more than 6 human labour days were required in Bihar and West Bengal during early eighties as against 4 days in Assam, Tamil Nadu and Karnataka and 2 days in Punjab. These variations are influenced by a number of factors which include the nature of technology adopted, the availability of labour force and regional characteristics[10] such as quality of land, agro-climatic conditions, etc.

In order to examine the extent to which labour use is influenced by yield changes over the period, labour use per hectare in days has been regressed on yield in quintals in the form of double log equation. The results presented in Table 7 indicate that only in Andhra Pradesh, Orissa and West Bengal, labour use had helped in raising yield per

hectare as indicated by positive coefficients significant at 1 per cent level of significance. About 44 to 72 per cent of the variations in yield per hectare during the period are explained by the changes in labour use in these states. In the remaining seven states, changes in labour use do not appear to have exerted any influence on yield variations during the period.

States have followed two different paths of output enhancing technological change.[11] Andhra Pradesh, Bihar, Orissa, Tamil Nadu and West Bengal had adopted labour using technology for raising yield, while Madhya Pradesh, Uttar Pradesh, Karnataka and Punjab used labour saving technology. In these states labour saving technology had been adopted probably because of scarcity of labour at the critical times in the production process. Punjab is a case in point where large proportion of labour force comes from outside.

Bullock Labour

In Tamil Nadu, Uttar Pradesh, Karnataka and Punjab the cost on bullock labour per hectare showed a decline during the period, indicated by significantly negative trend coefficients. A similar declining trend in the share of bullock labour in cost of cultivation has also been observed (Table 8).

In these states, declining use of bullock labour and its share in cost of cultivation, however, seems to be compensated to some extent, by the increasing use of machine labour, which is discussed below. On the other hand, in Bihar and Orissa use of bullock labour along with its share in cost of cultivation showed an increase. These states continue to be low productivity states. In Assam too, where the use of machine labour is minimum, share of bullock labour in cost of cultivation has shown an increase.

Machine Labour

The use of machine labour was quite low, ranging from Rs 22 to Rs 28 per hectare at constant prices during triennium ending early eighties in Andhra Pradesh, Tamil Nadu and Uttar Pradesh as against Rs 106 per hectare in Punjab. The increasing use of machine labour in Punjab is indicated by a significantly positive trend coefficient (Table 9). This is explained to a considerable extent, by the farmers' willingness to harvest paddy quickly and get the fields ready in time for sowing of wheat and simultaneously to meet the immediate challenge of rising wages. These factors did not seem to have relevance in the other states.

However, the positive and significant trend coefficients of the machine labour as well as its share in cost of cultivation in Andhra Pradesh, Tamil Nadu, Uttar Pradesh and Karnataka indicate that the use of machine labour increased during the period (Table 9). Such trends are reassuring in as much as some sections of farmers in these states appear to have realized the benefits of the new technology.

Fertilizer Use

Wide variations in fertilizer use have been observed among the states. In Punjab, the fertilizer use in terms of NPK nutrients was the highest, (173 kg per hectare) during early eighties as against negligible in Assam and only 18 kg per hectare in Bihar. It was in the range of 126-132 kg per hectare in Andhra Pradesh and Tamil Nadu during the same period. In Madhya Pradesh, Orissa, Uttar Pradesh, West Bengal and Karnataka, it ranged from 21 kg to 76 kg per hectare. An important point to be noted is that fertilizer use was almost double over the period in Andhra Pradesh, Bihar, Orissa, Tamil Nadu, West Bengal and Punjab. As a result, the trend coefficients turn out to be significantly positive in these states (Table 10).

Double log equation between fertilizer use in terms of NPK as independent variable and yield in quintals as dependent variable was estimated to examine the relationship between the two. The results of the estimated equation presented in Table 11 indicate that the fertilizer use had been helpful in raising yield, suggested by the positive and significant coefficients in Andhra Pradesh, Bihar, Tamil Nadu, West Bengal and Punjab.

About 34 to 85 per cent of variations in yield over the period are explained by fertilizer use in these states.

Irrigation

Though paddy is grown as a rainfed crop in major producing states, some amount of direct irrigation is provided as supplement. In Andhra Pradesh, Tamil Nadu and Uttar Pradesh the amount spent on irrigation during early eighties ranged between Rs 66-83 per hectare at 1972-73 prices. Such amount is rather high as compared to other traditional states (Table 12). In Tamil Nadu and Uttar Pradesh, the cost on irrigation remained the same over the period indicated by the non-significant trend coefficients. In Orissa and West Bengal, irrigation costs increased over the period.

In the case of Punjab, however, the results indicate the significantly negative trend coefficient for the irrigation cost at constant prices as well as its share in cost of cultivation. It seems that farmers of Punjab have started using water more economically over the period, being a scarce resource.

Rental Value of Owned Land

In the cost analysis undertaken by the Directorate of Economics & Statistics, Ministry of Agriculture, Government of India, the rental value of owned land is taken as a proportion of the gross value of the output. It, therefore, reflects the productivity value of land rather than its price (rent) as determined by the demand supply situation at any point of time. One would, however, expect that greater the productivity of land, higher will be its price (rent/rental value) per unit of area.

The rental value of owned land per hectare increased over the period in all the states except in Bihar and Uttar Pradesh where it declined by 34 per cent and 12 per cent respectively.[12] The result is also borne out by the significantly positive trend coefficients particularly in Andhra Pradesh, Assam, West Bengal, Karnataka and Punjab. So is the case with its share in cost of cultivation (Table 13). The rising share of rental value of owned land indirectly reflects the increased demand for land, resulting from the gains in the profitability of investment in the new technology. This appears to be more so in the case of Punjab, where 75-80 per cent of rice production is marketed.

V. CHANGES IN COST OF CULTIVATION/PRODUCTION AND ITS ASSOCIATION WITH YIELD AND RETURNS

The changes that had taken place in cost of cultivation/production in the process of technological development are examined in this section.

Total Cost of Cultivation: Operational and Fixed

The total cost (Cost C2) per hectare during triennium ending early seventies and early eighties given in Table 14 clearly indicates that Andhra Pradesh recorded the highest increase of about 45 per cent from Rs 1,486 during triennium ending 1973-74 to Rs 2,158 during triennium ending 1983-84. This was followed by West Bengal (35 per cent). Cost increases in Assam, Bihar, Orissa, Tamil Nadu and Punjab ranged between 19-23 per cent over the period. In all the states (except Assam, Madhya Pradesh and Uttar Pradesh), the total cost of cultivation per hectare increased in real terms, indicated by the significantly positive trend coefficients (Table 14).

The important development is in Punjab, where despite increase in yield, operational cost had shown a declining tendency. In all other states except Madhya Pradesh and Karnataka, operational cost increased over the period indicated by the positive and significant trend coefficients (Table 15).

Among traditional producing states, in Andhra Pradesh, Bihar and Uttar Pradesh, the share of operational cost in cost of cultivation had gone up as indicated by the significantly positive trend coefficients. This suggests that the new technology had helped in raising yield in these states alongwith increasing operational cost (Table 15).

Yield Per Hectare

The yield per hectare was high at 33 quintals during early seventies in Punjab as compared to the traditional states under which Andhra Pradesh and Tamil Nadu had yield of about 23-25 quintals per hectare (Table 16).

What surprises, however, is that yield had shown a declining tendency in a state like Karnataka, which is categorised as technologically developed state because of higher yield per hectare during early seventies. In Punjab, Andhra Pradesh and Tamil Nadu yield increased by about 30-60 per cent over the period. Whereas in Uttar Pradesh, it remained more or less at around 21 quintals per hectare. However, triennium changes in yield over the period have been more or less in conformity with the observation based on the trend coefficients estimated for the period as a whole (Table 16).

Cost of Production

It may be seen from Table 17 that unit cost was the highest at Rs 84 in Uttar Pradesh during early eighties, followed by Bihar (Rs 78), West Bengal (Rs 68), Andhra Pradesh (Rs 66), and Karnataka (Rs 65). In Assam, Madhya Pradesh and Punjab it ranged from Rs 43 to Rs 48 during early eighties. The lower cost of production in Punjab was due to higher yield of about 53 quintals per hectare resulting from the new technology mix. In the case of Assam and Madhya Pradesh, unit cost in the range of Rs 43-48 was low, since a proportionately larger area under paddy cultivation was under traditional practices, requiring less monetary expenditure.

In states like Tamil Nadu and Punjab, where the rise in yield was faster, cost of production declined by 16 and 25 per cent respectively over the period. This is also indicated by significantly negative trend coefficients. In the case of Madhya Pradesh, since cost of cultivation per hectare showed a marginal decline, even small increase in yield had resulted in lowering cost of production by 14 per cent during early eighties over early seventies. In Andhra Pradesh and Karnataka, although unit cost has shown only marginal increase of about 3-4 per cent, the trend coefficient turned out to be significantly positive in the former. However, in Bihar and Orissa being technologically less developed states, moderate rise in yield seems to have been obtained at increasing cost of production by about 7-10 per cent over the period (Table 17).

Cost-Yield Association

(a) Time Series

To what extent unit cost of production had been influenced by yield changes reflecting the impact of technological changes during the period of study is examined here by regressing the former on the latter. The regression coefficients given in Table 18 suggest that in Assam, Madhya Pradesh, Karnataka, Orissa, Uttar Pradesh, Tamil Nadu, West Bengal and Punjab, the increased yield had significantly reduced cost of production during the period of the study, suggested by significantly negative coefficients. However, in Andhra Pradesh cost of production had not shown any relationship with yield changes. Similar is the case with Bihar, although the coefficient has a negative sign, implying thereby that higher yield has tendency to reduce unit cost of production.

(b) Cross Sectional Analysis

In order to check the above relationship further, the correlation coefficients between yield per hectare and the total cost (Cost C2) per quintal of paddy among states in different years are presented in the following statement.

Year	Correlation coefficient
1972-73	0.72
1974-75	0.34
1981-82	(-) 0.26
1982-83	(-) 0.42

It is evident from the above statement that in the initial stage of technological development during early seventies, unit cost and yield were positively correlated among states. However, when the new technology became well spread not only in terms of area coverage but also in terms of higher level of input use like fertilizer, irrigation, etc., which form the important ingredients of the new technology during early eighties, the relationship between yield and cost of production turned out

to be negative, suggested by the negative correlation coefficients in 1981-82 and 1982-83. This suggests that the new technology succeeded in raising yields while reducing unit cost at the same time.[13]

Overall Performance: Output-Input Ratio

Having discussed the cost - yield association, it would be interesting to examine the trends in overall performance of paddy cultivation in different states. This has been attempted by examining the trends in output-input ratio, which in a way indicates overall performance of the investment made. Since the technological change had reduced cost of production to a certain extent by raising yield as discussed above, output-input ratio is to be improved in the process of technological development. It may be seen from Table 19 that the states which had obtained higher increases in yield like Punjab and Tamil Nadu, output-input ratio too increased by 27 and 17 per cent respectively over the period.

There are, however, exceptions like Andhra Pradesh and West Bengal, where despite substantial increase in yield, overall performance was not at all upto the mark; output-input ratio declined by about 5 per cent in the former and the latter could achieve only a marginal increase of about 2 per cent over the period. Bihar is another typical case, where despite yield increase of 11 per cent, output-input ratio declined substantially by about 36 per cent over the period. The position is different in the case of Madhya Pradesh, where with 13 per cent rise in yield, output-input ratio increased by 16 per cent, suggesting thereby some improvement in economic performance over the period (Table 19).

VI. RELATIVE ECONOMIC EFFICIENCY: CROSS SECTIONAL ANALYSIS

The differences in resource use efficiency for any group of farmers in a state may be due to technical and/or economic efficiency. Since the thrust of the study is on comparison among differentiated groups of farms in the concerned individual state, the factors such as structural, institutional, etc., are supposed to get isolated. Further, the emphasis is more on economic efficiency than technical one, although knowledge of both is important for policy purposes.

Cost of Production and its Variation

Orissa shows an yield of 20 quintals per hectare at a cost of Rs 124 per quintal. On the other hand, Tamil Nadu nearly had obtained higher yield (38 quintals per hectare) but with more cost of production (Rs 193 per quintal). Even the most technologically advanced state like Punjab gives an yield of 49 quintals per hectare but only at much higher unit cost (Rs 156 per quintal) than Orissa (Table 20). It seems that due to high level of aggregation at state level and in view of wide variations in unit cost among states, the negative association between yield and unit cost has not emerged. Precisely because of these reasons, the analysis of efficiency in resource use has been attempted by classifying the farms on the basis of yield and unit cost into the most and the least efficient groups, with a view to get an idea whether the above negative association between yield and unit cost over the period gets further support from the cross sectional analysis and to the scope for raising yield on farms operating at different levels of efficiency.

It may be seen from Table 20 that the efficient farmers have about 135 to 350 per cent higher yields than those of the least efficient farmers among both the categories of states. This seems to have resulted in lower cost of production (Cost C2) among the most efficient farmers by about 34 to 41 per cent than those among the least efficient farmers. When yield is increased at higher level, it resulted in lower cost of production. The emerging implication is that once the household level data are disaggregated by efficiency levels, the association between yield and cost turns out to be negative, supporting the earlier observation based on time series analysis.

There exist substantial variations in cost of production for all the farms combined. Variation in Cost C2 happens to be the highest, being 60 per cent in Tamil Nadu, followed by about 37 per cent in Andhra Pradesh and about 30 per cent in Orissa among traditional producing states. It is lower at 50 per cent in Punjab because of large scale adoption of the new technology (Table 20). These trends are broadly in conformity with the proposition mentioned earlier that variations in unit

cost may be lower in technologically less developed as well as developed states, although the reasons are different in both situations.

It may be noted that cost variations in technical efficiency are higher among the most efficient farmers than those of the least efficient farmers in the traditional states except Orissa. In the case of non-traditional state of Punjab variation is lower among the most efficient farmers than among the least efficient farmers. In the case of economic efficiency, however, there does not seem to be much difference in cost variations among the traditional and non-traditional states. In both the groups, variations in the total Cost (Cost C2) as well as operational cost (Cost A2) are lower among the most efficient farmers than those among the least efficient farmers. Lower variations in cost of production among the most economic efficient farmers are probably due to the fact that these farmers, being cost conscious make serious efforts in reducing unit cost and they seem to form a more homogeneous category (Table 20).

Cost of Cultivation among Most and Least Efficient Groups of Farmers

In Tamil Nadu the most technical efficient farmers had about three and half times more yield per hectare than those of the least technical efficient farmers. This has been achieved with the total cost of Rs 9,587 per hectare as against Rs 4,556 for the least efficient farmers, showing an increase of about 115 per cent. In Andhra Pradesh and Orissa also, about 184 and 209 per cent higher yield has been obtained by the most technical efficient farmers by incurring about 168 and 77 per cent more on cost of cultivation as compared to the least efficient ones (Table 21). However, in non-traditional paddy producing state of Punjab, the cost differential among the most technical efficient farmers as compared to the least technical efficient farmers had been slightly lower than the traditional producing states. This is probably due to the fact that yield differentials among the most and the least technical groups were more than those of cost differences. The former has 135 per cent as against 48 per cent in the latter.

The position is interesting in the case of economic efficiency. Cost of cultivation per hectare happens to be lower among most economic efficient farmers who are minimizing unit cost, than those of the least economic efficient farmers but the yield differentials are quite large. For instance, in Tamil Nadu, the most economic efficient farmers are incurring about 40 per cent less on cost of cultivation than those of the least economic efficient farmers but these farmers had obtained yield of 58 quintals per hectare as against about 23 quintals of the least economic efficient farmers, showing an increase of about 157 per cent. More or less similar is the case with Orissa, Karnataka and Punjab.

The comparison of cost of cultivation per hectare between the most and the least efficient farmers categorized by efficiency measures reveals interesting results. In the case of technical efficiency, the relationship between cost of cultivation and yield turns out to be positive in the sense that both yield and cost of cultivation are higher among the most efficient farmers than those of the least efficient farmers in all the states. Whereas in the case of economic efficiency, the most efficient farmers are obtaining much higher yield with lower cost of cultivation as compared to the least efficient farmers in all the states except Andhra Pradesh. Even operational cost is lower among the most economic efficient farmers than those among the least economic efficient farmers, suggesting thereby the scope to reduce it while raising yield.

Relative Cost Structure of Most and Least Efficient Groups of Farmers

The most technical efficient farmers spent less (by about 8 to 12 percentage points) on operational cost than those of the least technical efficient farmers in all the states except Punjab, where farmers spent slightly more on operational cost (by about 1.40 percentage points) than that of the least technical efficient farmers. In the case of the least economic efficient farmers, the relative importance of operational cost is even lower as compared to the least technical efficient farmers. This is evident from the fact that the most technical efficient farmers are incurring less on operational cost (by about 8 to 14 percentage points) than those of the least technical efficient farmers in all the states except Tamil Nadu, where the difference in the relative importance of operational cost is only marginal among the most and the least economic efficient farmers. Barring

Tamil Nadu, the relative importance of operational cost in the total cost of cultivation among the most economic efficient farmers as compared to the least economic efficient farmers in all the states in a way suggests that the most economic efficient farmers minimize the operational cost while raising the yield (Table 22).

Analysis of Important Inputs by Technical and Economic Efficiency

The most technical efficient farmers of Punjab had obtained yield of about 67 quintals per hectare, which was more than double of the yield of the least technical efficient farmers (Table 20). The higher yield seems to have been brought about by incurring more by about 29 to 33 per cent on human labour, 214 per cent on machine labour, 57 per cent on fertilizer and manure, 87 per cent on irrigation, as compared to the least technical efficient farmers (Table 22). However, the position is quite different in the case of economic efficiency. The most economic efficient farmers had obtained higher yield by spending less on several inputs. The most striking situation is in the case of Punjab, where the most economic efficient farmers had about 55 per cent higher yield (57 quintals per hectare) as compared to the least economic efficient farmers (Table 20). The expenditure on most of inputs are lower than those of the least economic efficient farmers. The notable item is irrigation on which the most economic efficient farmers had spent less by about 45 per cent than those of the least economic efficient group (Table 22).

Among the traditional producing states also the position is more or less similar as has been observed in Punjab. In Orissa technology being at low level, the difference in cost of cultivation among the most economic efficient and the least economic efficient group is only to the extent of about 9 per cent. The position is rather different in Andhra Pradesh in the sense that the most economic efficient farmers had spent more than the least economic efficient groups to obtain higher level of yield (Table 22).

About 40 to 58 per cent of differences in cost of cultivation per hectare among the most technical and economic efficient farmers are accounted for by hired human labour, bullock labour, fertilizer and manure and irrigation in all the states. Similarly, about 35 to 63 per cent of the differences among the least technical and economic efficient farmers are explained by these inputs (Table 22). This suggests that these inputs play crucial role in influencing yield among the most efficient farmers as well as among the least efficient farmers.

Comparative Analysis of Cost of Cultivation among Most and Least Efficient Groups by Technical and Economic Efficiency

Least Efficient

The least economic efficient farmers had higher cost of cultivation compared to the least technical efficient farmers in all the states. Higher cost of cultivation had influenced yield only by 15-31 per cent among states. This is evident from the following statement (for statewise details, see Table 23).

States	Percentage increase in cost of cultivation and yield among the least economic efficient group over the least technical efficient group	
	Total Cost	Yield
Traditional		
Tamil Nadu	101.23	18.16
Andhra Pradesh	18.95	14.89
Karnataka	53.82	31.44
Orissa	35.95	18.16
Non-Traditional		
Punjab	65.84	29.14

The comparative analysis of cost of production of the least efficient groups by efficiency measures indicate that unit costs are higher among economic groups than those of technical ones in all the states, evident from the following statement:

(Rs)

States	Cost of production per quintal	
	Technical Efficiency	Economic Efficiency
Traditional		
Tamil Nadu	297.22	370.95
Andhra Pradesh	212.03	231.19
Karnataka	154.82	246.23
Orissa	152.99	179.71
Non-Traditional		
Punjab	211.83	268.76

Among the least economic efficient groups, the new technology is adopted at slightly higher level as reflected in more use of fertilizer, irrigation and machine labour than those of technical groups in all the states. This may be seen from the following statement.

(Rs per ha)

States	Fertiliser and Manure		Machine Labour		Irrigation	
	Technical	Economic	Technical	Economic	Technical	Economic
Traditional						
Tamil Nadu	596	902	85	260	240	737
Andhra Pradesh	658	818	51	54	202	314
Karnataka	589	903	36	185	43	89
Orissa	191	282	8	12	12	17
Non-Traditional						
Punjab	823	975	205	543	733	2,156

If the least economic efficient farmers are considered at initial stage of technological development, it reassures the earlier observation that once farmers started adopting the new technology, it resulted in higher cost of production as had happened upto mid seventies. Once they proceed at a higher level of technological development, cost of production turned out to be lower, as has been the case with the most economic efficient farmers. The most technical efficient groups are, of course, an exception because they are interested in maximizing yield rather than reducing unit cost.

Most Efficient

It may be seen from the following statement that in all the states except Orissa, the most technical efficient farmers had spent more on the total cost by about 43 to 79 per cent for obtaining higher yield in the range of 5 to 33 per cent over the economic efficient farmers, (for statewise details cost of cultivation, see Table 24).

States	Percentage increase in cost of cultivation and yield among the most technical efficient group over the most economic efficient group	
	Total Cost	Yield
Traditional		
Tamil Nadu	79.06	5.12
Andhra Pradesh	17.08	10.04
Karnataka	57.58	33.39
Orissa	43.39	12.94
Non-Traditional		
Punjab	53.20	17.16

Resource Productivity of All Inputs combined: Output Input Ratio

Output input ratios by yield and unit cost among the most and the least efficient farmers are presented in the following statement, with a view to know how the productivity of all inputs combined differs by measures of efficiency:

States	Technical Efficiency		Economic Efficiency	
	Most	Least	Most	Least
Traditional				
Tamil Nadu	1.08	0.70	1.30	0.54
Andhra Pradesh	1.20	0.70	1.29	0.67
Kamataka	1.78	0.93	1.93	1.04
Orissa	1.42	0.95	1.49	0.86
Non-Traditional				
Punjab	1.07	0.83	1.42	0.65

The above statement indicates that overall productivity of inputs is much higher among the most efficient groups than among the least efficient ones by both the measures of efficiency in all the states. The least efficient farmers are invariably losers in the sense that on one rupee investment, their returns are less than a rupee in all the states, except in Karnataka where the least economic efficient farmers earn slightly more than a rupee. Further, the productivity of all inputs among the most economic efficient farmers is higher than among the most technical efficient farmers in all the states, but it is substantially higher in Kamataka and Punjab. This suggests that those efficient farmers minimizing unit cost are obtaining much higher returns on their investment as compared to those maximizing yield per hectare. In the case of the least efficient groups, the technical ones had better performance than the economic groups.

Scope for Increasing Yield

The scope for raising yield by technical as well as economic efficiency has been attempted on the assumptions that: (i) in the first instance, the least efficient farmers at best in the near future may go in to achieve yield obtained on an average by the sample farmers; (ii) in the next stage it would be possible for the sample farmers in general to achieve the yield level which is at present obtained by the most efficient farmers; and (iii) finally, the least efficient farmers may also be in a position to reach the yield level obtained at present by the most efficient farmers.

It may be seen from Table 25 that the yield of the least economic efficient groups may be raised by 32 to 52 per cent by encouraging them to reach the level obtained on an average by the sample farmers. Similar is the case when the sample farmers as a whole would reach the yield level obtained at present by the most technical efficient farmers. However, the scope of raising yield is quite substantial when the least efficient farmers would be in a position to reach the yield level obtained by the most efficient groups.

These estimates indicate the achievable scope for raising yield in the sense that yield levels were obtained by a particular group of farmers. However, to achieve such a level of yield by the sample farmers in general requires lot more extension and research efforts. It seems that in Andhra Pradesh and Karnataka upgradation of technology is important. Whereas in a state like Orissa equally important is the removal of constraints such as water logging.

VII. CONCLUSIONS

Changes that had taken place in main input use in the process of technological development may be summed up as follows:

(i) Wherever the technological development had taken place, the share of human labour in cost of cultivation declined for the obvious reason that certain operations have been mechanized, reducing thereby the labour intensity in paddy cultivation.

(ii) Share of bullock labour in cost of cultivation too decreased over the period. It gets substituted to some extent by the machine labour in some

states where its share in cost of cultivation had gone up.

(iii) Once the technology gets adopted on a higher scale and becomes well spread, the share of land in cost of cultivation tends to increase, as had happened in the case of Punjab, where the profitability on investment in agriculture had gone up consequent upon the adoption of new technology.

Rising relative shares of purchased inputs in cost of cultivation clearly suggest the increasing monetization of agriculture. Agriculture is, therefore, becoming more susceptible to domestic and international market forces and hence to government interventions. It is in this context that the government policies and programmes have now become 'critical' to the development of agriculture.

One thing that stands out clearly is that the new technology, while raising yield, had reduced unit cost of paddy during the period of study in most of the states. Changes in cost-yield association in the process of technological development show interesting pattern. In the initial stage of technological development, higher yield was obtained with more unit cost. When the adoption of new technology became well spread during early eighties, higher yield resulted in lower cost of production.

Farmers started adopting the new technology in non-traditional state of Punjab by adjusting the input use in a manner, which resulted in higher returns on the investment. Some of the traditional states like Tamil Nadu with high yield, West Bengal with moderate level of yield and Madhya Pradesh with low yield have also shown similar economic performance.

Cross sectional analysis has also shown that those farmers using the new technology on higher scale reflected in their yields, had lower unit cost. Such an association between unit cost and yield, however, does not emerge by looking at state level data because of high level of aggregation. The emerging implication is that the influence of new technology on unit cost in a cross sectional framework could be captured by analysing the household level data by the levels of efficiency.

Lower variations in cost of production among the most economic efficient farmers than those among the least economic groups seem to suggest that the most economic efficient farmers being cost conscious make serious attempt in reducing cost of production and form a homogeneous category. Further, such farmers are economizing even the operational costs, which are lower than those for the least economic efficient farmers, indicating thereby the scope to reduce operational cost, while raising yield.

The most economic efficient farmers had pushed up yield at much higher level at lower cost of cultivation by using judicious combination of inputs. Whereas, the most technical efficient farmers had obtained rather the highest yield at the increased cost of cultivation as compared to the least technical efficient farmers. However, the most technical efficient farmers had spent more on the total inputs for obtaining higher yield than those of the most economic efficient farmers. It suggests that there is scope to reduce cost of cultivation for improving their economic performance among the most technical efficient farmers.

Those farmers minimizing unit cost (i.e. economic efficiency) are obtaining much higher returns on their investments as compared to those maximizing yield (i.e. technical efficiency); for, output-input ratios are higher among the former than those among the latter.

Yield of the least economic efficient groups of farmers may be raised substantially among different states by encouraging them to reach the level obtained on average by the sample farmers. This, however, requires a lot more extension and research efforts.

NOTES

1. Paddy is the single crop accounting for the largest area of about 39 per cent of the total area under cereals, about 31 per cent of the area under foodgrains and 24 per cent of the total cropped area in the country. The rice production accounts for about 39 per cent of the foodgrain production. Further, about 14 per cent of the paddy production is procured for running the public distribution system in the country.

2. This is estimated by Planning Commission, [1992, Vol. II, p. 14].

3. It has been observed that for the crops (such as wheat, paddy and cotton) having superior technology, the growth in productivity has been faster than the input use in many states, [CACP, 1987, p. 9]. For similar observation that the technological development during 1972-83 in general resulted in reducing the real cost of production of paddy, wheat, sugarcane and groundnut in different states, [Kumar and Mruthyunjaya, 1989, p. 43]. On the other hand, it has been

estimated that, 'on the whole, an expenditure of Rs 272 on inputs (including consumption) was incurred in 1970-71 to obtain Rs 1,250 as output per hectare of gross cropped area. While in 1984-85 an expenditure of Rs 460 was incurred (69 per cent more) to obtain Rs 1,665 as output (only 33 per cent more), both at 1970-71 prices' [Nadkarni, 1988, p. A 114].

4. For details, see Table 1.

5. For details, see Table 2.

6. The terms 'technological change' and 'new technology' are used loosely.

7. The new technology while raising the output is expected to influence the use of human labour depending, of course, upon the nature of technological change. For instance, high yielding varieties of seeds and fertilizers, which are in the nature of land augmenting technological change, are expected to raise yield by using more human labour per unit of land. It has been argued that in the initial stage of development, the land augmenting technological changes play an important role in raising the use of human labour, but at more advanced stage of development, mechanisation becomes more important in reducing the labour intensity in agriculture. For details, see [Ishikawa, 1981].

In Punjab while incorporating both direct and indirect employment effects of the new technology on the basis of input-output matrix, it has been observed that the new technology had negative impact on labour use. This was not compensated by the positive effects of crop mix and intensity effects on labour use, [Krishna, 1975]. Whereas in the case of Haryana again based on input-output matrix, it was concluded that employment potential of the new technology was fairly high, [Bhalla, 1976].

8. For elasticities of substitution among inputs based on the data of the National Accounts Statistics and the General Crop Estimation Surveys, see [Paul and Mehta, 1991].

9. It may be noted that due to low initial base of production during pre-technology period (i.e. 1952-53 to 1964-65), output growth turned out to be higher at 3.1 per cent per annum than the growth rate of 2.5 per cent during the post technology period for the country as a whole (Table 4). However, maintaining the growth rate of 2.60 per cent during the post technology period is important in itself due to higher production base.

10. About two fifths of the variations in human labour in the cultivation of paddy were attributed to the regional characteristics. For details, see [Tyagi, 1981, p. 107].

11. For similar observations, see [Bhalla, 1987, p. 546].

12. The decrease may be due to the fact that yield had not shown much improvement over the period.

13. For similar observation about the increased productivity resulting in declining unit cost, see [Tyagi, 1986, p. 350; and Kumar P. and Mruthyunjaya, 1989].

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APPENDIX-I
DATA SOURCE: COMPARABILITY AND REPRESENTATIVENESS

The Comprehensive Scheme for Studying the Cost of Cultivation/Production of Principal Crops is the main source of data utilized in the study. The comparability of cost estimates and its representativeness are discussed here.

The sampling design of the comprehensive scheme, cost concepts, imputation procedures, allocation of joint costs, apportionment of joint costs and evaluation of farm assets are adopted from the publication, *Cost of Cultivation of Principal Crops in India,* Directorate of Economics and Statistics, Department of Agriculture and Cooperation, Ministry of Agriculture, Government of India, New Delhi, 1991.

II. Sampling Design of the Scheme

From 1970-71 to 1983-84, the sample for study was selected with reference to a single crop selected in each state.

Based on the recommendation of the Special Expert Committee in 1979, the aggregate sample size was increased from about 6,000 holdings to about 9,000 holdings from 1984-85, with a view to adopt a crop complex approach and ensure high degree of efficiency of the cost estimates.

The present design of the scheme continues to be a three stage stratified random sampling design with tehsils as the first stage unit, villages/clusters of villages as the second-stage unit and holdings as the third and ultimate stage unit. Each State is demarcated into homogeneous agro-climatic zones based on cropping pattern, soil types, rainfall, etc. The primary sampling units (tehsils) are allocated to different zones in proportion to the total area of all crops covered in the study. The primary sampling units are selected in each zone (stratum) with probability proportional to the area under the selected crops, and with replacement. Within each tehsil, the village/cluster is also selected following the same procedure. In each selected village/cluster, all the operational holdings are enumerated and classified according to size into 4 to 5 size classes, the class limit being fixed uniformly for all villages/clusters. In each size class, two holdings are selected by simple random sampling without replacement. However, if in any village/cluster, a particular size class does not contain even two holdings, more holdings are selected from the other adjacent size to make up the deficit.

III. Cost Items

The items of cost cultivation covered both the paid-out costs (out of pocket expenses) and the imputed costs. The items covered under these costs are:

Paid-out costs:
(i) Hired labour (human, animal and machinery).
(ii) Maintenance expenses on owned animals and machinery.
(iii) Expenses on material inputs such as seed (home grown and purchased), fertiliser, manure (owned and purchased), pesticides and irrigation.
(iv) Depreciation on implements and farm buildings (such as cattle sheds, machine sheds, storage sheds).
(v) Land reveune.
(vi) Rent paid for leased-in land.

Imputed costs:
Value of family labour, rent of owned land and interest on owned fixed capital, for which the farmer does not incur any cash expenses.

IV. Cost Concepts

Costs are generated following certain cost concepts. These cost concepts and the items of costs included under each concept are give below:

Cost A1: (i) Value of hired human labour.
(ii) Value of hired bullock labour.
(iii) Value of owned bullock labour.
(iv) Value of owned machinery labour.
(v) Hired machinery charges.
(vi) Value of seed (both farm produced and purchased).
(vii) Value of insecticides and pesticides.
(viii) Value of manure (owned and purchased).
(ix) Value of fertiliser.
(x) Depreciation on implements and farm buildings.
(xi) Irrigation charges.
(xii) Land revenue, cesses and other taxes.
(xiii) Interest on working capital.
(xiv) Miscellaneous expenses (artisans, etc.)

Cost A2: Cost A1 + rent paid for leased in land.
Cost B1: Cost A1 + interest on value of owned fixed capital assets (excluding land).
Cost B2: Cost B1 + rental value of owned land (net of land revenue) and rent paid for leased-in land.
Cost C1: Cost B1 + imputed value of family labour.
Cost C2: Cost B2 + imputed value of family labour.

It may be noted that in this study we have mainly used the cost concepts of A2 and C2, while discussing the results.

V. Imputation Procedures

Some of the inputs used in the production process come from family sources. The procedures adopted for deriving imputed values of these inputs are as under:

Item	Procedure
1. Family labour	On the basis of wages paid to attached farm servant.
2. Owned animal labour	On the basis of cost of maintenance which includes the following: (a) Cost of green and dry fodder. (b) Cost of concentrates. (c) Depreciation on animals and cattle sheds. (d) Upkeep labour charges. (e) Other expenses, if any.
3. Owned machinery charges	On the basis of cost of maintenance of farm machinery which includes diesel, electricity, lubricants, depreciation, repairs and other expenses, if any.
4. Implements	Depreciation and charges on account of minor repairs.
5. Farm produced manure	Evaluated at rates prevailing in the village.
6. Rent of owned land	Estimated on the basis of prevailing rents in the village for identical type of land or as reported by the sample farmers, subject to the ceiling of fair rents given in the land legislation of the concerned state.
7. Interest on owned fixed capital	Interest on present value of fixed assets charged at the rate of 10% per annum.
8. Interest on working capital	Interest is charged at the rate of 12.5% per annum on the working capital for half the period of the crop.
9. Kind payments	The kind payments are evaluated at prices prevalent in the village at the time such payments are made.
10. Main product and by-product	Imputed on the basis of post-harvest prices prevailing in the selected villages.

VI. Allocation of Joint Costs

The expenditure incurred on, or imputed for, some of the cost items relate to the farm as a whole. Such joint costs are allocated to individual enterprises, among different categories of livestock and so on. Depreciation on farm buildings and implements, land rent, land revenue, cesses and taxes, interest on owned fixed capital are such costs which are allocated to individual crop enterprises in proportion to their areas. The cost on livestock is allocated to each category of animals in proportion of its numbers to the total number of animals owned by the farmer.

VII. Apportionment of Joint Costs

The apportionment of total cost incurred jointly for different crops grown in crop mixtures is done in proportion to the total value of output contributed by individual crops in the crop mixtures. The apportionment of total cost of cultivation between the main product and the by-products is done in proportion to their contribution to the total value of output.

VIII. Evaluation of Farm Assets

The following procedure is adopted for the evaluation of farm assets.

Item	Procedure
Owned and self cultivated land soils	Evaluated at rates prevalent in the villages taking into account the differences in type of distance from village, source of irrigation, etc.
Farm buildings (cattle sheds, storage sheds, etc.)	Evaluated at rates prevailing in the village.
Implements and other farm machinery	Evaluated at market prices.
Livestock	Evaluated at market prices.

IX. Variations in Sampling Coverage

The variations in sampling coverage in the Comprehensive Scheme for Studying the Cost of Cultivation of Principal Crops that had taken place over the period, have to be kept in view while interpreting the trends in cost estimates. It may be seen from Appendix 1.1 that the number of clusters allotted to paddy crop in different years under the cost scheme have varied over the period. For instance, in Andhra Pradesh, the cost estimates for 1971-72 and 1972-73 were generated on the basis of main sample consisting of 40 clusters, but from 1973-74 to 1978-79, it was estimated on the basis of sub-sample consisting of 10 clusters. During 1981-82 to 1983-84, clusters were again raised to 40. It was further raised to 60 clusters during 1984-85, as was recommended by the Special Expert Committee mentioned above. Similar is the position in all the paddy producing states.

Since the cost estimates are generated on the basis of varying number of clusters selected in the different years, this may also be partly responsible for the changes in the cost structure over the period.

X. Comparability of Cost Estimates

Keeping in view the variability of clusters over the period, the comparability of the cost estimates has been examined on the basis of changes in the structural characteristics of sample cultivators over the period. The data on the farm structure of sample cultivators of the comprehensive scheme of the cost of cultivation are not easily available for the seventies. However, the changes in structural characteristics of the farms selected in the comprehensive scheme during early seventies and mid-eighties only for Punjab and Madhya Pradesh are presented in the following statement.

Structural Characteristics	Punjab		Madhya Pradesh	
	1971-72	1986-87	1970-71	1984-85
(i) Total number of holdings studied	200	178	400	500
(ii) Average size of holdings (hectare)	5.81	4.04	4.29	4.42
(iii) Average size of farm family	7.90	4.92	6.55	4.87
(iv) Average size of farm family per hectare	1.36	1.22	1.53	1.10
(v) Cultivated land per farm family member (hectare)	0.74	0.82	0.65	0.91
(vi) Average intensity of cropping	1.65	1.63	1.03	1.17

It is evident from the above statement that there does not seem to be much change in the average size of holding over the period in Madhya Pradesh. It decreased in Punjab from 5.81 hectares in 1971-72 to 4.04 hectares in 1986-87, probably because of increasing division of holdings over the years. This, in turn, is reflected in lowering the average size of farm family in Punjab. However, in Punjab there does not seem to be any change in the intensity of cropping of the sample farmers over the period. This is fairly understandable in the sense that it was already high in the earlier period and effecting further increases would require investment in infrastructure to sustain it. In Madhya Pradesh, the intensity of cropping increased from 1.03 in 1970-71 to 1.17 in 1984-85.

These changes in the structural characteristics of the sample farms over the period are reflective of the various forces operating in the agriculture sector. Viewed in this context, the cost estimates based on the comprehensive scheme seem to be by and large comparable over the period; for, the structural characteristics of sample holdings in mid-eighties donot differ much from those observed in early seventies.

XI. Representativeness of Cost Estimates

In order to know the representativeness of the cost estimates, the yield per hectare obtained in the comprehensive scheme of the cost of cultivation has been compared with the yield generated under the General Crop Estimation Surveys in the country. The correlation coefficients between both the estimates during the period of study are presented in the following statement.

States	Correlation coefficients between yield per hectare generated under the Comprehensive Scheme and General Crop Estimation surveys
Andhra Pradesh	0.89
Assam	0.60
Bihar	0.31
Madhya Pradesh	0.70
Orissa	0.76
Tamil Nadu	0.52
Uttar Pradesh	0.59
West Bengal	0.74
Kamataka	(-)0.36
Punjab	0.93

The above statement indicates that with the exception of Bihar and Kamataka, the correlation coefficients between the yield per hectare estimated under the comprehensive scheme and the General Crop Estimation Surveys are quite high ranging from 0.52 to 0.93 in different states. This suggests that cost estimates generated under the comprehensive scheme are representative to a large extent of the area in most of the states.

APPENDIX LL NUMBER OF CLUSTERS ALLOCATED TO PADDY CROP IN DIFFERENT YEARS UNDER THE COMPREHENSIVE SCHEME FOR STUDYING THE COST OF CULTIVATION OF PRINCIPAL CROPS

States	1971-72	1972-73	1973-74		1974-75		1975-76		1976-77		1977-78		1978-79		1979-80		1980-81		1981-82 to 1983-84	1984-87
		Main Samples	Main Samples	Sub Samples	Main Samples	Sub Samples	Main Samples	Sub Samples	Main Samples	Sub Samples	Main Samples	Sub Samples	Main Samples	Sub Samples	Main Samples	Sub Samples	Main Samples	Sub Samples		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)
Traditional																				
Andhra Pradesh	40	40		10		10		10		10		8		10	30			10	40	60
Assam	30	30		9		9	25			10	25			10		10		10	30	45
Bihar	40	40		10		10		10		12		12						10	40	60
Madhya Pradesh		30		10		10		10		10		10							40	60
Karnataka			22			5		5											30	45
Orissa	30	30		8		8		8	20		25			10		15	20		30	45
Tamil Nadu	40			10		10		10		10	25			8		10		10	40	60
Uttar Pradesh							29			11		11			20			10	50	75
West Bengal	40	40		10		10		10	26			10	32			10		10	40	60
Non-Traditional																				
Punjab						8								5					20	30

APPENDIX - II

METHODOLOGY FOR CONVERTING INPUTS FROM CURRENT TO CONSTANT PRICES AND ITS PROBLEMS

Since the data from the comprehensive scheme are available in physical terms for inputs like seed, fertiliser and manure, human labour and bullock labour, these inputs have been converted at constant prices (i.e. 1972-73 prices).

For inputs like machine labour, pesticides, irrigation, depreciation on implements, the price indices based on the Index Numbers of Prices of Agricultural inputs have been constructed following the procedure developed earlier [Kahlon and Tyagi, 1988]. The details of these indices are as follows:

Price Index of Irrigation = 0.4761 (0.85) (diesel price index) +
0.15 (lubricating oil price index) +
0.2534 (Price index for all commodities) +
0.2715 (price index of machinery)

Price Index of Machine Labour = 0.33 (price index of diesel oil) +
0.053 (price index of lubricating oil) +
0.617 (price index of tractor)

Price Index of Depreciation Charges of Implements = 0.5 (machinery price index) +
0.5 (tractor price index)

These indices have been used to convert the inputs from current prices to constant prices.

The interest on working capital has been estimated at constant prices by using the State Bank of India's Call Loan' rate for cooperative banks. Whereas for the interest on fixed capital, the index for capital formation* has been used to convert it into constant prices.

The Index Numbers of Wholesale Prices for All Commodities have been used to convert the land revenue at constant prices.

The index numbers for paddy prices with 1972-73 = 100 in each state have been constructed. The same has been used for estimating the rental value of owned land at constant prices.

The main limitation of this methodology is that in the case of certain inputs such as land revenue, interest of fixed capital, etc., the indicators have been used for want of data.

Since triennium changes in early eighties over early seventies (for year included during early seventies and early eighties among states see Appendix II-I.) are not in a position to depict the situation for the period as a whole, the trend coefficients on the basis of time series data at constant prices have also been estimated. These estimates have been discussed alongwith triennium changes over the period in each state.

Data under the comprehensive scheme are not available for certain years in some states. The gap for certain years have, therefore, been filled up through interpolation. For one year missing, the average of preceding and succeeding years have been taken. When data are not available for more than two years, the trend values have been taken into account for filling up the gap in the series.

APPENDIX II-I. YEARS INCLUDED DURING EARLY SEVENTIES AND EARLY EIGHTIES IN MAJOR PADDY PRODUCING STATES

States	Early Seventies			Early Eighties		
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Traditional						
Andhra Pradesh	71-72	72-73	73-74	81-82	82-83	83-84
Assam	71-72	72-73	73-74	82-83	83-84	84-85
Bihar	72-73	73-74	74-75	81-82	82-83	83-84
Madhya Pradesh	72-73	73-74	74-75	83-84	84-85	85-86
Karnataka	73-74	74-75	75-76	83-84	84-85	85-86
Orissa	71-72	72-73	73-74	82-83	83-84	84-85
Tamil Nadu	71-72	72-73	73-74	79-80	80-81	81-82
Uttar Pradesh	75-76	76-77	77-78	81-82	82-83	83-84
West Bengal	71-72	72-73	73-74	82-83	83-84	84-85
Non-Traditional						
Punjab	72-73	73-74	74-75	84-85	85-86	86-87

* The index of capital formation includes the items such as cement, lime, transport equipments, machinery and machine tools, iron, steel and ferro-alloys, logs, timber and bamboo, agricultural implements and bricks; for methodology, see [Kahlon and Tyagi, 1988, p. 255].

TABLE 1. DISTRIBUTION OF AREA AND PRODUCTION OF RICE IN DIFFERENT PERIODS IN MAJOR PADDY PRODUCING STATES

(in percentage)

States	Area				Production			
	1952-53 to 1956-57 (AV.)	1960-61 to 1964-65 (AV.)	1972-73 to 1976-77 (AV.)	1983-84 to 1987-88 (AV.)	1952-53 to 1956-57 (AV.)	1960-61 to 1964-65 (AV.)	1972-73 to 1976-77 (AV.)	1983-84 to 1987-88 (AV.)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Traditional								
Andhra Pradesh	3.34	9.40	9.10	8.70	11.20	12.30	12.60	12.30
Assam	2.25	5.30	5.60	5.70	6.40	5.00	5.00	4.30
Bihar	6.35	14.80	13.50	12.70	12.70	12.60	10.70	9.00
Madhya Pradesh	13.67	11.90	12.00	12.10	10.30	9.00	7.40	7.40
Karnataka	2.69	3.10	2.90	2.80	3.50	4.20	4.50	3.60
Orissa	12.42	9.60	11.90	10.60	8.30	11.00	9.00	7.60
Tamil Nadu	2.60	7.30	6.60	5.40	9.00	10.70	11.30	8.70
Uttar Pradesh	11.90	12.10	11.90	13.40	8.30	9.00	9.00	12.00
West Bengal	14.15	12.80	13.80	13.00	17.20	14.30	14.40	13.90
Non-Traditional								
Punjab	0.19	0.70	1.50	4.20	0.60	0.80	3.00	8.80

TABLE 2. PERCENTAGE OF RICE AREA COVERED UNDER HIGH YIELDING VARIETIES IN DIFFERENT YEARS IN MAJOR PADDY PRODUCING STATES

States	Years					% of Rice Area under Irrigation in 1988-89
	1970-71	1975-76	1980-81	1985-86	1989-90	
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Traditional						
Andhra Pradesh	15.3	64.0	76.7	81.5	90.5	95.7
Assam	6.8	14.6	25.3	41.2	51.4	33.8
Bihar	6.5	14.6	34.2	35.8	30.5	35.7
Madhya Pradesh	6.2	25.0	31.9	40.7	47.6	20.1
Karnataka	14.0	48.0	65.9	68.9	76.5	57.7
Orissa	4.1	10.3	29.0	37.4	51.4	34.4
Tamil Nadu	67.7	69.1	86.7	95.1	92.2	90.3
Uttar Pradesh	14.8	34.1	48.1	65.6	78.4	40.4
West Bengal	11.0	19.1	35.3	39.4	40.2	24.6
Non-Traditional						
Punjab	33.4	91.3	93.0	95.1	93.7	99.1
All India	15.6	31.3	45.4	56.8	62.0	43.6

TABLE 3. YIELD PER HECTARE OF HIGH YIELDING VARIETIES OF RICE IN MAJOR PADDY PRODUCING STATES

(in tonnes)

States	1970-71	1976-77	1987-88
(1)	(2)	(3)	(4)
Traditional			
Andhra Pradesh	2.0	1.8	2.1
Assam	-	1.1	1.3**
Bihar	-	1.4	1.3
Madhya Pradesh	1.2	-	1.5
Karnataka	2.5	1.8	2.2
Orissa	1.7	1.1	1.2
Tamil Nadu	2.1	2.2	3.0
Uttar Pradesh	-	1.2	1.5*
West Bengal	-	-	2.8
Non-Traditional			
Punjab	2.3	-	3.1*
All India	2.0	1.7	2.0

* 1984-85; ** 1986-87.

TABLE 4. COMPOUND GROWTH RATES PER CENT PER ANNUM OF AREA, PRODUCTION AND YIELD OF RICE IN DIFFERENT PERIODS IN MAJOR PADDY PRODUCING STATES

States	1952-53 to 1964-65			1967-68 to 1988-89			1952-53 to 1988-89		
(1)	Area (2)	Yield (3)	Production (4)	Area (5)	Yield (6)	Production (7)	Area (8)	Yield (9)	Production (10)
Traditional									
Andhra Pradesh	2.80	1.48	4.32	0.67	2.68	3.37	0.98	2.04	3.04
	(64.81)	(35.26)		(19.88)	(79.53)		(32.24)	(67.11)	
Assam	1.25	-0.51	0.74	0.67	0.67	1.34	1.02	0.41	1.43
	(168.92)	(-69.92)		(50.00)	(50.00)		(71.33)	(28.67)	
Bihar	0.23	3.08	3.32	-0.12	0.92	0.80	0.14	1.22	1.36
	(6.93)	(92.77)		(-15.00)	(115.00)		(10.29)	(89.71)	
Madhya Pradesh	1.20	0.80	2.01	0.81	1.02	1.84	0.81	0.54	1.35
	(57.14)	(38.10)		(44.02)	(55.43)		(60.00)	(40.00)	
Karnataka	1.84	2.88	4.77	0.05	0.64	0.69	0.71	1.80	2.52
	(38.57)	(60.38)		(7.25)	(92.75)		(28.17)	(71.43)	
Orissa	1.08	1.52	2.63	-0.34	0.79	0.45	0.28	1.50	1.78
	(41.06)	(57.79)		(-75.56)	(175.56)		(15.73)	(81.27)	
Tamil Nadu	2.84	1.99	4.89	-1.43	2.17	0.71	-0.01	2.06	2.05
	(58.08)	(40.70)		(-201.41)	(305.63)		(-0.49)	(100.69)	
Uttar Pradesh	1.81	2.36	4.21	1.14	3.88	4.98	1.09	2.49	3.61
	(42.99)	(56.06)		(22.89)	(77.91)		(30.19)	(68.97)	
West Bengal	0.13	1.24	1.38	0.41	1.61	2.03	-1.57	3.50	1.93
	(9.42)	(89.85)		(20.20)	(79.31)		(-81.35)	(181.35)	
Non-Traditional									
Punjab	6.82	1.74	8.68	9.75	4.02	14.16	6.41	4.34	11.03
	(78.57)	(20.05)		(68.85)	(28.39)		(58.11)	(39.35)	
All India	1.47	1.68	3.18	0.56	2.06	2.60	0.81	1.75	2.57
	(46.23)	(52.83)		(21.54)	(79.23)		(31.52)	(68.04)	

Note: Figures in parentheses are the percentage contribution to production growth.

TABLE 5. MAIN INPUTS ACCOUNTING FOR CHANGES IN THE TOTAL COST OF CULTIVATION AT CONSTANT PRICES DURING EARLY EIGHTIES OVER EARLY SEVENTIES

States (1)	Main Inputs and its Impact on Changes in Total Cost over the Period (2)
Traditional	
Andhra Pradesh	Human Labour (20), Fertilizer (32), Interest on Working Capital (8), Rental Value of Owned Land (32)
Assam	Human Labour (8), Interest on Working Capital (9), Rental Value of Owned Land (91)
Bihar	Human Labour (23), Bullock Labour (35), Fertilizer (8), Irrigation (12), Rental Value of Owned Land (13)
Madhya Pradesh	Human Labour (-205), Manure (102), Fertilizer (114), Rental Value of Owned Land (-246)
Karnataka	Human Labour (-688), Bullock Labour (-617), Manure (153), Fertilizer (59), Pesticides (16), Irrigation (372), Interest on Working Capital (233), Rental Value of Owned Land (671)
Orissa	Human Labour (22), Bullock Labour (16), Fertilizer (12), Interest on Working Capital (12), Rental Value of Owned Land (30)
Tamil Nadu	Human Labour (15), Fertilizer (39), Irrigation (11), Interest on Working Capital (68), Rental Value of Owned Land (38)
Uttar Pradesh	Human Labour (-87), Bullock Labour (-48), Machine Labour (23), Manure (27), Fertilizer (113), Interest on Working Capital (18), Rental Value of Owned Land (-237)
West Bengal	Human Labour (28), Fertilizer (20), Interest on Working Capital (9), Rental Value of Owned Land (39)
Non-Traditional	
Punjab	Human Labour (-13), Bullock Labour (-25), Fertilizer (44), Irrigation (-13), Rental Value of Owned Land (50).

Note: Figures in parenthesis are the percentage accounted for changes in the cost of cultivation over the period.

TABLE 6. CHANGES IN HUMAN LABOUR PER HECTARE AT CONSTANT PRICES IN DAYS PER HECTARE AND PER QUINTAL OF PADDY DURING TRIENNIUM ENDING EARLY SEVENTIES AND EARLY EIGHTIES AND THE TREND COEFFICIENTS OF HUMAN LABOUR PER HECTARE AND ITS SHARE IN COST OF CULTIVATION PER HECTARE AT CONSTANT PRICES IN MAJOR PADDY PRODUCING STATES

States	Human Labour Per Hectare in Days During Triennium Ending			Human Labour in Days Per Quintal of Paddy During Triennium Ending			Human Labour Per Hectare at Constant Prices in Rs During Triennium Ending			Trend Coefficients of Human Labour Per Hectare at Constant Prices			Trend Coefficients of the Share of Human Labour in Cost of Cultivation at Constant Prices		
	Early Seventies	Early Eighties	% Change During Early 80's over Early 70's	Early Seventies	Early Eighties	% Change During Early 80's over Early 70's	Early Seventies	Early Eighties	% Change During Early 80's over Early 70's	Constant (a)	Coefficient (b)	R^2	Constant (a)	Coefficient (b)	R^2
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Traditional															
Andhra Pradesh	109.40	161.86	47.95	4.67	4.95	6.00	341.35	473.79	38.80	323.45 (23.89)	13.51*** (1.77)	0.84	23.83 (0.79)	-0.16* (0.09)	0.22
Assam	78.51	84.94	8.19	4.97	4.43	-10.87	268.00	278.60	3.96	264.08 (8.79)	0.81 (0.65)	0.12	35.12 (2.13)	-0.11 (0.22)	0.02
Bihar	95.23	119.03	24.99	5.78	6.50	12.46	301.65	361.85	19.96	283.31 (28.78)	8.01*** (2.41)	0.53	21.33 (5.96)	0.29 (0.64)	0.02
Madhya Pradesh	80.58	69.58	-13.65	6.29	4.75	-24.49	199.81	172.57	-13.63	207.48 (13.17)	-2.05** (0.87)	0.31	27.67 (1.39)	-0.20* (0.14)	0.18
Karnataka	136.23	121.09	-11.11	3.96	3.61	-8.84	504.37	447.64	-11.25	519.56 (22.22)	-4.69*** (1.65)	0.42	25.82 (1.18)	-0.52*** (0.15)	0.71
Orissa	107.31	124.49	16.01	6.54	6.69	2.29	257.55	298.78	16.01	247.73 (18.88)	4.65** (1.25)	0.53	31.34 (1.28)	-0.08 (0.13)	0.03
Tamil Nadu	145.33	152.49	4.73	5.83	4.18	-28.30	457.83	511.39	11.70	438.45 (44.93)	6.41* (4.28)	0.20	31.84 (2.57)	-0.47* (0.34)	0.18
Uttar Pradesh	122.10	110.23	-9.63	5.90	5.27	-10.68	546.40	493.80	-9.63	546.17 (34.86)	6.33* (4.50)	0.22	31.62 (2.82)	-0.27 (0.29)	0.15
West Bengal	109.82	141.92	29.23	6.17	6.08	-1.46	325.12	420.00	29.18	310.88 (38.03)	9.30*** (2.53)	0.53	27.63 (1.06)	-0.03 (0.11)	0.01
Non-Traditional															
Punjab	117.14	65.93	-19.57	3.56	1.98	-44.28	599.74	542.38	-9.56	567.50 (60.97)	-5.62* (3.64)	0.15	31.62 (4.08)	-0.59** (0.25)	0.32

Note: Figures in parentheses are the standard errors of the coefficients.
*** Significant at 1 per cent level of significance.
** Significant at 5 per cent level of significance.
* Significant at 10 per cent level of significance.

TABLE 7. REGRESSION COEFFICIENTS OF LABOUR USE PER HECTARE IN DAYS ON YIELD PER HECTARE IN QUINTALS IN MAJOR PADDY PRODUCING STATES

States	Constant (a)	Standard errors	Coefficient (b)	Standard errors	R^2
(1)	(2)		(3)		(4)
Traditional					
Andhra Pradesh	-3.24	1.24	0.94***	0.17	0.72
Assam	4.56	3.54	-0.26	0.54	0.01
Bihar	1.92	2.19	0.14	0.51	0.02
Madhya Pradesh	-2.36	3.27	0.77	0.51	0.17
Karnataka	4.39	2.03	-0.12	0.29	0.02
Orissa	-4.26	2.13	1.03***	0.31	0.45
Tamil Nadu	-2.30	3.64	0.80	0.51	0.21
Uttar Pradesh	5.14	2.26	-0.31	0.33	0.15
West Bengal	-1.98	1.60	0.72**	0.23	0.44
Non-Traditional					
Punjab	9.95	4.22	-0.90	0.63	0.20

Note: *** Significant at 1 per cent level of significance.

TABLE 11. REGRESSION COEFFICIENTS OF PER HECTARE FERTILIZER USE IN NPK ON YIELD PER HECTARE IN QUINTALS IN MAJOR PADDY PRODUCING STATES

States	Constant (a)	Standrad errors	Coefficient (b)	Standard errors	R^2
(1)	(2)		(3)		(4)
Traditional					
Andhra Pradesh	1.62	0.21	0.38***	0.05	0.85
Assam	2.89	0.04	-0.01	0.03	0.01
Bihar	2.60	0.13	0.09**	0.04	0.30
Madhya Pradesh	2.10	0.37	0.18	0.12	0.16
Karnataka	3.39	0.87	0.03	0.20	0.03
Orissa	2.48	0.22	0.12	0.08	0.15
Tamil Nadu	0.48	0.36	0.63***	0.08	0.87
Uttar Pradesh	2.98	0.40	0.04	0.11	0.02
West Bengal	2.66	0.13	0.12**	0.05	0.34
Non-Traditional					
Punjab	0.97	0.63	0.57***	0.12	0.72

Notes: *** Significant at 1 per cent level of significance.
** Significant at 5 per cent level of significance.

TABLE 8. CHANGES IN COST OF BULLOCK LABOUR PER HECTARE AT CONSTANT PRICES DURING TRIENNIUM ENDING EARLY SEVENTIES AND EARLY EIGHTIES AND THE TREND COEFFICIENTS OF THE COST OF BULLOCK LABOUR PER HECTARE AND ITS SHARE IN COST OF CULTIVATION PER HECTARE AT CONSTANT PRICES IN MAJOR PADDY PRODUCING STATES

States	Cost of Bullock Labour at Constant Prices During Triennium Ending		% Change During Early 80's over Early 70's	Trend Coefficients of Cost of Bullock Labour at Constant Prices			Trend Coefficients of the Share of Bullock Labour in Cost of Cultivation at Constant Prices		
	Early Seventies	Early Eighties		Constant (a)	Coefficient (b)	R^2	Constant (a)	Coefficient (b)	R^2
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Traditional									
Andhra Pradesh	98.32	113.95	15.90	85.47	1.78	0.12	6.74	-0.13**	0.42
				(19.60)	(1.45)		(0.43)	(0.04)	
Assam	131.14	127.95	-2.92	132.57	-0.76	0.18	17.50	-0.16	0.13
				(6.58)	(0.48)		(1.16)	(0.12)	
Bihar	226.40	319.20	40.99	199.90	8.14***	0.43	18.46	0.13	0.03
				(34.91)	(2.92)		(2.34)	(0.25)	
Madhya Pradesh	100.71	101.06	0.35	96.06	0.12	0.01	12.94	0.06	0.03
				(10.23)	(0.68)		(1.20)	(0.12)	
Karnataka	188.69	137.64	-27.05	196.84	-4.06***	0.51	10.05	-0.33**	0.60
				(16.26)	(1.21)		(0.97)	(0.12)	
Orissa	126.48	156.69	23.89	112.35	3.14***	0.41	14.14	0.05	0.05
				(16.47)	(1.09)		(0.73)	(0.07)	
Tamil Nadu	145.97	123.46	-15.42	339.99	-25.13*	0.19	11.07	-0.41***	0.51
				(181.33)	(17.28)		(1.03)	(0.13)	
Uttar Pradesh	235.86	206.81	-12.32	246.69	-5.65***	0.62	15.11	-0.29**	0.66
				(12.75)	(1.64)		(0.89)	(0.09)	
West Bengal	190.71	192.80	1.10	194.01	0.09	0.01	17.31	-0.36***	0.72
				(11.97)	(0.79)		(0.65)	(0.06)	
Non-Traditional									
Punjab	168.69	57.81	-65.73	137.33	-7.31***	0.47	9.08	-0.46***	0.71
				(35.51)	(2.12)		(1.39)	(0.11)	

Notes: Figures in parentheses are the standard errors of the coefficients.
*** Significant at 1 per cent level of significance.
** Significant at 5 per cent level of significance.
* Significant at 10 per cent level of significance.

TABLE 9. CHANGES IN MACHINE LABOUR PER HECTARE AT CONSTANT PRICES DURING TRIENNIUM ENDING EARLY SEVENTIES AND EARLY EIGHTIES AND THE TREND COEFFICIENTS OF THE MACHINE LABOUR PER HECTARE AND ITS SHARE IN COST OF CULTIVATION PER HECTARE AT CONSTANT PRICES IN MAJOR PADDY PRODUCING STATES

States	Machine Labour Per Hectare at Constant Prices During Triennium Ending		% Change During Early Eighties over Early Seventies	Trend Coefficients of Machine Labour Per Hectare at Constant Prices			Trend Coefficients of the Share of Machine Labour in Cost of Cultivation at Constant Prices		
	Early Seventies	Early Eighties		Constant (a)	Coefficient (b)	R^2	Constant (a)	Coefficient (b)	R^2
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Traditional									
Andhra Pradesh	19.33	28.25	46.15	13.71	1.52***	0.42	1.04	0.02	0.11
				(7.22)	(0.53)		(0.22)	(0.02)	
Assam	-	-	-	-	-	-	-	-	-
Bihar	-	-	-	-	-	-	-	-	-
Madhya Pradesh	-	1.67	-	1.13	0.02	0.05	-	-	-
				(0.51)	(0.03)				
Karnataka	4.00	6.50	62.50	5.10	0.06*	0.19	0.18	0.01*	0.44
				(0.51)	(0.04)		(0.05)	(0.006)	
Orissa	-	2.00	-	2.34	0.08**	0.22	-	-	-
				(0.71)	(0.04)				
Tamil Nadu	4.33	24.33	461.89	3.18	2.14***	0.62	0.27	0.09**	0.40
				(5.83)	(0.55)		(0.29)	(0.03)	
Uttar Pradesh	8.00	22.00	175.00	7.06	2.37***	0.46	-0.33	0.14**	0.58
				(7.51)	(0.96)		(0.52)	(0.05)	
West Bengal	-	-	-	-	-	-	-	-	-
Non-Traditional									
Punjab	22.33	106.04	374.88	50.91	5.23***	0.37	1.32	0.23*	0.36
				(31.72)	(1.90)		(1.48)	(0.11)	

Notes: Figures in parentheses are the standard errors of the coefficients.
*** Significant at 1 per cent level of significance.
** Significant at 5 per cent level of significance.
* Significant at 10 per cent level of significance.

TABLE 10. CHANGES IN FERTILIZER USE PER HECTARE AT CONSTANT PRICES AND IN KG OF NUTRIENTS PER HECTARE DURING TRIENNIUM ENDING EARLY SEVENTIES AND EARLY EIGHTIES AND THE TREND COEFFICIENTS OF FERTILIZER USE PER HECTARE, AND PER HECTARE OF NUTRIENTS AND THE SHARE OF FERTILIZER USE IN COST OF CULTIVATION PER HECTARE AT CONSTANT PRICES IN MAJOR PADDY PRODUCING STATES

States	Fertilizer Use Per Hectare at Constant Prices During Triennium Ending			Fertilizer Use in Kg of Nutrients Per Hectare During Triennium Ending			Trend Coefficients of Fertilizer Use Per Hectare at Constant Prices			Trend Coefficients of Fertilizer Use in Kg Nutrients Per Hectare			Trend Coefficients of the Share of Fertilizer Use in Cost of Cultivation Per Hectare at Constant Prices		
	Early Seventies	Early Eighties	% Change During Early 80's over Early 70's	Early Seventies	Early Eighties	% Change During Early 80's over Early 70's	Constant (a)	Coefficient (b)	R^2	Constant (a)	Coefficient (b)	R^2	Constant (a)	Coefficient (b)	R^2
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Traditional															
Andhra Pradesh	156.48	373.92	138.96	52.23	126.84	138.29	106.06	25.56***	0.89	40.73	6.05***	0.41	8.40	0.72***	0.84
							(32.03)	(2.37)		(29.77)	(2.20)		(0.85)	(0.09)	
Assam	-	0.54	-	-	0.27	-	-	-	-	-	-	-	-	-	-
Bihar	22.2	42.54	90.10	9.42	17.90	90.02	24.64	2.83*	0.20	9.46	1.41*	0.22	1.61	0.18	0.17
							(21.59)	(1.80)		(9.48)	(0.90)		(1.27)	(0.13)	
Madhya Pradesh	41.29	56.47	36.76	15.58	21.31	36.78	44.29	1.19	0.11	15.41	0.74	0.15	5.46	0.19	0.18
							(14.63)	(0.97)		(6.22)	(0.59)		(1.33)	(0.14)	
Karnataka	211.86	216.66	2.27	74.55	76.29	2.33	215.76	0.58	0.01	71.15	1.24	0.05	9.73	0.0008	0.01
							(25.81)	(1.92)		(12.90)	(2.44)		(1.55)	(0.19)	
Orissa	21.61	44.15	104.30	10.05	20.54	104.38	21.68	1.33*	0.19	12.08	0.53*	0.14	2.80	0.06	0.05
							(12.17)	(0.81)		(6.17)	(0.35)		(0.77)	(0.08)	
Tamil Nadu	175.14	317.17	81.10	72.94	132.18	81.22	118.32	19.12***	0.83	62.29	6.44***	0.54	9.00	0.65***	0.79
							(29.84)	(2.84)		(20.62)	(1.96)		(0.85)	(0.11)	
Uttar Pradesh	118.17	186.56	57.87	28.54	45.17	58.27	102.46	10.11***	0.72	30.99	0.11***	0.61	2.82	0.62***	0.76
							(18.43)	(2.38)		(6.73)	(0.03)		(1.49)	(0.15)	
West Bengal	27.52	111.52	304.14	8.74	35.83	309.95	8.46	7.59***	0.56	1.08	2.71***	0.57	0.73	0.42***	0.52
							(29.61)	(1.96)		(9.60)	(0.71)		(1.13)	(0.12)	
Non-Traditional															
Punjab	183.81	381.14	107.36	84.10	173.25	106.00	236.41	13.50	0.47	99.55	11.04***	0.47	8.62	0.55**	0.52
							(66.43)	(3.99)		(32.23)	(4.42)		(2.54)	(0.20)	

Note: Figures in Parentheses are the standard errors of the coefficients.
*** Significant at 1 per cent level of significance.
** Significant at 5 per cent level of significance.
* Significant at 10 per cent level of significance.

TABLE 12. CHANGES IN IRRIGATION COST PER HECTARE AT CONSTANT PRICES DURING TRIENNIUM ENDING EARLY SEVENTIES AND EARLY EIGHTIES AND THE TREND COEFFICIENTS OF IRRIGATION COST PER HECTARE AND ITS SHARE IN COST OF CULTIVATION PER HECTARE AT CONSTANT PRICES IN MAJOR PADDY PRODUCING STATES

States	Irrigation Cost Per Hectare at Constant Prices During Triennium Ending			Trend Coefficients of Irrigation Cost Per Hectare at Constant Prices			Trend Coefficients of the Share of Irrigation Cost in Cost of Cultivation at Constant Prices		
	Early Seventies	Early Eighties	% Change During Early 80's over Early 70's	Constant (a)	Coefficient (b)	R^2	Constant (a)	Coefficient (b)	R^2
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Traditional									
Andhra Pradesh	33.67	66.00	96.02	43.58	2.98	0.16	2.95	0.05	0.02
				(28.20)	(2.09)		(0.98)	(0.11)	
Assam	-	-	-	-	-	-	-	-	-
Bihar	2.00	18.33	816.50	14.97	-0.02	0.01	0.21	0.06*	0.31
				(8.61)	(0.72)		(0.30)	(0.03)	
Madhya Pradesh	2.70	5.30	96.30	2.44	0.18	0.10	0.17	0.05**	0.37
				(2.35)	(0.15)		(0.21)	(0.02)	
Karnataka	3.21	34.00	959.19	7.65	2.36***	0.56	-0.21	0.17***	0.65
				(8.37)	(0.62)		(0.45)	(0.05)	
Orissa	1.30	6.00	351.13	2.27	0.18*	0.13	0.29	0.001	0.03
				(2.07)	(0.12)		(0.14)	(0.01)	
Tamil Nadu	74.67	83.00	11.16	65.64	1.27	0.04	4.84	-0.07	0.04
				(20.77)	(1.98)		(0.88)	(0.11)	
Uttar Pradesh	60.67	70.00	15.38	54.40	0.79	0.02	2.79	0.05	0.03
				(17.77)	(2.29)		(1.51)	(0.15)	
West Bengal	5.00	22.67	353.40	3.78	1.16**	0.42	0.27	0.07**	0.32
				(5.93)	(0.39)		(0.27)	(0.02)	
Non-Traditional									
Punjab	229.97	170.53	-25.85	276.88	-7.68***	0.44	16.40	-0.57***	0.76
				(40.26)	(2.40)		(1.51)	(0.12)	

Notes: Figures in parentheses are the standard errors of the coefficients.
*** Significant at 1 per cent level of significance.
** Significant at 5 per cent level of significance.
* Significant at 10 per cent level of significance.

TABLE 13. CHANGES IN THE RENTAL VALUE OF OWNED LAND PER HECTARE AT CONSTANT PRICES DURING TRIENNIUM ENDING EARLY SEVENTIES AND EARLY EIGHTIES AND THE TREND COEFFICIENTS OF RENTAL VALUE OF OWNED LAND PER HECTARE AND ITS SHARE IN COST OF CULTIVATION PER HECTARE AT CONSTANT PRICES IN MAJOR PADDY PRODUCING STATES

States	Rental Value of Owned Land Per Hectare at Constant Prices During Triennium Ending			Trend Coefficients of Rental Value of Owned Land Per Hectare at Constant Prices			Trend Coefficients of the Share of Rental Value of Owned Land in Cost of Cultivation at Constant Prices		
	Early Seventies	Early Eighties	% Change During Early Eighties over Early Seventies	Constant (a)	Coefficient (b)	R^2	Constant (a)	Coefficient (b)	R^2
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Traditional									
Andhra Pradesh	535.15	746.59	39.51	489.71	18.33***	0.66	0.35	-0.0007	0.03
				(66.37)	(3.60)		(0.02)	(0.001)	
Assam	163.38	280.34	71.59	171.68	9.60***	0.59	0.24	0.008***	0.53
				(39.60)	(2.15)		(0.04)	(0.002)	
Bihar	295.05	194.64	-34.03	316.30	-9.57***	0.75	0.40	-0.004***	0.49
				(27.13)	(1.47)		(0.02)	(0.001)	
Madhya Pradesh	119.75	161.86	35.16	140.77	1.22	0.03	0.35	-0.003	0.09
				(33.64)	(1.82)		(0.04)	(0.002)	
Karnataka	919.02	974.55	6.04	866.09	7.30***	0.42	0.40	0.002*	0.18
				(41.91)	(2.27)		(0.01)	(0.001)	
Orissa	291.75	341.93	17.20	268.05	2.78	0.14	0.33	-0.0001	0.03
				(46.47)	(2.52)		(0.02)	(0.001)	
Tamil Nadu	429.44	569.22	32.55	415.55	5.34	0.02	0.20	0.006*	0.24
				(164.64)	(6.93)		(0.05)	(0.003)	
Uttar Pradesh	474.99	416.75	-12.27	495.98	-4.17**	0.31	0.27	-0.002***	0.32
				(30.86)	(1.67)		(0.01)	(0.0001)	
West Bengal	436.43	599.52	37.37	424.87	11.23***	0.41	0.36	-0.001	0.01
				(66.27)	(3.59)		(0.04)	(0.002)	
Non-Traditional									
Punjab	480.75	705.94	46.84	470.89	16.87***	0.66	0.23	0.004***	0.50
				(59.30)	(3.22)		(0.02)	(0.001)	

Notes: Figures in parentheses are the standard errors of the coefficients.
*** Significant at 1 per cent level of significance.
** Significant at 5 per cent level of significance.
* Significant at 10 per cent level of significance.

TABLE 14. CHANGES IN OPERATIONAL AND TOTAL COST OF CULTIVATION PER HECTARE AT CONSTANT PRICES DURING TRIENNIUM ENDING EARLY SEVENTIES AND EARLY EIGHTIES AND THEIR TREND COEFFICIENTS IN MAJOR PADDY PRODUCING STATES

States	Operational Cost Per Hectare			Total Cost Per Hectare			Trend Coefficients of Operational Cost (Cost A^2)			Trend Coefficients of Total Cost (Cost C^2)		
	Early 70's	Early 80's	% Change During Early 80's over Early 70's	Early 70's	Early 80's	% Change During Early 80's over Early 70's	Constant (a)	Coefficient (b)	R^2	Constant (a)	Coefficient (b)	R^2
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Traditional												
Andhra Pradesh	829.36	1336.50	61.15	1486.73	2158.19	45.16	796.55	44.74***	0.91	1399.38	64.51***	0.89
							(68.89)	(3.74)		(114.42)	(6.21)	
Assam	473.31	496.57	5.13	690.75	819.83	18.69	462.30	2.63**	0.44	750.15	5.05	0.16
							(14.66)	(0.79)		(57.69)	(3.13)	
Bihar	654.36	888.29	35.75	1167.25	1434.68	22.91	613.71	18.39***	0.74	1140.12	18.97***	0.55
							(53.86)	(2.92)		(84.22)	(4.56)	
Madhya Pradesh	416.79	436.20	4.65	717.56	704.30	-1.85	418.75	1.65	0.08	764.92	-2.49	0.05
							(28.23)	(1.53)		(55.41)	(3.01)	
Karnataka	1140.92	1131.97	-0.79	2186.39	2194.67	0.40	1136.57	4.39	0.15	2125.93	8.15***	0.30
							(51.73)	(2.81)		(61.47)	(3.33)	
Orissa	515.91	648.51	25.70	858.88	1048.16	22.04	499.92	11.30***	0.68	780.06	19.73***	0.63
							(38.10)	(2.07)		(75.09)	(4.07)	
Tamil Nadu	1045.07	1295.29	23.94	1627.95	1995.04	22.55	991.67	27.60***	0.73	1401.53	49.84***	0.64
							(82.02)	(4.45)		(184.30)	(9.99)	
Uttar Pradesh	1117.80	1172.41	4.89	1808.56	1748.09	-3.35	1101.72	5.61***	0.62	1798.92	-3.85**	0.33
							(21.75)	(1.17)		(26.78)	(1.45)	
West Bengal	673.61	931.20	38.24	1171.84	1591.66	35.83	654.64	21.14***	0.67	1118.01	37.45***	0.73
							(73.76)	(3.98)		(111.87)	(6.07)	
Non-Traditional												
Punjab	1368.60	1530.84	11.85	1948.18	2392.66	22.94	1512.84	-17.90	0.07	1888.96	29.30***	0.63
							(321.92)	(17.46)		(110.63)	(6.00)	

Notes: Figures in parentheses are the standard errors of the coefficients.
*** Significant at 1 per cent level of significance.
** Significant at 5 per cent level of significance.
* Significant at 10 per cent level of significance.

TABLE 15. TREND COEFFICIENTS OF THE SHARE OF OPERATIONAL AND FIXED COSTS IN COST OF CULTIVATION AT CONSTANT PRICES IN MAJOR PADDY PRODUCING STATES

States	Operational Cost			Fixed Cost		
	Constant (a)	Coefficient (b)	R^2	Constant (a)	Coefficient (b)	R^2
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Traditional						
Andhra Pradesh	54.62	0.54***	0.53	45.72	-0.57***	0.56
	(1.37)	(0.15)		(1.34)	(0.15)	
Assam	62.02	-0.14	0.01	37.73	0.16	0.01
	(3.65)	(0.38)		(3.75)	(0.39)	
Bihar	53.06	0.60**	0.39	39.76	-0.18	0.00
	(2.31)	(0.24)		(9.64)	(1.04)	
Madhya Pradesh	38.51	1.87*	0.28	62.63	0.04	0.01
	(9.64)	(1.01)		(1.96)	(0.20)	
Karnataka	53.93	-0.13	0.03	46.03	0.12	0.03
	(2.46)	(0.31)		(2.52)	(0.31)	
Orissa	62.63	0.04	0.01	37.36	-0.04	0.01
	(1.96)	(0.20)		(1.96)	(0.20)	
Tamil Nadu	69.75	-0.31	0.03	30.24	0.31	0.03
	(4.49)	(0.58)		(4.49)	(0.58)	
Uttar Pradesh	57.80	0.73**	0.62	42.21	-0.73**	0.62
	(2.47)	(0.25)		(2.50)	(0.26)	
West Bengal	55.69	0.23	0.10	44.32	-0.23	0.11
	(1.97)	(0.21)		(1.96)	(0.21)	
Non-Traditional						
Punjab	73.85	-0.65***	0.74	26.13	0.65***	0.74
	(1.80)	(0.14)		(1.80)	(0.14)	

Notes: Figures in parentheses are the standard errors of the coefficients.
*** Significant at 1 per cent level of significance; ** Significant at 5 per cent level of significance; * Significant at 10 per cent level of significance.

TABLE 16. CHANGES IN YIELD PER HECTARE IN QUINTALS DURING TRIENNIUM ENDING EARLY SEVENTIES AND EARLY EIGHTIES AND ITS TREND COEFFICIENTS IN MAJOR PADDY PRODUCING STATES

States	Yield per hectare in quintals			Trend Coefficients of Yield per hectare		
	Early Seventies	Early Eighties	% Change during Early 80's over Early 70's	Constant (a)	Coefficient (b)	R^2
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Traditional						
Andhra Pradesh	23.41	32.60	39.26	21.79	0.89***	0.71
				(2.79)	(0.15)	
Assam	15.80	19.18	21.39	15.76	0.25***	0.41
				(1.48)	(0.08)	
Bihar	16.48	18.31	11.10	16.90	0.08	0.07
				(1.44)	(0.07)	
Madhya Pradesh	12.81	14.66	14.44	14.24	0.05	0.11
				(2.47)	(0.13)	
Karnataka	34.39	33.51	-2.56	35.29	-0.19*	0.24
				(1.69)	(0.09)	
Orissa	16.42	18.61	13.34	14.27	0.34**	0.40
				(2.12)	(0.11)	
Tamil Nadu	24.93	36.41	46.05	22.05	1.19***	0.79
				(2.99)	(0.16)	
Uttar Pradesh	20.67	20.91	1.16	20.58	0.05	0.09
				(0.95)	(0.05)	
West Bengal	17.79	23.35	31.25	16.25	0.63***	0.59
				(2.58)	(0.14)	
Non-Traditional						
Punjab	32.90	53.39	62.28	27.50	1.83**	0.78
				(4.77)	(0.26)	

Notes: Figures in parentheses are the standard errors of the coefficients.
*** Significant at 1 per cent level of significance; ** Significant at 5 per cent level of significance; * Significant at 10 per cent level of significance.

TABLE 17. CHANGES IN TOTAL COST OF PRODUCTION PER QUINTAL OF PADDY AT CONSTANT PRICES DURING TRIENNIUM ENDING EARLY SEVENTIES AND EARLY EIGHTIES AND ITS TREND COEFFICIENTS IN MAJOR PADDY PRODUCING STATES

States	Total Cost (Cost C2) Per Quintal of Paddy			Trend Coefficients of Total Cost of Production Per Quintal of Paddy		
	Early Seventies	Early Eighties	% Change in Early 80's over Early 70's	Constant (a)	Coefficient (b)	R^2
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Traditional						
Andhra Pradesh	63.51	66.20	4.24	30.22	0.35*	0.17
				(14.97)	(0.19)	
Assam	43.72	42.74	-2.25	76.27	-0.43	0.16
				(22.35)	(0.28)	
Bihar	70.83	78.35	10.62	-83.85	1.83***	0.69
				(32.46)	(0.41)	
Madhya Pradesh	56.02	48.04	-14.25	71.67	-0.37	0.07
				(36.73)	(0.80)	
Karnataka	63.58	65.49	3.00	36.52	0.20	0.06
				(28.23)	(0.35)	
Orissa	52.31	56.32	7.67	49.37	-0.06	0.01
				(25.00)	(0.32)	
Tamil Nadu	65.30	54.79	-16.09	133.70	-1.07**	0.35
				(37.99)	(0.49)	
Uttar Pradesh	87.50	83.60	-4.46	112.48	-0.48	0.06
				(70.93)	(0.88)	
West Bengal	65.87	68.17	3.49	55.78	-0.05	0.01
				(41.68)	(0.53)	
Non-Traditional						
Punjab	59.15	44.81	-24.25	151.62	-1.28***	0.61
				(31.99)	(0.39)	

Notes: Figures in parentheses are the standard errors of the coefficients.

*** Significant at 1 per cent level of significance; ** Significant at 5 per cent level of significance; * Significant at 10 per cent level of significance.

TABLE 18. REGRESSION COEFFICIENTS OF YIELD PER HECTARE ON TOTAL COST PER HECTARE AND COST OF PRODUCTION PER QUINTAL OF PADDY AT CONSTANT PRICES IN MAJOR PADDY PRODUCING STATES

States	Total Cost (C2) Per Hectare			Total Cost (C2) Per Quintal of Paddy		
(1)	Constant (a) (2)	Coefficient (b) (3)	R^2 (4)	Constant (a) (5)	Coefficient (b) (6)	R^2 (7)
Traditional						
Andhra Pradesh	2.203	0.014***	0.82	57.28	0.05	0.01
	(2.142)	(0.002)		(4.60)	(0.16)	
Assam	5.912	0.015*	0.24	70.95	-1.58***	0.38
	(1.681)	(0.007)		(9.18)	(0.51)	
Bihar	6.884	0.008***	0.48	63.23	-0.20	0.02
	(1.080)	(0.002)		(20.89)	(1.64)	
Madhya Pradesh	-12.163	0.036***	0.68	77.41	-2.48***	0.87
	(1.407)	(0.006)		(4.23)	(0.29)	
Karnataka	52.723	-0.008	0.11	100.28	-1.42***	0.76
	(1.830)	(0.007)		(10.54)	(0.31)	
Orissa	-1.852	0.020***	0.83	70.10	-1.52***	0.57
	(1.138)	(0.002)		(6.05)	(0.36)	
Tamil Nadu	-3.845	0.020***	0.85	66.91	-0.54*	0.19
	(2.599)	(0.002)		(8.83)	(0.29)	
Uttar Pradesh	41.420	-0.012	0.14	169.37	-4.54***	0.91
	(0.923)	(0.007)		(11.99)	(0.57)	
West Bengal	-2.653	0.017***	0.82	74.65	-1.13**	0.29
	(1.711)	(0.002)		(9.90)	(0.47)	
Non-Traditional						
Punjab	-55.851	0.046***	0.68	87.60	-0.93***	0.89
	(5.769)	(0.008)		(5.16)	(0.10)	

Notes: Figures in parentheses are the standard errors of the coefficients.
*** Significant at 1 per cent level of significance; ** Significant at 5 per cent level of significance; * Significant at 10 per cent level of significance.

TABLE 19. CHANGES IN OUTPUT-INPUT RATIO BASED ON THE TOTAL COST DURING TRIENNIUM ENDING EARLY SEVENTIES AND EARLY EIGHTIES

States	Output-Input Ratio		% Change in Early 80's over Early 70's
(1)	Early 70's (2)	Early 80's (3)	(4)
Traditional			
Andhra Pradesh	1.26	1.20	-4.76
Assam	1.37	1.46	6.57
Bihar	1.41	1.18	-36.31
Madhya Pradesh	1.29	1.50	16.28
Karnataka	2.03	1.97	-2.96
Orissa	1.36	1.31	-3.68
Tamil Nadu	1.01	1.18	16.83
Uttar Pradesh	0.99	1.00	1.01
West Bengal	1.51	1.54	1.99
Non-Traditional			
Punjab	0.85	1.21	27.37

TABLE 20. VARIATION IN COST OF PRODUCTION IN SOME STATES: 1984-85

Item	Level of Technology based on the yield of rice per hectare	Efficiency Most & Least	No. of Households in the Sample	Yield		Operational Cost (Cost A1)		Total Cost (Cost C2)	
				Mean Q/Hectare	Coefficient of Variation (%)	Mean Rs/Quintal	Coefficient of Variation (%)	Mean Rs/Quintal	Coefficient of Variation (%)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
All Sample Households									
Traditional									
(a) Tamil Nadu	Medium		425	38.14	95.58	125.42	69.26	193.33	60.48
(b) Andhra Pradesh	Medium		425	35.48	36.2	93.93	46.34	151.28	36.94
(c) Orissa	Low		405	20.69	57.78	65.64	40.91	124.45	29.7
(d) Karnataka	High		75	45.61	44.17	64.77	53.95	132.69	87.66
Non-traditional									
(c) Punjab	High		185	48.78	30.12	95.08	62.16	155.89	49.51
Efficiency: (i) TECHNICAL (i.e. YIELD)									
Traditional									
(a) Tamil Nadu	Medium	(i) Most efficient (Top - 20 %)	85	68.71 (+350.00)	102.94	86.71 (-55.72)	58.34	148.5 (-50.04)	59.75
		(ii) Least efficient (Below - 20 %)	85	15.24	54.64	195.82	69.16	297.22	58.2
(b) Andhra Pradesh	Medium	(i) Most efficient (Top - 20 %)	85	52.58 (+209.48)	8.39	66.47 (-55.89)	21.11	116.44 (-34.00)	13.34
		(ii) Least efficient (Below - 20 %)	85	16.99	28.07	141.1	38.98	212.03	33.81
(c) Orissa	Low	(i) Most efficient (Top - 20 %)	81	33.06 (+184.51)	63.23	48.18 (-42.28)	27.52	102.29 (-34.00)	15.63
		(ii) Least efficient (Below - 20 %)	81	11.62	16.81	88.6	26.29	154.99	25.16
(d) Karnataka	High	(i) Most efficient (Top - 20 %)	15	70.51 (+282.17)	6.79	48.3 (-36.02)	22.96	94.95 (-38.67)	15.45
		(ii) Least efficient (Below - 20 %)	15	18.45	29.77	75.49	40.81	154.82	35.41

(contd.)

TABLE 20 (CONTD.)

Item	Level of Technology based on the yield of rice per hectare	Efficiency Most & Least	No. of Households in the Sample	Yield		Operational Cost (Cost A1)		Total Cost (Cost C2)	
				Mean Q/Hectare	Coefficient of Variation (%)	Mean Rs/Quintal	Coefficient of Variation (%)	Mean Rs/Quintal	Coefficient of Variation (%)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Non-Traditional									
(e) Punjab	High	(i) Most efficient (Top - 20 %)	37	67.2 (+135.03)	13.03	80.28 (-63.55)	68.16	128.82 (-51.48)	45.24
		(ii) Least efficient (Below - 20 %)	37	28.59	24.21	128.04	61.84	211.83	51.15
(ii) ECONOMIC (i.e. Cost of production) A. OPERATIONAL COST (COST A2)									
Traditional									
(a) Tamil Nadu	Medium	(i) Most efficient (Top - 20 %)	85	57.86 (+150.80)	126.45	59.04 (-76.80)	28.53	102.98 (-71.10)	35.78
		(ii) Least efficient (Below - 20 %)	85	23.08	58.89	254.47	46.45	355.22	41.87
(b) Andhra Pradesh	Medium	(i) Most efficient (Top - 20 %)	85	46.16 (+135.03)	21.67	57.56 (-63.55)	10.79	109.93 (-51.48)	10.44
		(ii) Least efficient (Below - 20 %)	85	19.64	38.73	157.93	36.14	228.93	35.15
(c) Orissa	Low	(i) Most efficient (Top - 20 %)	81	24.69 (+79.43)	25.14	37.87 (-66.49)	15.81	97.08 (-43.90)	14.13
		(ii) Least efficient (Below - 20 %)	81	13.76	34.46	106.5	24.55	173.05	25.59
(d) Karnataka	High	(i) Most efficient (Top - 20 %)	15	49.94 (+62.73)	41.3	34.27 (-69.19)	19.37	77.15 (-66.83)	22.89
		(ii) Least efficient (Below - 20 %)	15	30.69	61.04	111.21	45.02	232.6	98.22
Non-Traditional									
(e) Punjab	High	(i) Most efficient (Top - 20 %)	37	55.93 (+53.78)	27.98	53.78 (-136.59)	13.88	104.45 (-146.57)	27.91
		(ii) Least efficient (Below - 20 %)	37	36.72	44.07	181.02	46.58	257.54	37.69

(contd.)

TABLE 20 (CONCLD.)

Item	Level of Technology based on the yield of rice per hectare	Efficiency Most & Least	No. of Households in the Sample	Yield		Operational Cost (Cost A1)		Total Cost (Cost C2)	
				Mean Q/Hectare	Coefficient of Variation (%)	Mean Rs/Quintal	Coefficient of Variation (%)	Mean Rs/Quintal	Coefficient of Variation (%)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
B. TOTAL COST (COST C2)									
Traditional									
(a) Tamil Nadu	Medium	(i) Most efficient (Top - 20 %)	85	58.19 (+157.02)	127.97	65.36 (-73.74)	34.74	92.98 (-74.93)	26.65
		(ii) Least efficient (Below - 20 %)	85	22.64	62.01	248.87	49.62	370.95	39.35
(b) Andhra Pradesh	Medium	(i) Most efficient (Top - 20 %)	85	47.87 (+145.24)	16.39	59.93 (-61.47)	14.73	107.2 (-53.63)	6.31
		(ii) Least efficient (Below - 20 %)	85	19.52	40.26	155.56	37.96	231.19	34.10
(c) Orissa	Low	(i) Most efficient (Top - 20 %)	81	24.67 (+79.68)	24.63	42.94 (-57.09)	22.65	90.71 (-49.38)	6.85
		(ii) Least efficient (Below - 20 %)	81	13.73	34.63	100.06	31.42	179.71	22.56
(d) Kamataka	High	(i) Most efficient (Top - 20 %)	15	52.86 (+117.98)	30.31	36.05 (-66.11)	26.97	78.59 (-68.08)	14.59
		(ii) Least efficient (Below - 20 %)	15	24.25	64.45	106.19	50.33	246.23	91.02
Non-Traditional									
(e) Punjab	High	(i) Most efficient (Top - 20 %)	37	57.16 (+54.82)	23.11	58.09 (-194.70)	21.61	97.33 (-176.13)	11.86
		(ii) Least efficient (Below - 20 %)	37	36.92	44.83	176.19	50.45	268.76	38.25

Note: Figures in parentheses are the percentage change among the most efficient group over the least efficient group.

TABLE 21. OPERATIONAL, FIXED AND TOTAL COST OF CULTIVATION AND YIELD PER HECTARE BASED ON DIFFERENT MEASURES OF EFFICIENCY IN SOME STATES FOR 1984-85

States		Cost and Yield Per Hectare	Technical Efficiency			Economic Efficiency		
			Most Efficient	Least Efficient	% Change Over Least Efficient	Most Efficient	Least Efficient	% Change Over Least Efficient
(1)		(2)	(3)	(4)	(5)	(6)	(7)	(8)
Traditional								
(a) Tamil Nadu	(i)	Operational Cost (Rs)	5883.82	3146.13	(+) 87.02	3814.04	6362.62	(-) 40.06
	(ii)	Fixed Cost (Rs)	3903.49	1410.36	(+) 176.77	1651.91	2806.85	(-) 41.15
	(iii)	Total Cost (Rs)	9787.31	4556.49	(+) 114.80	5465.95	9169.47	(-) 40.39
		Yield (in quintals)	68.71	15.24	(+) 350.85	58.19	22.64	(+) 157.02
(b) Andhra Pradesh	(i)	Operational Cost (Rs)	4070.60	2932.36	(+) 38.82	3407.88	3522.12	(-) 3.24
	(ii)	Fixed Cost (Rs)	2712.27	1104.56	(+) 145.55	2385.39	1279.64	(+) 86.41
	(iii)	Total Cost (Rs)	6782.87	4036.92	(+) 168.02	5793.27	4801.76	(+) 20.65
		Yield (in quintals)	52.58	16.99	(+) 209.48	47.87	19.52	(+) 145.24
(c) Orissa	(i)	Operational Cost (Rs)	2300.10	1477.13	(+) 55.71	1524.28	2071.64	(-) 26.42
	(ii)	Fixed Cost (Rs)	1559.66	705.85	(+) 120.96	1167.51	896.13	(-) 30.25
	(iii)	Total Cost (Rs)	3859.76	2182.99	(+) 76.81	2691.79	2967.77	(-) 9.30
		Yield (in quintals)	33.06	11.62	(+) 184.51	42.94	13.73	(+) 79.68
(d) Karnataka	(i)	Operational Cost (Rs)	3949.29	2159.41	(+) 82.89	2464.91	3201.75	(-) 23.02
	(ii)	Fixed Cost (Rs)	3312.89	1128.77	(+) 193.49	2151.67	1856.84	(+) 15.88
	(iii)	Total Cost (Rs)	7262.18	3288.18	(+) 120.86	4616.58	5058.59	(-) 8.74
		Yield (in quintals)	70.51	18.45	(+) 282.17	52.86	24.25	(+) 117.98
Non-Traditional								
(e) Punjab	(i)	Operational Cost (Rs)	5788.06	3819.12	(+) 51.55	3649.51	7030.14	(-) 48.04
	(ii)	Fixed Cost (Rs)	2800.86	1968.10	(+) 42.31	1956.70	2567.26	(-) 23.78
	(iii)	Total Cost (Rs)	8558.92	5787.22	(+) 48.31	5606.21	9597.40	(-) 41.59
		Yield (in quintals)	80.28	28.59	(+) 135.05	57.16	36.92	(+) 54.82

TABLE 22. RELATIVE IMPORTANCE OF VARIOUS INPUTS IN COST OF CULTIVATION PER HECTARE AMONG THE MOST AND THE LEAST EFFICIENT FARMERS BASED ON DIFFERENT EFFICIENCY MEASURES IN SOME STATES FOR 1984-85

(in per cent)

Items	TAMIL NADU						ANDHRA PRADESH						ORISSA					
	Efficiency Based on						Efficiency Based on						Efficiency Based on					
	Yield		Changes in % Point	Total Cost (Cost C2)		Changes in % Point	Yield		Changes in % Point	Total Cost (Cost C2)		Changes in % Point With	Yield		Changes in % Point With	Total Cost (Cost C2)		Changes in % Point With
	Most Efficient	Least Efficient	With Respect to Most Efficient Farmers	Most Efficient	Least Efficient	With Respect to Most Efficient Farmers	Most Efficient	Least Efficient	With Respect to Most Efficient Farmers	Most Efficient	Least Efficient	Respect to Most Efficient Farmers	Most Efficient	Least Efficient	Respect to Most Efficient Farmers	Most Efficient	Least Efficient	Respect to Most Efficient Farmers
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)
(i) *Operational Cost*	60.12	69.05	(-)8.93	69.78	69.39	(+0.39)	60.01	72.64	(-)12.63	58.82	73.35	(-)14.53	59.59	67.67	(-)8.08	56.63	69.80	(-)13.17
1. Hired human labour	22.76	21.96	(+)0.80	26.84	20.21	(+)6.63	20.64	18.43	(+)2.21	21.26	17.53	(+)3.73	17.94	19.73	(-)1.79	17.53	17.14	(+)0.39
2. Family labour	2.71	5.31	(-)2.60	3.12	4.74	(-)1.62	4.22	7.82	(-)3.60	3.89	8.21	(-)4.32	13.68	15.03	(-)1.35	11.56	18.73	(-)7.17
3. Bullock labour	9.92	12.75	(-)2.83	8.99	17.50	(-)8.51	6.47	16.89	(-)10.42	5.18	16.36	(-)11.18	9.84	14.63	(-)4.79	9.76	15.91	(-)6.15
4. Machine labour	2.26	1.86	(+)0.40	2.67	2.84	(-)0.14	4.18	1.27	(+)2.91	4.94	1.12	(+)3.82	0.43	0.39	(+)0.04	0.40	0.40	-
5. Seed	3.59	5.66	(-)2.07	4.92	3.34	(+)1.58	2.58	4.07	(-)1.49	2.98	3.70	(-)0.72	4.14	8.30	(-)4.16	5.90	6.01	(-)0.11
6. Fertilizer and manure	12.94	13.07	(-)0.13	16.19	9.83	(+)6.36	15.47	16.30	(-)0.83	14.83	17.04	(-)2.21	11.18	8.76	(+)2.42	9.24	9.48	(-)0.24
7. Insecticides	1.01	1.11	(-)0.10	1.50	0.91	(+)0.59	2.00	0.90	(+)1.10	2.09	0.89	(+)1.20	0.21	0.03	(+)0.18	0.19	-	(+)0.19
8. Irrigation	3.18	5.27	(-)2.09	3.53	8.04	(-)4.51	2.76	5.00	(-)2.24	1.97	6.53	(-)4.56	0.78	0.54	(+)0.24	0.68	0.58	(+)0.10
9. Interest on working capital	1.74	1.93	(-)0.19	2.02	1.96	(+)0.06	1.69	1.96	(-)0.27	1.66	1.97	(-)0.31	1.39	1.62	(-)0.23	1.37	1.55	(-)0.18
10. Miscellaneous	0.01	0.13	(-)0.12	-	0.02	(-)0.02	-	-	-	-	-	-	-	-	-	-	-	-
(ii) *Fixed Cost*	39.88	30.95	(+)8.93	30.22	30.61	(-)0.39	39.99	27.36	(+)12.63	41.18	26.65	(+)14.53	40.41	32.33	(+)8.08	43.37	30.20	(+)13.17
11. Land revenue	0.31	0.49	(-)0.18	0.42	0.23	(+)0.19	0.38	0.40	(-)0.02	0.46	0.38	(+)0.88	0.16	0.41	(-)0.15	0.24	039	(-)0.15
12. Rent paid	6.55	2.06	(+)4.49	1.87	5.94	(-)4.07	-	0.78	(-)0.78	0.19	0.96	(-)0.77	0.98	1.44	(-)0.46	0.79	1.55	(-)0.76
13. Rental value of owned land	24.82	18.74	(+)6.08	21.18	13.13	(+)8.05	35.76	20.19	(+)15.57	38.20	19.20	(+)19.00	34.27	21.83	(+)12.44	36.14	20.12	(+)16.02
14. Interest on fixed capital	7.08	8.42	(-)1.34	5.60	10.22	(-)4.62	3.10	4.76	(-)1.66	1.79	4.90	(-)3.11	3.27	5.41	(-)2.14	3.94	5.33	(-)1.39
15. Depreciation	1.12	1.24	(-)0.12	1.15	1.09	(-)0.06	0.75	1.23	(-)0.48	0.54	1.21	(-)0.67	1.73	3.24	(-)1.51	2.26	2.81	(-)0.56
Total Cost	100.00	100.00		100.00	100.00		100.00	100.00		100.00	100.00		100.00	100.00		100.00	100.00	

(Contd.)

TABLE 22. (CONCLD.)

Items	KARNATAKA						PUNJAB					
	Efficiency Based on						Efficiency Based on					
	Yield		Changes in % Point	Total Cost (Cost C2)		Changes in % Point	Yield		Changes in % Point	Total Cost (Cost C2)		Changes in % Point
	Most Efficient	Least Efficient	With Respect to Most Efficient Farmers	Most Efficient	Least Efficient	With Respect to Most Efficient Farmers	Most Efficient	Least Efficient	With Respect to Most Efficient Farmers	Most Efficient	Least Efficient	With Respect to Most Efficient Farmers
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
(i) *Operational Cost*	54.38	65.67	(-)11.29	53.39	63.29	(-)9.90	67.39	65.99	(+)1.40	65.10	73.25	(-)8.15
1. Hired human labour	15.48	12.87	(+)2.61	14.58	13.07	(+)1.51	13.12	14.61	(-)1.49	15.92	11.91	(+)4.01
2. Family labour	5.51	18.26	(-)12.75	7.74	15.38	(-)7.64	7.10	8.18	(-)1.08	6.79	7.46	(-)0.67
3. Bullock labour	4.87	8.64	(-)3.77	4.29	5.33	(-)1.04	3.05	5.98	(-)2.93	3.68	6.30	(-)2.62
4. Machine labour	0.68	1.10	(-)0.42	1.22	3.65	(-)2.43	7.52	3.55	(+)3.97	6.12	5.66	(+)0.46
5. Seed	3.88	3.83	(+)0.05	3.82	2.56	(+)1.26	1.65	2.65	(-)1.00	2.63	1.42	(+)1.21
6. Fertilizer and manure	19.55	17.91	(+)1.64	16.44	17.86	(-)1.42	15.08	14.22	(+)0.86	18.85	10.15	(+)8.70
7. Insecticides	1.62	0.32	(+)1.30	1.81	2.23	(-)0.42	2.11	2.30	(-)0.19	3.02	5.89	(-)2.87
8. Irrigation	1.31	1.30	(+)0.01	2.11	1.77	(+)0.34	15.94	12.66	(+)3.28	6.32	22.46	(-)16.14
9. Interest on working capital	1.48	1.44	(+)0.04	1.38	1.44	(-)0.06	1.82	1.75	(+)0.07	1.77	2.00	(-)0.23
10. Miscellaneous	-	-	-	-	-	-	-	0.09	(-)0.09	-	-	-
(ii) *Fixed Cost*	45.62	34.33	(+)11.29	46.61	36.71	(+)9.90	32.61	34.01	(-)1.40	34.90	26.75	(+)8.15
11. Land revenue	0.19	0.26	(-)0.07	0.17	0.10	(+)0.07	0.05	1.07	(-)1.02	0.08	0.04	(+)0.04
12. Rent paid	1.09	-	(+)1.09	1.38	-	(+)1.38	3.36	7.86	(-)4.50	2.40	5.80	(-)3.40
13. Rental value of owned land	34.33	18.39	(+)15.94	36.99	20.62	(+)16.37	21.59	19.81	(+)1.78	25.20	15.48	(+)9.72
14. Interest on fixed capital	8.47	13.80	(-)5.33	6.80	14.31	(-)7.51	5.94	4.80	(+)1.14	5.82	4.04	(+)1.78
15. Depreciation	1.54	1.88	(-)0.34	1.27	1.68	(-)0.41	1.67	1.47	(+)0.20	1.40	1.39	(+)0.01
Total Cost	100.00	100.00		100.00	100.00		100.00	100.00		100.00	100.00	

TABLE 23. BREAK UP OF TOTAL COST OF CULTIVATION PER HECTARE AMONG THE LEAST EFFICIENT FARMERS BASED ON DIFFERENT MEASURES OF EFFICIENCY IN SOME STATES FOR 1984-85

	ANDHRA PRADESH				TAMIL NADU				ORISSA			
	Yield	Total Cost	Difference Over Total Cost	Impact on Cost Changes (%)	Yield	Total Cost	Difference Over Total Cost	Impact on Cost Changes (%)	Yield	Total Cost	Difference Over Total Cost	Impact on Cost Changes (%)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
OPERATIONAL COST	2932.36	3522.12	-589.76	77.11	3146.13	6362.62	-3216.49	69.73	1477.13	2071.64	-594.51	75.75
1. Hired human labour	744.01	841.91	-97.90	12.80	1000.71	1852.85	-852.14	18.47	430.77	508.58	-77.81	9.90
2. Family labour	315.71	393.54	-77.83	10.18	242.16	435.01	-192.85	4.18	313.10	555.96	-242.86	30.95
3. Bullock labour	681.64	785.59	-103.95	13.59	580.74	1604.81	-1024.07	22.20	304.68	472.22	-167.54	21.35
4. Machine labour	51.12	53.92	-2.80	0.37	84.89	260.07	-175.18	3.80	8.45	11.84	-3.39	0.43
5. Seed	164.18	177.78	-13.60	1.78	257.72	306.23	-48.51	1.05	181.15	178.46	2.69	-0.34
6. Fertilizer and Manure	658.20	818.34	-160.14	20.94	595.62	901.78	-306.16	6.64	191.28	281.48	-90.20	11.49
7. Insecticides	36.37	42.69	-6.32	0.82	50.48	83.64	-33.16	0.72	0.59	-	0.59	-0.08
8. Irrigation	201.84	313.55	-111.71	14.60	240.16	737.22	-497.06	10.78	11.83	17.17	-5.34	0.70
9. Interest on working capital	79.29	94.80	-15.51	2.03	88.00	179.62	-91.62	1.98	35.27	45.93	-10.66	1.35
10. Miscellaneous	-	-	-	-	5.65	1.39	4.26	-0.09	-	-	-	-
Fixed Cost	1104.56	1279.64	-175.08	22.89	1410.36	2806.85	-1396.49	30.27	705.85	896.13	-190.28	24.25
11. Land revenue	15.98	18.32	-2.34	0.31	22.30	21.45	0.85	-0.02	9.02	11.72	-2.70	0.34
12. Rent paid	31.58	46.29	-14.71	1.92	93.68	544.08	-450.40	9.76	31.54	46.14	-14.60	1.86
13. Rental value of owned land	815.34	922.04	-106.70	13.96	853.97	1203.82	-349.85	7.58	476.45	597.05	-120.60	15.37
14. Interest on fixed capital	192.08	235.32	-43.24	5.65	383.48	937.24	-553.76	12.00	118.11	157.81	-39.70	5.06
15. Depreciation	49.58	57.62	-8.04	1.05	56.93	100.26	-43.33	0.95	70.73	83.41	-12.68	1.62
Total Cost	4036.92	4801.76	-764.84	100.00	4556.49	9169.47	-4612.98	100.00	2182.99	2967.77	-784.78	100.00

(Contd.)

TABLE 23. (CONCLD.)

	KARNATAKA				PUNJAB			
	Yield	Total Cost	Difference Over Total Cost	Impact on Cost Changes (%)	Yield	Total Cost	Difference Over Total Cost	Impact on Cost Changes (%)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
OPERATIONAL COST	2159.41	3201.75	-1042.34	58.90	3819.12	7030.14	-3211.02	84.25
1. Hired human labour	423.34	661.19	-237.85	13.45	845.35	1142.59	-297.24	7.80
2. Family labour	600.58	778.14	-177.56	10.04	473.51	715.80	-242.29	6.36
3. Bullock labour	283.98	269.83	14.15	-0.82	346.55	604.39	-257.83	6.76
4. Machine labour	36.21	184.59	-148.38	8.38	205.22	543.49	-338.27	8.88
5. Seed	126.10	129.44	-3.34	0.19	153.66	136.52	17.14	-0.44
6. Fertilizer and Manure	588.93	903.09	-314.16	17.76	822.85	974.51	-151.66	3.98
7. Insecticides	10.38	112.62	-102.24	5.78	133.11	565.71	-432.60	11.35
8. Irrigation	42.65	89.41	-46.76	2.64	732.69	2155.63	-1422.94	37.35
9. Interest on working capital	47.24	73.44	-26.20	1.48	101.38	191.50	-90.12	2.36
10. Miscellaneous	-	-	-	-	5.10	-	5.10	-0.13
Fixed Cost	1128.77	1856.04	-727.27	41.10	1968.10	2567.26	-599.16	15.73
11. Land revenue	8.31	4.92	3.39	-0.18	4.07	4.08	-0.01	-
12. Rent paid	-	-	-	-	455.20	556.43	-101.23	2.66
13. Rental value of owned land	604.79	1043.01	-438.22	24.76	1145.91	1485.52	-339.61	8.91
14. Interest on fixed capital	453.72	723.31	-269.59	15.23	277.83	388.09	-110.26	2.89
15. Depreciation	61.95	84.80	-22.85	1.29	85.09	133.14	-48.05	1.27
Total Cost	3288.18	5057.79	-1769.61	100.00	5787.22	9597.40	-3310.18	100.00

TABLE 24. BREAK UP OF TOTAL COST OF CULTIVATION PER HECTARE AMONG THE LEAST EFFICIENT FARMERS BASED ON DIFFERENT MEASURES OF EFFICIENCY IN SOME STATES FOR 1984-1985

	ANDHRA PRADESH				TAMIL NADU				ORISSA			
	Yield	Total Cost	Difference Over Total Cost	Impact on Cost Changes (%)	Yield	Total Cost	Difference Over Total Cost	Impact on Cost Changes (%)	Yield	Total Cost	Difference Over Total Cost	Impact on Cost Changes (%)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
OPERATIONAL COST	4070.60	3407.88	662.72	66.97	5883.82	3814.04	2069.78	47.90	2300.10	1524.28	775.82	66.43
1. Hired human labour	1399.69	1231.80	167.89	16.97	2227.83	1467.14	760.69	17.60	692.59	471.85	220.74	18.90
2. Family labour	286.44	225.55	60.89	6.15	264.47	170.37	94.10	2.18	527.98	311.21	216.77	18.56
3. Bullock labour	438.72	300.27	138.45	13.99	971.16	491.23	479.93	11.12	379.70	262.77	116.93	10.01
4. Machine labour	283.95	285.98	-2.03	-0.20	220.26	146.19	74.07	1.73	16.66	10.84	5.82	0.50
5. Seed	174.74	172.91	1.83	0.18	351.20	268.78	82.42	1.92	159.92	158.88	1.04	0.09
6. Fertilizer and Manure	1049.08	859.24	189.84	19.18	1266.79	884.68	382.11	8.84	431.69	248.79	182.90	15.66
7. Insecticides	135.97	121.29	14.68	1.48	98.50	82.12	16.38	0.38	8.29	5.00	3.29	0.28
8. Irrigation	187.34	114.41	72.93	7.37	311.67	193.12	118.55	2.74	29.57	18.18	11.39	0.98
9. Interest on working capital	114.67	96.43	18.24	1.85	170.27	110.41	59.86	1.39	53.70	36.76	16.94	11.45
10. Miscellaneous	-	-	-	-	1.37	-	1.37	-	-	-	-	-
Fixed Cost	2712.27	2385.39	326.88	33.03	3903.49	1651.91	2251.58	52.10	1559.66	1167.57	392.15	33.57
11. Land revenue	25.19	26.37	-1.18	-0.12	29.41	23.10	6.31	0.15	6.20	6.49	-0.29	-0.02
12. Rent paid	-	10.15	-10.15	-1.03	643.26	102.24	541.02	12.52	37.99	21.35	16.64	1.42
13. Rental value of owned land	2425.74	2213.12	212.62	21.49	2428.83	1157.87	1270.96	29.41	1322.80	972.70	350.10	29.98
14. Interest on fixed capital	210.44	103.47	106.97	10.81	693.00	306.09	386.91	8.95	126.19	106.21	19.98	1.70
15. Depreciation	50.90	32.28	18.62	1.88	108.99	62.61	46.38	1.07	66.48	60.76	5.72	0.49
Total Cost	6782.87	5793.27	989.60	100.00	9787.31	5465.95	4321.36	100.00	3859.70	2691.79	1167.91	100.00

(Contd.)

TABLE 24. (CONCLD.)

	KARNATAKA				PUNJAB			
	Yield	Total Cost	Difference Over Total Cost	Impact on Cost Changes (%)	Yield	Total Cost	Difference Over Total Cost	Impact on Cost Changes (%)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
OPERATIONAL COST	3949.29	2464.91	1484.38	56.11	5788.06	3649.51	2138.55	71.70
1. Hired human labour	1124.03	673.09	450.94	17.04	1126.52	892.53	233.99	7.84
2. Family labour	400.24	357.32	42.92	1.62	609.68	380.86	228.82	7.67
3. Bullock labour	353.86	198.24	155.62	5.88	261.34	206.48	54.86	1.84
4. Machine labour	49.20	56.41	-7.21	-0.27	645.66	343.29	302.37	10.14
5. Seed	281.53	176.23	105.30	3.98	141.81	147.50	-5.69	-0.19
6. Fertilizer and Manure	1419.64	758.76	660.88	24.98	1295.47	1056.78	238.69	8.00
7. Insecticides	117.79	83.72	34.07	1.29	181.56	169..14	12.42	0.42
8. Irrigation	95.45	97.27	-1.82	-0.06	1369.10	353.88	1015.22	34.04
9. Interest on working capital	107.55	63.87	43.68	1.65	156.92	99.05	57.87	1.94
10. Miscellaneous	-	-	-	-	-	-	-	-
Fixed Cost	3312.89	2151.67	1161.22	43.89	2800.86	1956.70	844.16	28.30
11. Land revenue	13.65	7.68	5.97	0.23	4.65	4.54	0.11	-
12. Rent paid	78.95	63.49	15.46	0.58	288.72	134.41	154.31	5.18
13. Rental value of owned land	2493.10	1707.78	785.32	29.68	1854.24	1413.04	441.20	14.79
14. Interest on fixed capital	615.38	314.11	301.27	11.39	509.79	326.32	183.47	6.15
15. Depreciation	111.81	58.61	53.20	2.01	143.46	78.39	65.07	2.18
Total Cost	7262.18	4616.58	2645.60	100.00	8588.92	5606.21	2982.71	100.00

TABLE 25. SCOPE FOR RAISING YIELD: YIELD RATIO AMONG DIFFERETIATED GROUPS OF FARMS BY MEASURES OF EFFICIENCY IN SOME STATES FOR 1984-85

States	Yield Ratio					
	Average of Sample Farmers over the Least Technical Efficient Farmers	Average of Sample Farmers over the Least Economic Efficient Farmers	Most Technical Efficient Farmers over Average of Sample Farmers	Most Economic Efficient Farmers over Average of Sample Farmers	Most Technical Efficient Farmers over Least Technical Efficient Farmers	Most Ecop-nomic Efficient Farmers over Least Technical Efficient Farmers
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Traditional						
Tamil Nadu	2.50	1.68	1.80	1.53	4.51	2.57
Andhra Pradesh	2.09	1.82	1.48	1.35	3.09	2.45
Karnataka	2.42	1.84	1.55	1.18	3.81	2.18
Orissa	1.78	1.52	1.60	1.19	2.85	1.80
Non-Traditional						
Punjab	1.71	1.32	1.38	1.17	2.35	1.55

PRICE AND NON-PRICE FACTORS IN THE GROWTH OF FERTILISER USE AFTER GREEN REVOLUTION

Anil Kumar Sharma

Due to the limitations on expanding area under crops due to physiographic reasons, the yield based growth is the most important task facing Indian agriculture today. Fertiliser is one of the most important components of this yield based growth. Increases in this crucial input are required to achieve the targets of foodgrain production. The role of price and non-price factors in the growth of fertiliser use between 1966-67 to 1986-87 has been studied in the present paper to find out whether price factor is important and if so, how much growth can be attributed to this variable. Studies in the past have tried to explain this but, some of the relevant variables were left out. None of the studies have attempted to quantify the growth which can be attributed to different variables. The present study is a modest attempt to quantify the contribution of price and non-price factors in this growth process. It is found that price elasticity of fertilisers varies from -0.26 to -0.41 in different models and the price variable explains only 20 per cent of the growth in fertiliser use during the study period, i.e. from 1966-67 to 1986-87. Non-price factors explain 80 per cent of the growth in fertiliser use. More than 60 per cent of the past growth is explained by four factors namely, irrigation, retail outlets, credit and area under high yielding varieties, and these four should be considered as the major factors for bringing larger increases in fertiliser use. Rainfall is also an important determinant of fertiliser use the effect of which can only be mitigated by bringing more area under irrigation. Irrigation development deserves the highest priority in expanding fertiliser use followed by opening more retail outlets right in the villages, enhanced credit facilities and increased spread of high yielding varieties respectively in that order. The income of the farmer is also an important determinant of the fertiliser demand and efforts should also be made to increase the income of the farmer. Policy makers in the past have relied heavily on the price factor. This distortion needs correction because subsidies on inputs like fertilisers are cutting into the resources for the development of non-price factors.

Introduction

Fertiliser consumption[1] in India has been increasing over the years. The total consumption of fertiliser nutrients (N, P 2 O 5, K 2 O) increased from 0.066 million tonnes in 1951-52 to 12.70 million tonnes in 1991-92, thus making India the fourth largest consumer of fertilisers in the world after Commonwealth of Independent States (formerly U.S.S.R.), China and U.S.A.[2] For achieving the target requirement of the level of 240 million tonnes by the year 2000 A.D., India would need to use 20 million tonnes of fertilisers which would mean an annual average growth of 0.83 million tonnes during this decade as compared to 0.63 million tonnes during the period 1980-81 to 1990-91. The role of fertilisers in agricultural development is well documented in literature [Sahota, 1969, Hayami and Ruttan, 1971] and needs no more emphasis. The importance of fertiliser in yield based growth which is essential for achieving the increased agricultural production[3] further increases because majority of Indian soils are deficient in nitrogen in general, low to medium in available phosphorus and medium to high in available potash. And also, because the intensive cultivation to get more and more out of the limited availability of land results in heavy removal of nutrients from the soils. This calls for increasing fertiliser consumption to replenish the loss from the soil and also to fulfill the nutrient requirements of the crops.[4] Therefore the question as to how fertiliser growth in India has been doing over time is of special interest or relevance.

Fertiliser use depends on factors like the price of fertiliser and crops, level of technology and the

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This paper is part of the dissertation submitted to the Hungarian Academy of Sciences, when the author was working there as Post Doctoral Fellow. Thanks are due to Professor S. Mészáros and the staff of the Research Institute for Agricultural Economics for the facilities provided during the author's stay in Hungary. The author is indebted to Professor V.M. Dandekar for his comments on an earlier draft of this paper. Usual disclaimers apply.

availability of complementary inputs like irrigation, availability of credit and distributional network. By employing different methods, one can arrive at different conclusions such as whether price or non-price variables are important in explaining the past growth and make policy recommendations based on those conclusions. Studies in the past have ignored some of these factors because they have recently been identified as major constraints in expanding fertiliser use. Some of the recent studies incorporating one or two of these factors found reduction in the effectiveness of price variable in producing substantial gains [Nagraj, 1983, Raju, 1989]. When price alone is used to explain the fertiliser demand or the demand for any input for that matter, it produces biased estimates because price is not the only factor which affects the demand for inputs. It is one of the several factors, so, the growth brought about by other factors needs to be differentiated and disentangled from the price variable which otherwise leads to wrong policy conclusions, which if taken further, distracts the attention of policy makers from other productive investments. This can only be achieved by estimating the relative responsiveness of different factors and only then can one formulate policies such as how much to emphasise this measure or that measure.

The main objective of the present study is to identify various forces which have played vital role in achieving the past growth in fertiliser use so that policies can be formulated for sustaining the same growth at least, and if possible to accelerate it because India needs to produce the targeted amount of foodgrains to feed the population of one billion by the turn of the century. The present study is a modest attempt to estimate demand functions with the latest data by employing different possible models and some new variables like credit and retail outlets are also included to measure their influence on fertiliser demand which otherwise have been omitted in the earlier studies partly because of data limitations and/or partly because they have recently been identified as important factors limiting the demand of fertilisers. Identifying sources of past growth is the first step in formulating policy requirements for the future.

Fertiliser Demand Models

Modern work on direct estimation of fertiliser demand functions dates from the results using Nerlove's distributed lag technique reported by Zvi Griliches in 1958 [Timmer, 1974]. Prior to this, very few attempts had been made to estimate fertiliser demand functions directly, even in the simplest fashion of fertiliser demand as a function of the relative price of fertiliser to product price. The Nerlovian model used by Griliches and many subsequent workers can be described as follows: Consider a simple demand function,

$$F_t^* = a + bRP_t + e_t \qquad (1)$$

Where,

F_t^* = desired demand for fertiliser in the long run equilibrium.

RP_t = price of fertiliser at time t relative to the price of agricultural output.

e_t = a random disturbance term

The adjustment function postulates that

$$F_t - F_{t-1} = r(F_t^* - F_{t-1}) \qquad (2)$$

where,

F^t = actual fertiliser consumption in time t, and

r = adjustment coefficient and $0 < r < 1$

This asserts that in the current period the producer will move only part of the way from his actual starting position F_{t-1} to the desired position F_t^*. The closer r is to unity the greater is the adjustment made in the current period.

Substituting equation (1) directly into equation (2) and rearranging terms, we get

$$F_t = r(a + bRP_t) + (1 - r)F_{t-1} + ur \qquad (3)$$

This is the estimating equation for a dynamic demand function for an input assuming a partial adjustment process to be operative. From such an equation one can obtain short run and long run responses of demand and also the speed at which demand is adjusted towards equilibrium as given by the adjustment coefficient. Since the variables are in logarithms, the short run elasticity of demand for fertiliser with respect to its relative price is given by the estimate 'rb' and the long run elasticity is given by 'rb / 1 - (1 - r)'. The model nearly always performs well because the presence of the lagged dependent variable "captures" the effects of excluded but otherwise relevant independent variables, thus yielding a more fully specified equation.

Using this model Griliches found, short run price elasticity of about -0.5 and an adjustment coefficient of approximately 0.25 for the United States.

Hayami [1964] using a simpler model than Griliches explained that nearly 100 per cent of the variation in Japanese fertiliser input per unit of cultivated land is explained by the technical progress in agriculture (which resulted in a continuous shift of the fertiliser demand schedule) and by the technical progress in the fertiliser industry (which lowered the price of fertiliser relative to the price of farm products). Over the period 1883-1937, 70 per cent of the increase in commercial fertiliser input is explained by the former influence and the remaining 30 per cent is explained by the latter. Due to the limited data the time variable was used as proxy for technical change. But because of its simplicity this has also been used to compare results obtained in different models and to see the growth in fertiliser demand due to the production function shift. And since most of the variables are highly correlated with time, time can therefore be used to represent them.

By employing the same methodology to our data the growth of fertiliser can be measured in these two components. The basic model is

$$F_t = F_o RP^a e^{bt} \qquad (4)$$

Where F_o = the level of fertiliser input per unit of land in the initial period.

t = time variable (1966-67 = 0).

Which in terms of growth rates can be expressed as follows:

$$g^*(F) = a\, g^*(RP) + b\, g^*(t) \qquad (5)$$

where,

$g^*(F)$ = rate of growth in fertiliser input per unit of gross cropped area,

$g^*(RP)$ = rate of decline in the price of fertiliser relative to the price of farm products,

$g^*(t)$ = rate of growth in the fertiliser demand schedule (corresponding to the shift in the agricultural production function),

a = price elasticity of demand for fertilisers, and

b = elasticity of demand with respect to shifting of the agricultural production function.

The equation (4) can be estimated by least squares after transforming it to logarithmic form. The relative magnitudes of these effects can be measured by 'ag * (RP)/g * (F)' and 'bg * (t)/g * (F)'.

The main hypothesis in this model is that the demand for fertiliser is derived from the demand for farm products. Changes in the quantity of fertiliser demanded will, there fore, be explained by the shifting of the agricultural production function and changes in fertiliser price relative to the price of farm products. If price alone is used to estimate demand, then it means that price is the only variable which determines the demand of a particular input. But this is not the case always. The experience of the developing countries shows that price, though important, it is not the only variable which affects fertiliser consumption. The non-price variables like high yielding varieties, irrigation which cause upward shifts in fertiliser response functions are also important variables. Time series analysis can not ignore the shifts in production technology of these variables. Certain other variables like credit, marketing and extension efforts which make inputs like fertiliser available to the farmers are also important variables which affect fertiliser consumption and

hence they also can not be ignored from the analysis.[5] When no explicit consideration is given to these variables, it leads to overestimation of the short run price elasticity of demand. What is estimated is in effect is a long-run demand function which measures the response to the changes in price along a long-run production function, an average of the different or shifting fertiliser response functions [David, 1976].

This argument can further be strengthened by the experience of a developing country like India in connection with the importance of price and non-price variables in influencing fertiliser consumption. The experience shows that price has played its role in promoting fertiliser consumption in those areas only where other variables like irrigation, high yielding varieties (particularly wheat and rice), retail outlets and credit were in place. The consumption of fertilisers does not involve fertiliser prices only but factors such as irrigation, credit, marketing efforts, extension efforts, etc., also. A study of 60 odd districts by the Planning Commission in the eastern region where fertiliser use is low indicated that in both low and high productivity districts, the physical and institutional environment of the district played a predominant role in explaining the low levels of fertiliser use. While explaining increased consumption of fertilisers in the sixth plan over the fifth plan period Desai [1986] concluded that increased consumption was not due to price but non-price factors. In fact farmers needed more units of crops to buy a unit of fertiliser during the sixth plan than in the years immediately preceding it. The growth was due to further expansion of irrigation and area sown to HYV's, pressure of excess supply which lead to greater promotional efforts and increased flow of institutional credit to the farmers.

From the above discussion it can be hypothesised that fertiliser demand is explained by the shift of agricultural production function, fertiliser price relative to the product price, improved liquidity of the farmer, physical and institutional factors and weather. The shift in agricultural production function has been accounted for by the variables like HYV's, irrigation and cropping intensity. The major role of that of farmer's income in influencing fertiliser demand in the short run should be identified separately to avoid interpretation of the other market influences [FAO, 1987]. Therefore, this variable was also included separately to measure its impact on fertiliser demand. Retail outlets and credit affect fertiliser consumption by converting the potential demand into effective demand and these two variables measure distributional and institutional constraints which hinder fertiliser use in developing countries and therefore has been included in the analysis. Weather on which there is no control and the agriculture is still rain dependent in most of the developing countries, was included as separate variable in the form of rainfall. All these variables were included in measuring their relative impact on the demand for fertilisers. The model can be specified as follows:

$$F_t = a\ HYV^{b1}\ IRR^{b2}\ CI^{b3}\ RO^{b4}\ GI^{b5}\ RF^{b6}\ RP^{b7}\ CR^{b8}\ e_t$$

The dynamic model or static dynamic model as it may be called, was also estimated with lagged values of the dependent variables included into the model.

Description Of Variables And Data

The study is based on the data from 1966-67 to 1986-87 drawn from various sources. The description of the variables and their estimation have been described below.

F_t = Fertiliser consumption per hectare of gross cropped area.

HYV = Percentage area under HYV's to the total cropped area.

IRR = Percentage gross irrigated area to total cropped area.

CI = Cropping Intensity. This figure represents the average aggregate cropping intensity at the country level and has been estimated as ((Gross cropped area/ Net area sown)*100).

RO = Retail outlets per thousand square kilometer of total geographical area.

GI = Gross income per hectare. Since the estimates for farm level per hectare income are not available, the total receipts from agriculture and animal husbandry were divided by the net sown area to arrive at the figure of gross income per hectare. This lagged income variable was used as proxy variable of the liquidity of the farmers.

RF = Rainfall. In India only 30 per cent of the total cropped area is irrigated and agriculture still depends on rainfall. Rainfall has been measured as annual rainfall in millimeters. The rainfall has been taken as the national average and it does not take into account the regional variation.

RP = Real Price. For deriving the average price of nitrogen, three fertilisers viz. Urea, Calcium Ammonium Nitrate and Ammonium Sulphate were obtained from *Indian Agriculture in Brief* and *Fertiliser Statistics* and weighted according to their share so as to arrive at the price of nitrogen. Phosphorus price was derived by weighting Single Super Phosphate and Diammonium Phosphate. The price of potash was taken as the price of murate of potash. To arrive at the price of NPK, prices derived from above were weighted according to the shares of nitrogen, phosphorus and potash in the total consumption to arrive at the final figure.

To derive product prices, crops like wheat, rice, maize, jowar, bajra, cotton, sugarcane, and groundnut were considered. These crops accounted for 87.89, 87.74 and 85.26 per cent of the nitrogen, phosphorus and potash consumption respectively in 1977-78 [FAI, 1990]. The support prices of these crops were used in these computations. To arrive at the prices of farm products, the weighted average was arrived at and weights were given according to the shares in consumption of different nutrients.

To arrive at the real price figures, the index of fertiliser prices was divided by the index of product prices of the previous year.[6]

CR = Credit. Credit has been estimated as short term and medium term loan advanced by the banks and cooperative societies per hectare. Data on credit for some years i.e from 1968-69 to 1973-74 and from 1973-74 to 1978-79 were not available, therefore to arrive at these figures the data were interpolated. After 1978-79 the data series were available for all the years.

e = error term.

Two forms of functions were fitted, namely, linear and double log transformation. Both the linear and Cobb-Douglas functional forms were tried in this analysis. The results of the Cobb-Douglas form have been retained for interpretation because it was found better when compared with the former. The parameters of the demand function were estimated by single equation ordinary least squares method.[7]

Results And Discussion

The results based on Griliches model are shown in Table 1. The first equation suffers from the problem of autocorrelation, therefore, this problem was dealt with in the second equation by employing search procedure.[8] The variables are significant at one percent level of significance and they explain 99 per cent of the variation in total fertiliser use. Since the variables are in logarithms, the short run elasticity of demand for fertiliser is -0.38 which means that 10 per cent increase in the price of fertiliser will reduce the demand for fertilisers by 3.8 per cent in the short run and by 11.8 per cent in the long run. The adjustment coefficient of 0.32 means that about one third of the disequilibrium in fertiliser use is eliminated in a single year. The comparison of this model with other models will be made in the forth-coming discussion but it can be said at this moment that price explains less variation in the fertiliser use. The lagged variable which captures the influence of other variables explains most of the variation.

TABLE 1: DEMAND FUNCTIONS BASED ON SIMPLE DYNAMIC MODEL

(1967 to 1987)

Variable		Equations				
		CONSTANT	RP	F_{t-1}	$\bar{R}^2$	D.W.
Ft	a.	0.2341	-0.2856 *** (0.1083)	0.7876 *** (0.0612)	0.9836	0.73
	b.	0.3524	-0.3821 *** (0.1117)	0.6814 *** (0.0717)	0.9900	2.09

Notes: (a) OLS estimate with autocorrelation. (b) OLS estimate after correction of autocorrelation. (1) Figures in parentheses are respective standard errors. (2) *** Significant at 1 per cent level of significance.

The results of the Hayami's model are presented in Table 2. The estimates of b are all positive and significant at 1 percent level and bear positive sign meaning thereby upward shift in the fertiliser demand schedule over time leading to an increase in fertiliser input. More than 98 per cent of the variation is explained by these two variables. The price elasticity coefficient is -0.41 which means that 10 per cent increase in fertiliser price will reduce demand for fertilisers by 4.1 per cent.

TABLE 2. DEMAND FUNCTIONS BASED ON HAYAMI'S MODEL

(1967 to 1987)

Variable		Equations				
		CONSTANT	RP	T	$\bar{R}^2$	D.W.
F_t	a.	0.9168	-0.3496** (0.1418)	0.0318*** (0.0034)	0.9760	0.72
	b.	0.8956	-0.4096*** (0.1569)	0.0316*** (0.0042)	0.9843	1.43

Notes: (a) OLS estimate with autocorrelation. (b) OLS estimate after correction of autocorrelation. (1) Figures in parentheses are respective standard errors. (2) *** Significant at 1 per cent level of significance.** Significant at 5 per cent level of significance.

Given the estimates of g * (F) and g * (RP)[9] and the estimates of a and b, the relative contribution of price change and technical change can be evaluated now. A perusal of Table 3 shows that although the coefficient of price variable is higher, but this does not mean that relative price exerted greater influence as compared to the prodution function shift. This difficulty can be overcome by determining the relative importance of these variables in influencing the demand for fertilisers. The demand for fertilisers (per hectare) grew at a rate of 4.06 per cent from 1966-67 to 1986-87, of which 3.16 per cent is attributable to the upward shift of the fertiliser demand function and 0.89 per cent is attributable to the decline in its relative price to the farm products. By setting this growth equal to 100, it can be concluded that about 78 per cent of the growth is explained by the technical progress in agriculture and the remaining 22 per cent is explained by the fall in prices of fertiliser relative to the farm product prices. This can further be corroborated by the results of distributed lag model. The price variable in this model also explains almost same amount of the variation. This can be made clear by multiplying the coefficient of real price variable with g * (RP) and 100, the variation explained turns out to be 20 per cent. The small difference could be attributed to the differences in the models used.

TABLE 3. AVERAGE CONTRIBUTION OF THE PRODUCTION FUNCTION SHIFT AND THE PRICE FALL TO THE INCREASE IN FERTILISERS

(1967 to 1987)

Model	Rate of increase in fertiliser $g^*(F) \times 100$	Contribution of production function $b \times 100$	Contribution of price fall shift	
			$ag^*(RP) \times 100$	Error
HAYAMI's	4.06	3.16	0.89	0.01
	(100)	(78)	(22)	(0)
GRILICHES's	4.06	-	0.83	-
	(100)		(20)	

Notes: 1. Figures in parentheses are total growth set equal to 100 and percentage contribution of each factor to growth.
2. Figures of relative contribution have been rounded off.

Model With all The Variables

The regression equations and related statistics of model with all the variables are presented in Table 4, which shows that OLS estimates of the equation are not appropriate because only two of the variables are significant and all other variables are not significant. Also the signs of variables are not significant. Also the signs of variables like irrigation, retail outlets and rainfall are negative and opposite to expectations. It was identified that this is due to the problem of multicollinearity in the model. Variables like HYV, irrigation, income, retail outlets and credit are highly inter-correlated. To mitigate the problems of multi-collinearity a number of methods have been proposed. The ridge regression and principal components regression analyses were used.[10]

TABLE 4. FERTILISER DEMAND EQUATIONS AND RELATED STATISTICS

Variables	Equations		
	OLS	PCOLS1	PCOLS2
Constant	5.0179	-1.3686	-1.9935
High Yielding Varieties	0.1064	0.1027***	0.1068 ***
	(0.0962)	(0.0006)	(0.0004)
Irrigation	-1.6705	0.6705***	0.6960 ***
	(1.6593	(0.0014)	(0.0007)
Cropping Intensity	0.1129	-0.0533***	0.0501 ***
	(0.4173)	(0.0054)	(0.0049)
Retail Outlets	0.2659	0.2448***	0.2554 ***
	(0.2263)	(0.0005)	(0.0004)
Gross Income	-0.4109	0.1862***	0.1928 ***
	(0.2459)	(0.0009)	(0.0008)
Rainfall	-0.5232	0.3952***	0.4439 ***
	(0.5040)	(0.005)	(0.0031)
Real Price	-0.4331**	-0.2582***	-0.2679 ***
	(0.2171)	(0.0005)	(0.0003)
Credit	0.8567***	0.1133***	0.1179 ***
	(0.2619)	(0.0008)	(0.0006)
Lagged Dependent Variable	-	-	0.1552***
			(0.0005)
$\bar{R}^2$	0.9757	0.9775	0.9796
D.W.	0.94	1.71	1.73

Notes: 1. OLS = Ordinary least square, PCOLS1 = Principal component ordinary least square corrected for autocorrelation. PCOLS2 = Principal component ordinary least square with lagged dependent variable corrected for autocorrelation.
2. Figures in parentheses are respective standard errors.
3. *** Significant at 1 per cent level of significance. ** Significant at 5 per cent level of significance. * Significant at 10 per cent level of significance.

Again it was discovered that principal components regression analysis gave better results. Both these methods produce biased estimates but the expected bias is greatly increased in ridge regression when the parameters are of opposite signs [Brown, W.G., 1973]. For this reason the results of principal component regression were retained for interpretation

Theoretically if one runs a regression using all principal components it will yield the same transformed coefficients as the original regression. There are several methods which have been proposed for the inclusion of principal components in the regression analysis [Hill *et al.*, 1977]. The characteristic root criterion (CRC) and t-value criterion (TVC) are the two traditional methods used in selecting a set of principal components [Hill *et al.*, 1977 and Massy, 1965]. The CRC method was applied and a threshold level of 95 per cent of the total variation to be kept was imposed. But it was found that the same level of variation could be explained by only two principal components and there was not much difference in the parameter estimates, so only two principal components were retained and regressions were run. This may be because the eigen values were greater than one only upto the second principal component and they together explained more than 89 per cent of the variation in the total factor analyses. The resulting equation is presented in Table 4.[11] It was found that results were in line with *a priori* expectations and can be interpreted easily.

Table 4 shows that more than 97 per cent of the variation is explained by the included variables and all the variables have the expected signs and are significant at 1 per cent level of significance. The most important variable with the highest elasticity is irrigation variable, where, it implies that 10 per cent increase in percentage irrigated area will expand demand for fertilisers by 6.7 per cent. The high elasticity of irrigation is attributable to the fact that fertiliser use is mostly concentrated in irrigated areas. Rainfed areas which constitute 70 per cent of the cultivated area consumes only 20 per cent of the total fertiliser [*Economic Survey*, 1989-90]. The next highest elasticity coefficient is that of rainfall. The sensitivity of fertiliser to rainfall has been increasing somewhat in the recent years. This is partly because the use of fertiliser has been spreading, of late, in the rainfed areas also and partly because the so called 'controlled' irrigation is also dependent on rainfall [Hanumantha Rao and Singh, 1986].

Price variable is third in elasticity and its coefficient is highly significant. It indicates that when relative price of fertiliser is increased by 10 per cent, the demand for fertiliser decreases by 2.6 per cent.[12] Fertiliser retail outlets and gross income per hectare also influence fertiliser demand and the elasticity coefficients of retail outlets and income are 0.24 and 0.19 respectively, which means that with the 10 per cent increase in the number of retail outlets per thousand square km of total geographical area, the demand for fertilisers will increase by 2.4 per cent. Similarly with 10 per cent increase in income the fertiliser demand will increase by 1.9 per cent. The demand is also sensitive to the credit advanced and HYV's. Their elasticity estimates are 0.11 and 0.10 respectively. Credit has been a major constraint in developing countries in influencing the demand for fertiliser [Ogunfovora and Norman, 1973 and Raju, 1989]. The fertiliser use has increased substantially with the introduction of HYV's, because these varieties are highly responsive to fertilisers and with the introduction of these varieties the demand for fertilisers has increased substantially [David, 1976, Hayami, 1964 and Desai, 1986].

The elasticity coefficient of cropping intensity is negative, however, it does not imply that with the increase in cropping intensity the demand for fertilisers will reduce but what it shows is that fertilisers are applied in a few crops and the loss of nutrients has not matched the removal. But this has to be interpreted with caution because, when the lagged dependent variable was included its sign became positive (PCOLS2, Table 4).

The lagged dependent variable when introduced in the static/dynamic model was found to be significant at 1 per cent level of significance. Now if one derives the long run elasticity coefficient from this model then it comes out to be -0.32 per cent which is less than the short run demand elasticity estimated by the Griliches's model and Hayami's model and the adjustment coefficient

is 0.85. This dramatic difference is caused by the absence of these variables in the earlier equations. In the earlier models lagged dependent variable and time variable captured the influence of these variables. This means that these variables almost certainly exert a significant and independent influence, their omission will badly bias the estimate of adjustment coefficient.[13]

Accounting for the Past Growth in Fertiliser Demand

Nothing concrete can be inferred regarding the relative contribution of each variable on past growth in fertiliser use from the elasticity coefficients unless one knows the proportion of variation explained by each variable. To measure the relative contribution of all these variables the same methodology was applied as explained earlier. In accounting for growth the following parameters were specified based on the results shown in Table 4, HYV = 0.1, IRR = 0.67, CI = 0.05, RO = 0.25, IN = 0.18, RF = 0.39, RP = 0.26 and CR = 0.11.

A measurement of the sources of growth in fertiliser demand during the study period has been presented in Table 5. The results indicate that more than 30 per cent of the growth in fertiliser use per hectare is accounted by the technological factors like HYV's and irrigation, the effect of the cropping pattern being negligible. The distributional and institutional measures accounted for by the retail outlets and credit explained 30 per cent of the increase in total fertiliser use. However, individually rainfall explained about 20 per cent of the increase in fertiliser use per hectare. The contribution of the price variable in explaining the past growth fell to 14 per cent. This means that 84 per cent of the increase is attributable to non-price factors.

TABLE 5. AVERAGE CONTRIBUTION OF DIFFERENT VARIABLES IN THE INCREASED DEMAND OF FERTILISERS

(1967 to 1987)

Factors	Contribution	Percent
Average Growth Rate of Fertiliser Use	4.06	100
High Yielding Varieties	0.74	18
Irrigation	0.64	16
Cropping Intensity	0.004	00
Retail Outlets	0.60	15
Income	0.61	15
Rainfall	0.82	20
Real Price	0.57	14
Credit	0.63	15
Unexplained Residual	-0.55	-13

Notes: 1. Total growth set equal to 100 and percentage contribution of each factor to growth. 2. Figures of relative contribution have been rounded off.

Conclusions and Policy Implications

From the above analysis, a number of conclusions and policy implications can be drawn. It is quite clear that past growth in fertiliser demand has been due to the shift in technology and measures taken on the front of removing physical and institutional bottlenecks. Four variables namely, irrigation, retail outlets, credit and HYV's account for more than 60 per cent of the past growth in per hectare fertiliser use. The real price of fertiliser explains only 14 to 22 per cent of the total increase in fertiliser use, if we take into account all these models. The price elasticity estimate varies from -0.26 to -0.41 in different models tried here.[14] Our result is almost in line with the earlier result of the Asian data on rice published by David [1976], where she explained that only one third of the variation in fertiliser use in Asian rice economy is accounted for by the price differences while the remaining two thirds by the environmental and varietal factors. This makes clear that fertiliser prices can not be relied upon as a major factor in pursuing future policy options. The constraints on the development and dissemination of HYV's development of irrigation, opening more and more retail outlets and making credit available to the farmer should be

seen as major policy options for sustaining future growth.

While a commendable achievement has been made in developing suitable varieties of rice, wheat and to some extent coarse cereals like bajra, jowar and maize, still around 40 per cent of area under these cereals remains untouched by high yielding varieties. Efforts should be made to take into account region specific production conditions in crop improvement [Jansen, Walker and Barker, 1990]. The study also shows that fertiliser availability especially for jowar and maize was the important infrastructural variable in explaining inter-regional variation in adoption of HYV's of these crops. Thus opening more retail outlets in these areas will help in bringing more area under HYV's and will also help in boosting fertiliser demand in these areas. Therefore, attempts should be made to open more and more retail outlets, right in villages so as to reach more number of farmers in remote and difficult areas and particularly in those states where their number is very less.

The high coefficient of elasticity of irrigation which is more than two times the coefficient of real price suggests that further increases will come with increased irrigation facilities. The disturbing feature is the fact that public investment in irrigation and flood control showed the biggest shortfall in real terms when compared with outlays contemplated both in the Sixth and Seventh Plans [Hanumantha Rao, 1989]. Also figures for country's 14 biggest states show that real investment in irrigation fell by 8 per cent between 1980-81 and 1987-88 despite more than three fold increase in real spending on rural development [The *Economist*, May, 1991]. Much of the unexploited potential lies in those areas which are short of resources and where most of the rural poverty is concentrated.

The neglect of irrigation can further be highlighted by the fact that increased irrigation in India would account for over 80 per cent of the increase in irrigated areas in Asia (excluding China) and 70 per cent of the increase in irrigated areas in the 93 developing countries [FAO, 1988]. What is more important is that, the development of irrigation and infrastructural development i.e., agro-distributional development have been found to have egalitarian impact on different regions and classes of farmers which otherwise have been worsened by price support and subsidy policies [de Janvery and Subbarao, 1986]. Two more studies by Quizon [1985] and Parikh and Suryanarayana [1989] also reveal that investment in irrigation is a more superior alternative compared to subsidising fertilisers for raising foodgrain production and meeting the objectives of equity in social justice.

However this does not mean that fertiliser use should remain concentrated either on irrigated areas and or on HYV's. Fertiliser use should be based on an analysis of local conditions and the responses of available varieties as has been suggested by Parikh [1978].

Similarly there exist disparities among various regions in the advancement of credit by the institutional agencies. The most advanced states have cornered major share of the past growth in credit. In order to boost fertiliser demand in areas where fertiliser use is less, more and more credit should be advanced and especially to small and marginal farmers. The importance of credit becomes more prominent because of the predominance of rainfed agriculture and small and marginal farmers who have a poor resource base. The income of the farmer is also an important determinant of the fertiliser demand and income of the farmer can be increased by developing ancillary activities within agriculture [Heady and Yeh, 1959 and Raju, 1989]. At present the only diversification which the small and marginal farmers find in India is moving out of agriculture and taking up service occupations in urban areas where the shortage of jobs already exists.

In the end it would be better to conclude that a sustained long run development in the use of inputs and agriculture as a whole for that matter is more dependent upon improvements in irrigation, credit, transportation, removing constraints, in the distributional and institutional systems. Price support and subsidy, are both short term measures and they should not be relied upon heavily and they should not distract the attention of policy markers from making investments in long term measures [Krishna, 1966]. Even in the short run a sharp increase in the subsidies may

crowed out resources from productive investments which is happening in the present circumstances. Despite increased flow of resources to agriculture the investment in agriculture has declined during the 1980s. However, this does not mean that prices of fertilisers do not have any role but, as has been seen, they cannot be given the lead role in future demand.[15] These distortions need to be corrected and investments in the long term measures only will ensure faster growth in the use of inputs and achieve the basic objectives of any development policy.

NOTES

1. Terms fertiliser use, fertiliser consumption and fertiliser demand have been used interchangeably in this paper and carry the same meaning.

2. India's fourth rank is only due to its size otherwise she ranks quite lower in per hectare use.

3. With limitations in expanding area under cultivation, a sizable expansion of the present arable land is not possible. That leaves us with the only alternative of increasing production through increased productivity of land.

4. Manures like farm yard manure alone can not meet the high nutrient requirements of crops and can not replenish the lost nutrients because major portion of it is burnt and finds its way as source of fuel and the rest is not enough and plenty for this purpose. Other organic manures are not used extensively in India. Similarly the use of bio-fertilisers is still in the introductory stages.

5. Factors like research and extension, availability of right kind of fertilisers at the right time also influence fertiliser demand but their quantification poses great difficulties and therefore these can not be included in the econometric models.

6. Since prices appear as ratio, the assumption of homogeneity is made for convenience.

7. Doubts can be raised about the use of single equation estimation procedure when the underlying model is of simultaneous nature. It is important to note here that during the period under study, proportion of the total supply of fertilisers was the result of autonomous decisions on the part of government rather than of the fertiliser price. Therefore parameters estimated from the single equation procedure would be free from simultaneity bias.

8. Although D.W. Statistics is biased estimate in lagged models but the reliability of h statistics if estimated will also lead to wrong estimates because of the smallness of the sample. The search procedure was preferred because it ensures that a global minimum has been found.

9. g^* (RP) and g^* (F) are average growth rates and were estimated as $RP_t = RP_o e^{g^*(RP)t}$ and $F_t = F_o e^{g^*(F)t}$ respectively.

10. The various other methods to overcome the problem of multicollinearity are augmentation of data, restricted least square, variable deletion and transformation of data but all these methods are not practical in our case.

11. The original equations had autocorrelation problem, therefore only the equation corrected for autocorrelation are presented here due to want of space.

12. The real price has become more important in the period after the introduction of high yielding varieties as compared to the earlier period [Hanumantha Rao and Singh, 1986]. This variable has also become more important because of the regional concentration of the fertiliser use in some areas where the rates of application have already reached quite high levels.

13. While interpreting Rao's equation Timmer [1974] came to similar conclusion. The long run elasticity from one equation where irrigation variable was excluded was found to be -6.36, and it got reduced to -0.34 in another equation where it was included.

14. This means that the elasticity estimates of -1.29 in the short run and -1.54 in the long run estimated by Subramaniyan and Nirmala [1991] in their study are very high. There appears to be a slip in their estimates.

15. Sometimes it is argued that technological change itself is induced by relative price movements. But only some aspects of innovation in the broadest sense, can be shown to be price induced. The price milieu determines the relative, privately perceived profitability of different techniques made available by the completed applied research and hence influences the rates of their diffusion, but, it can not by itself explain the evolution of basic knowledge and the level and growth of public investment in research, extension, infrastructure, and human capital in different parts of the world [Krishna, 1982].

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AGRARIAN RELATIONS AND POVERTY

H.R. Sharma

In two previous papers, published in Jan-March and April-June 1992 issues of this Journal, we examined the changes in the agrarian relations in India in terms of changes in the distribution of operational and ownership holdings, changes in the magnitude and types of tenancy and economic conditions of agricultural labour households. In the present paper, we shall examine how diverse agrarian features such as concentration of holdings, magnitude and types of tenancy, in particular share tenancy, numerical preponderance of agricultural labour households, and so on impinge upon the general rural poverty and poverty among cultivating and agricultural labour households.

The agrarian features such as skewed distribution of holdings, proliferation of sub-marginal and marginal holdings, magnitude of agricultural tenancy, particularly share tenancy, preponderance of agricultural labour households, and so on directly impinge upon rural poverty. However, somewhat surprisingly, while the role of outmoded agrarian relations in perpetuating the agricultural backwardness and thereby poverty is widely discussed and acknowledged, their effect on poverty are not analysed systematically. To put the record straight, the regressive role of traditional agrarian relations in perpetuating poverty is considered, almost dogmatically, so self-evident that a rigorous cause and effect analysis is not considered essential.

Likewise, a plethora of studies are available on the incidence of poverty and its measurement. Yet a very few of among them have examined the genesis of poverty. The studies of Minhas [1970], Dandekar and Rath [1971], Bardhan [1974] and the ILO [1977] for different states are the notable instances. Falling in the same tradition, some recent studies have questioned, *inter alia*, the methodology of estimating the magnitude of poverty [Minhas *et al.*, 1987, Pp. 19-49]. A few studies which have sought to identify the poverty alleviating or poverty augmenting factors are: Ahluwalia's [1978, Pp. 298-323] highlighting the inverse relationship between poverty and agricultural development; Narain's study [see Mellor and Desai, 1985] highlighting the positive relationship between poverty and price level; and Kakwani-Subbarao's study [1990, Pp. A2-A16] examining the effect of growth and distribution on poverty. Nevertheless, a few studies which have suggested concrete empirical relationship between diverse aspects of agrarian relations and poverty can also be pointed out. For example, Sau's study [1971] reported very high degree of relationship between different aspects of agrarian relations such as land concentration, proportion of holdings below five acres, proportion of agricultural labour households and the magnitude of poverty; Shergill's study [1989, Pp. A9-A12] quantifies the cause and effect relationship between (a) the proportion of agricultural labourers and poverty, (b) gini coefficient of distribution of operational holdings and poverty, (c) the proportion of total operated area leased-in and poverty, and (d) the proportion of operated area leased-in under share tenancy and poverty. Bardhan's study [1985, Pp. 76-94] examines the factors perpetuating the incidence of poverty among agricultural labour households in West Bengal. Kurien [1978] and Joshi [1982, Pp. 66-81] have also explored the theoretical nexus between agrarian relations and poverty. The empirical relationship between diverse aspects of agrarian relations and poverty is of extreme importance, surely for devising developmental strategy and mounting poverty alleviating programmes. The present paper discusses the trends in general rural poverty, poverty among marginal, small and agricultural labour households and analyses the relationship between diverse agrarian features, agricultural development and poverty.

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The present paper is based on the report 'Agrarian Relations and Poverty' with which the author was associated while he was a doctoral candidate in the Centre for the Study of Regional Development, School of Social Sciences, Jawaharlal Nehru University, New Delhi. The report was submitted to the Planning Commission, Government of India, New Delhi. The author is extremely grateful to Professor G.K. Chadha, who was the project director, for encouraging and guiding him to prepare the present paper. He alone, however, is responsible for the remaining errors and omissions.

Trends in General Rural Poverty

Table 1 gives the statewise picture for the total rural population. The following comments are in order. In the fifties, the states characterised by a high incidence of poverty were West Bengal, Bihar, Orissa, Tamil Nadu, Kerala, Andhra Pradesh, Uttar Pradesh, and so on, and those reporting low incidence were Punjab-Haryana, Rajasthan, Assam, etc. In mid sixties, a high percentage of the poor were reported again by practically the same set of states, namely, West Bengal, Bihar, Orissa, Tamil Nadu, Kerala, and so on. Punjab-Haryana, Rajasthan and Assam continued to have a lower incidence of poverty during sixties as well. In the eighties too, states such as West Bengal, Bihar, Orissa, Madhya Pradesh, Kerala, Tamil Nadu, etc., continued to reel under a high incidence of poverty.

An important feature emanating from the Table is an alternating pattern of change from one period to the other. For example, during the closing years of the fifties, the incidence of poverty declined by varying degrees in states such as Bihar, Gujarat, Madhya Pradesh, Maharashtra, Orissa, Punjab-Haryana, Tamil Nadu, Uttar Pradesh and West Bengal, while no significant change occurred in Andhra Pradesh, Assam, Karnataka, Kerala and Rajasthan. During the most part of the sixties, particularly till the arrival of the green revolution, poverty increased in most of the states. The states affected were Bihar, Gujarat, Karnataka, Madhya Pradesh, Maharashtra, Orissa, Tamil Nadu, Uttar Pradesh and West Bengal. During the seventies and eighties, the incidence of rural poverty declined in many states particularly in Bihar. The incidence of poverty had declined in a majority of the states during late fifties, it increased by varying degrees from the begining to the closing years of sixties. It, however, declined there after. This pattern could perhaps be explained in terms of the implementation of the first round of the land reforms during the fifties and the onset of green revolution and launching of various anti-poverty programmes during the seventies.

The firm statistical relationship between the percentage of rural population below poverty line and time(T) is set out in Table 2. To capture the alternative poverty graph , first, during 1957-58 to 1968-69 when the poverty graph declined and then started rising, and, second, during the period 1961-62 to 1988 when it increased and then declined, quadratic time trends are fitted. The statistical evidence given in Table 2 confirms the inverted U shape poverty graph for the period 1961-62 to 1988.

Poverty among Cultivating Households

We have worked out, though in a fairly crude manner, poverty estimates exclusively for the cultivating households using data emanating from quinquennial surveys on employment and unemployment for two years: 1977-78 and 1983. The estimates are reproduced in Table 3. A few points need to be underlined.

First, the incidence of poverty among cultivating households declined during the period 1977-78 to 1983 in practically all the states; quite a few states, namely, Andhra Pradesh, Gujarat, Karnataka, Kerala and Orissa recorded a big decline. In Madhya Pradesh, Uttar Pradesh and West Bengal the decline was moderate. However, in Maharashtra substantial decline in the incidence of poverty among cultivating households was associated with the marginal decline in general rural poverty. Further, it is significant to see a decline in poverty of varying degrees among those operating no land, sub-marginal and marginal cultivating households as it is discernible for higher categories ; in fact the drop in the percentage points of poverty among the lowest categories is much higher compared with the one among the higher categories. On the whole, it comes out from the table unambiguously that the army of rural poor resides very largely among those who cultivate small holdings. It is important to see that in many states households cultivating no land show a slightly lower percentage of the poor compared with those cultivating extremely tiny pieces of land, say, up to 0.49 acre or even up to 0.99 acre.

Poverty among Agricultural Labour Households

The incidence of poverty among agricultural labour households based on Agricultural/ Rural Labour Enquiry Reports, for a few selected years

from 1956-57 to 1983, is given in Table 4 . The general decline in poverty over the period is discernible among agricultural labour households as it was in the case of rural population in general. The most striking fact is the very high incidence of poverty among these households in eastern states notably, West Bengal, Bihar, and Orissa, and fairly high in Tamil Nadu, Madhya Pradesh, Uttar Pradesh and Maharashtra. It was relatively low in Punjab, Jammu & Kashmir, Gujarat, Andhra Pradesh and Kerala. In other words, there has been a high degree of association between state's position in the incidence of general rural poverty and that of agricultural labour households; the coefficient of rank correlation was as high as 0.73 in 1956- 57 and 0.68 in 1963-64.

Determinants of Poverty

To analyse the effect of various aspects of agrarian relations on poverty, the following variables are chosen:

i) Proportion of Households not Owning any Land = PLLH These include the households which own less than 0.01 acre of land.

ii) Proportion of Households Neither Owning Nor Operating any Land = PHNOWNOPL.

iii) Proportion of Agricultural Labour Households = POAGRILH: Households which earn more than 50 per cent of their income from wage-paid employment in agriculture are included in this category.

iv) Proportion of Landless Agricultural Labour Households = POAGRILLH: Those among the agricultural labour households which possess no land constitute this part.

v) Proportion of Operated Area Leased-in = POPLI: It is the total of the leased-in area without referring to the terms of tenancy.

vi) Percentage of Total Leased-in Area Obtained Under Share Crop Tenancy = POPLIUST.

vii) Proportion of operated area leased-in by holding less than 2.50 acres = POPLIM.

viii) Proportion of operated area leased-in by holdings less than 5. 00 acres = POPLIS.

ix) Proportion of operated area leased-in by holdings less than 2.50 acres under share crop tenancy = POPLIMUST.

x) Proportion of operated area leased-in by holdings less than 5.00 acres under share crop tenancy = POPLISUST.

xi) Agricultural Labourers per large holdings (operating more than 15.00 acres of land) = ALPLH.

xii) Proportion of Sub-marginal Holdings = PSBMOPH These include all holdings below 0.99 acre.

xiii) Proportion of Marginal Holdings = PMOPH : The holdings under (xii) above are included in this category. In other words, these include sub-marginal holdings.

xiv) Proportion of Small Holdings = PSOPH All holdings (including those under (xii) & (xiii) above operating land less than 4.99 acres are included in this category.

xv) Average Size of Operational Holdings = AVOPH.

xvi) Land:Man Ratio (Total Land Operated Area/All Cultivating Households) = LMORPRA.

xvii) Gini Coefficient of Operational Holdings = GINOP.

xviii) Agricultural Productivity Per Worker = AGPRW

xix) Per Capita Agricultural Income of Rural Population = PCAGIRP.

xx) Proportion of Rural Population under Poverty = POVG .

xxi) Proportion of Households Cultivating no Land Under Poverty = POVLLH

xxii) Proportion of Marginal Households (cultivating less than 2.49 acres) Under Poverty = POVMH

xxiii) Proportion of Small Households (cultivating less than 4.99 acres and including marginal households) Under Poverty =POVSH

xxiv) Proportion of Agricultural Labour Households (these are those who earn more than 50 per cent of their total income from wage employment in agriculture) Under Poverty = POVALH

Relationship between Agrarian Features and Poverty

To begin with, an insight into the nature\degree of association between various aspects of agrarian relations and rural poverty can be had from the correlation coefficients presented in Table 5. The table invites a number of comments.

First, none of the variables representing different aspects of landlessness (PLLH, PHNOWNOPL, and POAGRILLH), except POAGRILLH for 1981-82, shows a significant correlation with poverty. On the face of it, the results seem somewhat puzzling. It may, however, be underlined that PLLH or PHOWNOPL cannot completely caricature the core of landlessness in the countryside. On the other hand, POAGRILLH measures the numerical strength of the landless more appropriately for our purpose and that is how we discover that its correlation with POVG is significantly positive for 1981-82. In short, we have some limping evidence to suggest that an increasing proportion of agricultural proletariats have the potential of raising the incidence of rural poverty: the mere fact that people are landless or they are not operating any land may not necessarily mean that they are poor inasmuch as such households conceal many other supportive realities incapable of being revealed by state level data. Second, the tenancy correlations both for magnitude of tenancy and share tenancy are not only insignificant and very low but the signs are also not mutually consistent, particularly for 1971-72. These relationships may be attributed to two reasons: (a) The incidence of tenancy has been declining steadily since the fifties so that its total effect as on agricultural production, earnings and poverty was reduced to a marginal phenomenon during 1970s and 1980s. (b) The extremely limited inter-state variations in the variables may also be responsible for correlation coefficients to be insignificant. Third, the correlation coefficients provide unambiguous evidence to support the view that the rising number of sub-marginal, marginal and small operational holdings and proliferation of agricultural labour households provide a surer breeding ground for poverty; the correlation coefficients for these variables are positive and significant for all the three years. The poverty augmenting effect of tiny holdings is also confirmed by the negative and significant correlation between average size of holdings and rural poverty for all three years. Fourth, the correlation coefficient between concentration of operational holdings and rural poverty was positive, albeit, statistically insignificant. Fifth, the negative correlation coefficients between proportion of rural poor and AGPRW and PCAGIRP and in many cases significant, are a reconfirmation of poverty reducing effects of agricultural development.

In sum, the overall impression that one gathers from Table 5 is that it is the sheer numerical strength of sub- marginal, marginal and small operational holdings and agricultural labour households which must become the basis for understanding the inter-state variations in rural poverty.

The degree of relationship between poverty among cultivating households and diverse agrarian features has been reported in Table 6 . As seen in the case of general rural poverty, AGPRW and PCAGIRP come out to be quite strong in their effect on reducing poverty among each section of cultivating households. Tenancy variables (POPLIM/POPLIS), expressly relevant for marginal and small farmers, also show their poverty augmenting effect, particularly among marginal cultivating households. Likewise, agricultural labour households per large holding, ALPLH reveals the poverty effect of rising proletarianisation. Lastly, a few broad insights, again based on zero order correlation coefficients, about the phenomenon of poverty among agricultural labour households are available in Table 7. To recall, agricultural labour households are those who earn more than 50 per cent of their annual income through wage paid employment in agriculture. It is, therefore, understandable, that a fairly sizeable proportion of such households are sub- marginal and marginal households. Thus, in consistent with earlier results while the variables AGPRW and PCAGIRP have a robust poverty alleviating effect, tenancy variables both in terms of magnitude and share tenancy promote poverty among agricultural labour households much more acutely; it is obvious from very high values of correlation coefficients. It may be because of the

fact that among the agricultural labour households the exigency of entering into to the lease market is relatively severer among marginal cultivating households than small households. The negative, albeit, uniformly non-significant, correlation coefficients between POVALH and GINOP is, however, difficult to explain and are contrary to the established view that land concentration is the root cause of rural poverty.

To further analyse the impact of above aspects of agrarian relations on poverty, a number of regression models were estimated. The results have been given in Tables 8, 9 and 10. Three tables throw up many crucial insights, in two broad directions. First, equation pairs la-lb, 2a-2b and 3a-3b, within each of the three tables, show the effect of a shift from sub-marginal to marginal and then to small cultivating households, at one of the three points of time. Second, the inter-temporal changes in the behaviour of general rural poverty in relation to the chosen agrarian-institutional variables can be guaged by looking at the overall picture emerging in the three sub-tables. In 1961-62 (Table 8), GINOP has a negative although statistically non-significant regression coefficient; in 1971-72 (Table 9) negative sign persists in each equation and statistical significance is also visible in a few equations; in 1981-82 (Table 10), the negative sign stays on in each equation and in many of them, it is statistically significant. The variable GINOP thus throws up an embarassing agrarian situation, namely, the increasing land concentration has the potential for reducing general rural poverty. To put the record straight, a negative regression (or correlation) coefficient for land concentration has been observed and reported by a few earlier studies also [e.g. Shergill, 1989, p. A10; Bhatty, 1974, p. 323]. Variable POAGRILH (proportion of agricultural labour households) clearly indicates the phenomenon of poverty augmentation in response to the rising numerical strength of households which largely depend on wage-paid employment in agriculture. It is extremely important to see that the regression coefficient for variable POAGRILH is positive and statistically significant, practically in each regression equation set out in Tables 8, 9 and 10. It almost emerges as an agrarian truism that the very presence of agricultural wage- earning households boosts up the phenomenon of rural poverty since for them low level of employment and earnings are the natural outcome of their extremely limited land base, if any, and lack of adequate employment outside agriculture. Variable AGPRW (agricultural productivity per worker) shows its beneficial effect in reducing rural poverty thanks to the negative sign of the regression coefficients in each and every equation. A feature of extreme significance is that while the regression coefficient for AGPRW is negative for all the three years (1961-62, 1971-72 and 1981-82), it gains statistical significance only in 1971-72 which is duly maintained in 1981-82 as well. This may be due to the fact that in 1961-62, the inter-state variations in agricultural productivity per worker were not so robust as to act as a meaningful explanation towards inter-state variations in rural poverty. With the arrival of the green revolution in late sixties, the 1971-72 picture showed inter-state differentials in agricultural productivity more clearly and more pervasively in terms of percolation gains to the lower strata. In 1981-82, the inter-state variations got further crystalized; the poverty alleviation effects of fast agricultural growth in certain states, and the continuing syndrome of agricultural backwardness in some others stood out more clearly than ever before. Hence the observed contrasts for AGPRW in Tables 9 and 10 against Table 8.

To grasp the impact of the rising numerical strength of sub-marginal or marginal or small farming households on general rural poverty, variables PSBMOPH, PMOPH and PSOPH have been introduced, in alternate equation pairs. Once again, it gets confirmed that the rising incidence of general rural poverty owed itself, *inter alia*, to the rising army of sub-marginal or marginal (including sub-marginal) or small (including marginal) cultivating households, whether one talks of 1961-62 (Table 8) or 1971-72 (Table 9) or 1981-82 (Table 10).

An overview of the preceding regression analysis reveals, on the one hand, the poverty aggravating impact of increasing proletarianization of the rural population, and, the poverty alleviating effect of land concentration on the other. The latter, although baffling and contradictory, in

terms of well-received theories and dogmas in agrarian literature, need not be dismissed as a statistical triviality. How can those two results be reconciled? In this context, 'it is not the degree of land concentration or high proportion of agricultural labourers individually that determines the incidence of rural poverty; rather it is a particular type of compound of these two facets of the agrarian structure that seems to result in mass rural poverty. Mass rural poverty is more likely to occur in agrarian scenarios in which a very numerous class of wage-dependent households gets compounded with a regime of small holder cultivators using traditional technology [Shergill, 1989, Pp. A11-A12].

To operationalize the above line of thinking, the two facets of the agrarian structure (land concentration and the proportion of agricultural labour households) are dovetailed into a single variable namely, the number of agricultural labourers per large holding (operating 15.0 acres or more). This new variable, ALPLH, captures proletarianization among the rural population, in a more blatant form, and would, therefore, admit of neat empirical interpretation. For example, given the level of agricultural development, a more numerous proliferation of agricultural labourers in relation to their capitalist employers in agriculture is very likely to breed a higher level of poverty. The additional advantage of the new variable ALPLH is that it will absorb the reality of many among the sub-marginal/marginal/small cultivators seeking wage-paid employment in agriculture, besides pursuing self-cultivation. Table 11 clearly validates our thinking. It seems that a combination of (continuing) high land concentration and high proportion of agricultural labourers, leading to lower values of ALPLH can result in lower incidence of poverty. On the other hand, a combination of low land concentration and high proportion of agricultural labourers, generating higher values of ALPLH may lead to higher incidence of general rural poverty. As far as the poverty-alleviating effect of rising per worker productivity is concerned, it is established perfectly and neatly in Table 11.

TABLE 11. CONTRASTING EFFECTS OF RISING PROLETARIANISATION AND AGRICULTURAL PRODUCTIVITY ON GENERAL POVERTY (POVG)

	Regression Coefficients					
Year	Intercept	ALPLH	AGPRW	R^2	$\bar{R}^2$	F
1	2	3	4	5	6	7
1961-62	44.25	0.53*	-0.8x10-4**	0.53	0.45	6.29*
		(3.27)	(-2.57)			
1971-72	58.24	0.09***	-0.1x10-4**	0.48	0.38	5.03*
		(1.87)	(-2.46)			
1981-82	54.83	0.11*	-0.01*	0.68	0.62	11.76*
		(3.33)	(-3.78)			

Note: (i) Figures in parentheses are 't' values. (ii) *, **, *** imply significance at 0.01, 0.05, 0.10 levels respectively.

Further, while explaining poverty among marginal and small households we have included two important agrarian variables: AGPRW and ALPLH and two crucial tenancy variables: POPLIM/POPLIS and POPLIMUST/POPLISUST as explanatory variables after taking cognizance of the correlation coefficients between poverty among cultivating households and various agrarian features, presented in Table 6. The results are presented in Table 12. A few comments are in order. Thanks to the exigency of low land:man ratio, marginal and small households are obliged to accept tenancy contracts under highly onerous terms of tenancy. The variables POPLIM/ POPLIS and POPLIMUST/ POPLISUST come out to be poverty aggravating. The variable ALPLH does not come out to be poverty aggravating specially in case of small households. It could perhaps be because of the fact that the dependence of small households on rural labour markets gets diluted as we move from marginal to small households. The general level of agricultural development surrogated by AGPRW once again shows poverty alleviating

effect for both the categories of households. A few regression equations for poverty among agricultural labour households are set out in Table 13. The results are in conformity with those presented earlier. For example, While ALPLH is responsible for worsening the poverty position of agricultural labour households, AGPRW has a potential of reducing poverty. Likewise, tenancy and share tenancy tend to aggravate poverty.

TABLE 12. REGRESSION ANALYSIS FOR POVERTY AMONG MARGINAL/SMALL CULTIVATING HOUSEHOLDS (POVMH/POVSH): 1982

Cultivating Household Category	Intercept	Regression Coefficient for				R^2	$\bar{R}^2$	F
		ALPLH	AGPRW	POPLIM/ POPLIS	POPLIMUST/ POPLISUST			
1	2	3	4	5	6	7	8	9
Marginal	48.76	0.07**	-0.02*	1.05*	-	0.91	0.82	15.50*
		(2.04)	(-5.76)	(4.22)				
Marginal	55.84	$0.60x10^3$	-0.01*	-	4.04*	0.95	0.90	30.51*
		(0.26)	(-5.67)		(6.17)			
Small (including marginal)	48.92	0.05	-0.02*	1.65*	-	0.87	0.75	10.07*
		(1.45)	(-4.93)	(3.42)				
small (including marginal)	52.11	0.8x104	-0.01*	-	3.05*	0.92	0.85	18.17*
		(0.29)	(-5.10)		(4.90)			

Note: 1. Figures in parenthesis are t values 2. * and ** mean significant at 0.01 and 0.05 per cent levels respectively.

TABLE 13. REGRESSION ANALYSIS FOR POVERTY AMONG AGRICULTURAL LABOUR HOUSEHOLDS (POVALH): 1971-72 AND 1982

Year	Intercept	Regression Coefficient for				R^2	$\bar{R}^2$	F
		ALPLH	AGPRW	POPLIS	POPLISUST			
1	2	3	4	5	6	7	8	9
1971-72	82.44	0.09***	-0.02*	0.54	-	0.75	0.57	4.34**
		(1.81)	(-3.47)	(1.31)				
1971-72	80.92	0.10***	-0.01*	-	0.68	0.77	0.59	4.73**
		(1.89)	(-3.13)	(1.31)				
1981-82	34.24	0.10**	-0.02*	2.50*	-	0.85	0.72	8.43*
		(2.06)	(-3.79)	3.74)				
1981-82	40.96	0.07	-0.01*	-	4.31*	0.88	0.78	11.94*
		(1.67)	(-3.14)	-	(4.68)			

Note: 1. Figures in parenthesis are t values 2. *, ** and *** mean significant at 0.01, 0.05 and 0.10 per cent levels respectively.

In sum, study offers some crucial insights into the role of agrarian relations in perpetuating \ mitigating rural poverty. The available evidence clearly indicates that the process of proliferation of tiny holdings provides an important breeding ground for rural poverty. Inasmuch as a preponderant majority of such households are agricultural labourers, the degree of agricultural proletarianisation has close counterpart in the incidence of rural poverty. The study also brings out the fact that the effect of land concentration on poverty has to be understood along with the degree of proletarianisation. It comes out clearly that while a high land concentration along with high proportion of agricultural labourers have poverty mitigating effect in areas of progressive agrarian capitalism, in backward agricultural scenarios, it breeds poverty. The poverty mitigating effect of agricultural development also comes out most unambiguously; not only that, our analysis shows that its effect has tended to become more pronounced over time, lending some credence to the 'trickle down' phenomenon. Insofar as the effect of tenancy and share tenancy is

concerned, while the evidence was not conclusive for general rural poverty, their effect on poverty among marginal and small cultivating households comes out quite clearly. Since a majority of such households are agricultural labourers, the poverty aggravating effect of tenancy and share tenancy is authenticated in their case too.

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TABLE 1. PERCENTAGE OF RURAL POVERTY BY STATES

States	1957/58	1959/60	1960/1	1961/2	1963/4	1965/6	1966/7	1967/8	1968/9	1969/70	1970/1	1973/4	1978	1983	1988
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Andhra Pradesh	53.5	48.8	50.1	47.2	45.6	41.5	45.4	47.9	46.0	47.3	41.0	39.8	57.8	46.3	42.0
Assam	28.0	31.4	25.6	29.4	24.4	24.2	31.3	46.8	38.4	47.3	35.3	39.3	-	38.1	-
Bihar	59.7	55.7	41.5	49.9	52.3	54.3	59.4	74.4	70.9	59.4	59.0	58.4	63.4	64.4	61.5
Gujarat	-	41.5	31.6	39.7	45.7	49.8	50.7	54.1	50.8	42.8	43.8	35.6	51.2	33.1	29.6
Karnataka	41.3	48.9	39.1	35.4	50.5	55.1	63.9	59.5	56.9	58.8	47.2	46.9	55.4	44.6	41.8
Kerala	59.6	62.3	57.8	50.3	52.8	60.7	70.7	67.1	63.4	64.6	62.0	49.3	72.9	51.8	49.2
Madhya Pradesh	57.7	46.4	43.8	40.0	43.6	42.1	47.2	58.3	62.3	56.0	52.9	52.3	59.2	51.6	48.4
Maharashtra	-	54.5	48.4	43.6	48.2	59.1	57.8	63.2	57.2	54.8	46.6	49.8	47.9	46.9	43.6
Orissa	66.6	63.4	62.4	49.3	60.0	61.9	62.1	64.2	64.7	71.2	65.0	58.0	66.2	49.5	46.0
Punjab-Haryana	28.0	24.2	18.8	22.3	29.4	26.5	26.5	29.5	33.9	24.0	23.6	23.0	17.1	18.1	-
Rajasthan	33.4	-	32.3	33.0	32.6	31.8	30.8	37.1	35.9	41.4	41.8	29.8	41.5	27.9	25.6
Tamil Nadu	67.8	64.4	53.9	51.0	52.0	57.4	59.5	62.7	58.1	60.6	57.3	48.3	67.6	49.7	46.6
Uttar Pradesh	52.3	36.7	37.9	35.4	56.6	53.7	47.1	55.2	60.2	46.4	40.6	47.3	44.1	40.6	37.6
West Bengal	62.3	61.4	40.4	58.3	63.3	64.0	56.5	64.3	80.3	74.9	70.1	66.0	67.6	60.6	57.6
All-India	53.4	48.7	42.0	42.3	49.1	50.4	51.1	57.4	57.9	53.5	49.1	47.6	53.0	44.9	41.7

Sources. 1. Ahluwalia, Montek, 'Rural Poverty and Agricultural Performance in India', *Journal of Development Studies*, Vol. 14, April, 1978. 2. World Bank, *India: Poverty, Employment and Social Sciences*, Vol. 1, Executive Summary and Main Report, May, 1989.

TABLE 2. TIME TREND FOR RURAL POVERTY, STATES PHASE REGRESSION EQUATIONS

States	Phase	Regression Equations		
Andhra Pradesh	1957-58/1968-69	Pov = 56.45 - 2.70* T + 0.157* T^2	R^2 = 0.76	F = 9.64
	1961-62/1988	Pov = 42.13 + 0.48 T - 0.013 T^2	R^2 = 0.03	F = 0.12
Assam	1957-58/1968-69	Pov = 34.22 - 3.37 T + 0.330** T^2	R^2 = 0.55	F = 3.59
	1961-62/1988	Pov = 14.91 + 2.55 * T - 0.061** T^2	R^2 = 0.38	F = 2.75
Bihar	1957-58/1968-69	Pov = 65.29 - 6.24* T + 0.601* T^2	R^2 = 0.81	F = 12.71
	1961-62/1988	Pov = 42.72 + 2.19** T- 0.053** T^2	R^2 = 0.30	F = 1.92
Gujarat	1957-58/1968-69	Pov = 39.36 - 0.48 T + 0.148 T^2	R^2 = 0.71	F = 7.74
	1961-62/1988	Pov = 39.59 + 1.28 T - 0.053** T^2	R^2 = 0.53	F = 5.07
Kamataka	1957-58/1968-69	Pov = 40.16 + 0.26 T + 0.133 T^2	R^2 = 0.67	F = 6.13
	1961-62/1988	Pov = 34.64 = 2.66* T - 0.083* T^2	R^2 = 0.40	F = 3.05
Kerala	1957-58/1968-69	Pov = 63.04 - 2.68 T + 0.263 T^2	R^2 = 0.46	F = 2.53
	1961-62/1988	Pov = 42.11 + 2.71** T - 0.082* T^2	R^2 = 0.36	F = 2.54
Madhya Pradesh	1957-58/1968-69	Pov = 65.55 - 8.29* T + 0.669* T^2	R^2 = 0.93	F = 41.67
	1961-62/1988	Pov = 25.11 + 3.37 * T - 0.086* T^2	R^2 = 0.59	F = 6.57
Maharashtra	1957-58/1968-69	Pov = 56.56 - 2.28 T + 0.279** T^2	R^2 = 0.56	F = 3.88
	1961-62/1988	Pov = 45.31 + 1.26 T - 0.045 T^2	R^2 = 0.34	F = 2.31
Orissa	1957-58/1968-69	Pov = 70.15 - 3.85* T + 0.297* T^2	R^2 = 0.45	F = 2.45
	1961-62/1988	Pov = 40.80 + 3.12* T - 0.100* T^2	R^2 = 0.73	F = 12.02
Punjab-Haryana	1957-58/1968-69	Pov = 28.41 - 2.10 T + 0.208* T^2	R^2 = 0.63	F = 5.00
	1961-62/1988	Pov = 26.94 + 0.16 T - 0.020 T^2	R^2 = 0.61	F = 6.92
Rajasthan	1957-58/1968-69	Pov = 35.23 - 1.13 T + 0.097** T^2	R^2 = 0.42	F = 2.14
	1961-62/1988	Pov = 23.54 + 1.73* T - 0.055* T^2	R^2 = 0.45	F = 3.67
Tamil Nadu	1957-58/1968-69	Pov = 72.81 - 5.52* T + 0.392* T^2	R^2 = 0.63	F = 5.07
	1961-62/1988	Pov = 43.61 + 1.97** T - 0.061* T^2	R^2 = 0.39	F = 2.90
Uttar Pradesh	1957-58/1968-69	Pov = 48.89 - 3.07 T + 0.0339*T^2	R^2 = 0.52	F = 3.21
	1961-62/1988	Pov = 42.68 + 1.10 T + 0.043 T^2	R^2 = 0.30	F = 1.92
West Bengal	1957-58/1968-69	Pov = 65.78 - 4.57 T + 0.44** T^2	R^2 = 0.49	F = 2.83
	1961-62/1988	Pov = 47.58 + 2.63* T - 0.077* T^2	R^2 = 0.41	F = 3.19
All-India	1957-58/1968-69	Pov = 55.81 - 3.97* T + 0.359 * T^2	R^2 = 0.82	F = 13.63
	1961-62/1988	Pov = 38.41 + 1.86* T - 0.059* T^2	R^2 = 0.55	F = 5.50

Note: * means significant at 0.05 level; ** means significant at 0.10 level.

TABLE 3. INCIDENCE OF POVERTY AMONG CULTIVATING HOUSEHOLDS

States	Years	Poverty Norms (Rs.)	Size of Area Cultivated (Acres) 0.00	0.01 to 0.49	0.50 to 0.99	1.00 to 2.49	2.50 to 4.99	Others	All House-holds
1	2	3	4	5	6	7	8	9	10
Andhra Pradesh	1977-78	54	54.30	43.86	46.53	41.76	31.63	25.37	41.15
	1983	76	28.12	31.65	35.56	32.64	29.06	22.71	31.55
Assam	1977-78	61	-	-	-	-	-	-	-
	1983	99	43.42	50.68	35.72	37.43	33.43	24.18	38.10
Bihar	1977-78	63	85.29	83.18	76.51	65.11	53.32	33.96	65.34
	1983	104	74.45	75.74	70.28	69.55	58.18	45.38	69.05
Gujarat	1977-78	56	53.71	62.77	69.34	57.50	47.17	21.98	42.23
	1983	85	32.81	26.33	33.99	29.06	32.09	19.36	29.06
Haryana	1977-78	62	46.96	29.44	39.15	26.71	21.62	15.56	25.67
	1983	92	42.02	26.82	19.11	8.29	24.44	15.24	26.67
Jammu & Kashmir	1977-78	57	62.89	47.37	37.59	32.34	35.11	19.66	30.84
	1983	91	27.96	26.37	24.11	22.76	19.33	19.47	22.97
Kamataka	1977-78	56	72.53	46.16	63.68	55.07	45.02	29.93	50.58
	1983	90	44.86	32.67	43.30	39.56	36.77	31.68	39.02
Kerala	1977-78	59	55.32	65.91	48.20	28.48	14.51	6.30	47.54
	1983	100	27.23	31.59	24.90	18.06	12.79	2.59	33.63
Madhya Pradesh	1977-78	57	75.16	60.68	77.06	66.14	62.21	41.98	53.36
	1983	85	50.85	57.60	57.72	53.56	49.60	40.64	47.40
Maharashtra	1977-78	60	77.55	65.14	68.39	66.52	61.28	46.27	73.85
	1983	91	49.93	35.77	36.94	45.93	44.21	37.58	44.56
Orissa	1977-78	52	85.69	73.71	74.59	66.71	50.83	33.50	61.56
	1983	94	54.75	63.86	57.21	59.36	51.70	45.79	53.92
Punjab-Haryana	1977-78	62	43.38	19.20	26.06	10.13	14.81	3.81	16.75
	1983	92	29.41	21.13	7.55	14.83	8.71	7.49	20.49
Rajasthan	1977-78	56	13.40	40.23	58.51	48.54	40.08	26.51	32.60
	1983	78	25.67	45.20	47.43	43.78	34.94	19.16	29.48
Tamil Nadu	1977-78	59	74.85	50.47	66.43	59.47	44.97	26.68	58.31
	1983	99	54.17	59.75	56.36	52.42	36.79	22.38	50.94
Uttar Pradesh	1977-78	57	66.29	70.41	62.20	50.43	38.71	23.26	46.23
	1983	87	47.09	57.54	52.37	49.62	42.45	32.26	36.38
West Bengal	1977-78	68	90.74	89.17	86.70	72.20	53.30	32.51	74.61
	1983	112	73.49	72.73	71.67	62.60	44.45	29.61	65.52
All-India	1977-78	57	68.60	65.48	63.79	53.83	43.97	30.04	50.62
	1983	91	47.49	51.81	48.49	45.50	39.99	31.61	43.76

Note: The cut off point (monthly per capita expenditure in Rs.) in column 3 is directly borrowed from Planning Commission estimates of poverty line for individual states. See Kakwani-Subarao, (1990, p. A3).

Source: The table has been prepared from data in (i) N.S.S. Report on the Quinquennial Survey on Employment and Unemployment; 32nd Round 1977-78. (ii) N.S.S. Report on Third Quinquennial Survey on Employment and Unemployment; 38th Round 1983. Kakwani, N. and Subbarao, K. 'Rural Poverty and Its Alleviation in India', *Economic and Political Weekly*, Review of Agriculture, March 31, 1990.

TABLE 4. TRENDS IN THE INCIDENCE OF POVERTY AMONG AGRICULTURAL LABOUR HOUSEHOLDS BY STATES

States	1956-57	1963-64	1974-75	1977-78	1983
Andhra Pradesh	63.75	50.42	49.34	34.50	22.53
Assam[a]	-	19.56	71.90	60.70	26.29
Bihar	79.40	52.86	80.90	72.69	68.72
Gujarat	80.54	52.59	65.03	43.22	18.33
Haryana	-	-	47.36	32.83	34.46
Jammu & Kashmir	-	-	33.19	31.72	9.96
Karnataka	55.61	53.12	69.58	52.07	34.47
Kerala	81.56	60.57	68.30	52.46	24.39
Madhya Pradesh	72.96	48.27	71.80	60.41	42.69
Maharashtra[b]	76.86	49.90	79.70	64.24	39.64
Orissa	78.94	66.90	81.20	75.28	62.63
Punjab[c]	44.64	27.03	27.42	19.80	13.53
Rajasthan	60.42	46.30	60.20	37.29	27.79
Tamil Nadu	84.60	55.09	63.80	56.23	43.58
Uttar Pradesh	73.21	56.82	68.80	51.09	44.93
West Bengal	71.44	77.57	86.10	76.50	70.54
All-India	68.75	51.53	71.20	64.30	39.52

Note: a = Figures for Assam for the year 1956-57 are inclusive of Manipur and Tripura. b = Figures for the year 1956-57 pertain to the old Bombay state and are thus inclusive of modern Gujarat. c = Figures for the years 1956-57 and 1964-65 are for combined Punjab including Haryana.
Source: 1. *The Second Agricultural Labour Enquiry Report, 1956-57*, Vol. 1; *Statement*: 8.1 p. 169. 2. *Rural Labour Enquiry, Final Report*, Table: 6.1p. 57. 3. *Rural Labour Enquiry, 1974-75: Summary Report on Income and Consumption Expenditure*; Table 3.2 (a) p. 38. 4. *Rural Labour Enquiry , 1977-78: Report on Consumption Expenditure*; Table: 3.1.1-20, Pp. 16-20. 5. *Rural Labour Enquiry, 1983: Report on Consumption Expenditure*; Table: 3.1.1-20, Pp. 76-104.

TABLE 5. ZERO ORDER CORRELATION COEFFICIENTS BETWEEN THE PROPORTION OF RURAL POOR (POVG) AND SELECTED AGRARIAN VARIABLES

	1981-82		1971-72		1961-62	
	Rank Cor.	Karl Pearson	Rank Cor.	Karl Pearson	Rank Cor.	Karl Pearson
1	2	3	4	5	6	7
PLLH	0.196	0.216	0.138	0.014	0.064	0.042
PHNOWNOPL	0.033	0.097	0.130	0.079	0.143	0.047
POAGRILLH	0.462**	0.105	0.002	-0.001	0.354	-
POPLI	0.121	0.011	-0.029	-0.190	-	-
POPLIS	0.248	0.198	0.103	0.112	-	-
PSBMOPH	0.481**	0.323	0.645*	0.557*	0.686*	0.468*
PMOPH	0.521**	0.466**	0.613*	0.646*	0.714*	0.591*
PSOPH	0.547**	0.527**	0.512**	0.622**	0.634*	0.566**
POAGRILH	0.560*	0.644*	0.609**	0.509**	0.702*	0.724*
ALPLH	0.727*	0.518*	0.562*	0.530*	0.759*	0.598*
GINOP	0.119	0.181	0.188	0.250	0.151	0.295
AGPRW	-0.367	-0.600	-0.156	-0.408	-0.166	-0.126
PCAGRIRP	-0.596*	-0.700*	-0.363	-0.582*	-0.273	-0.485**
AVOPA	-0.550*	-0.524**	-0.574*	-0.589*	-0.454*	-0.498**
LMROPRA	-0.474**	-0.492**	-0.387	-0.351	-	-

Note: *, **, *** denote levels of significance at 1 per cent, 5 per cent and 10 per cent respectively.

TABLE 6. ZERO-ORDER CORRELATION COEFFICIENTS BETWEEN PROPORTION OF POOR AMONG CULTIVATING HOUSEHOLDS (POVSH) AND OTHER AGRARIAN-INSTITUTIONAL VARIABLES: 1983

Variables	Poor households Cultivating					
	0.00 Acre (POVLL)		Upto 2.49 Acres (POVMH)		Upto 4.99 Acres (POVSH)	
	Rank Correlation	Karl Pearson	Rank Correlation	Karl Pearson	Rank Correlation	Karl Pearson
1	2	3	4	5	6	7
AGPRW	-0.367	-0.359	-0.573*	-0.679*	-0.582*	-0.665*
PCAGRIP	-0.349	-0.374	-0.557*	-0.698*	-0.554*	-0.661*
POPLIM	-	-	0.472**	0.452*	-	-
POPLIS	-	-	0.389	0.325	0.402	0.352
POPLIMUST	-	-	0.663*	0.757*	-	-
POPLISUST	-	-	0.587*	0.653*	0.554*	0.664*
ALPLH	0.411	0.180	-	-	-	-

Note: * means significant at 0.05 per cent level; ** means significant at 0.10 per cent level.

TABLE 7. ZERO-ORDER CORRELATION COEFFICIENTS BETWEEN PROPORTION OF POOR AMONG AGRICULTURAL LABOUR HOUSEHOLDS (POVALH) AND OTHER AGRARIAN-INSTITUTIONAL VARIABLES

Variables	1981-82		1971-72		1961-62	
	Rank Correlation	Karl Pearson	Rank Correlation	Karl Pearson	Rank Correlation	Karl Pearson
1	2	3	4	5	6	7
AGPRW	-0.495**	-0.489**	-0.367**	-0.620*	-0.007	-0.095
PCAGRIP	-0.512**	-0.534**	-0.495**	-0.761**	-0.327	-0.410
POPLIM	0.713*	0.616*	0.653*	0.451**	-	-
POPLIS	0.463**	0.477*	0.349	-0.006	-	-
POPLIMUST	0.744*	0.869*	0.545*	0.466**	-	-
POPLISUST	0.591*	0.748*	0.371	0.392	-	-
AVOPA	-0.341	-0.382	-0.486**	-0.450**	-0.389	-0.263
GINOP	-0.186	-0.232	-0.291	0.016	-0.035	0.325
ALPLH	0.460**	0.247	0.420	0.210	0.574*	0.343

Note : * means significant at 0.05 per cent level; ** means significant at 0.10 per cent level

TABLE 8. SELECTED AGRARIAN FEATURES, AGRICULTURAL DEVELOPMENT AND RURAL POVERTY (POVG): REGRESSION ESTIMATES FOR 1961-62

Year	Eq. No	Intercept	GINOP	POAGRILH	AGPRW	PSBMOPH	PMOPH	PSOPH	R^2	$\bar{R}^2$	F
1	2	3	4	5	6	7	8	9	10	11	12
1961-62	1a	44.16	-32.80	0.72**	-0.00005	0.33***	-	-	0.66	0.50	4.28**
			(-0.84)	(2.68)	(-1.25)	(1.75)					
	1b	35.42	-28.76	0.80**	-	0.20	-	-	0.60	0.47	4.91**
			(-0.72)	(2.65)		(1.25)					
1961-62	2a	32.63	-18.21	0.65**	-0.00004	-	0.26**	-	0.68	0.55	4.98**
			(-0.50)	(2.49)	(-1.13)		(2.08)				
	2b	29.23	-19.70	0.72**	-	-	0.20***	-	0.64	0.54	6.05*
			(-0.53)	(2.74)			(1.77)				
1961-62	3a	16.06	3.60	0.66**	-0.00002	-	-	0.22**	0.70	0.57	5.40*
			(0.10)	(2.58)	(-0.87)			(2.26)			
	3b	14.56	0.85	0.69**	-	-	-	0.21**	0.68	0.59	7.16*
			(0.02)	(2.78)				(2.16)			
1961-62	4a	34.57	-18.78	0.87*	-0.00001	-	-	-	0.54	0.40	3.90**
			(-0.45)	(3.08)	(-0.33)						
	4b	33.20	-19.27	0.87*	-	-	-	-	0.53	0.45	6.30*
			(-0.48)	(3.25)							

Note: (i) Figures in parentheses are 't' values. (ii) *, **, *** imply significance at 0.01, 0.05 and 0.10 levels respectively.

TABLE 9. SELECTED AGRARIAN FEATURES, AGRICULTURAL DEVELOPMENT AND RURAL POVERTY (POVG): REGRESSION ESTIMATES FOR 1971-72

Year	Eq. No	Intercept	GINOP	POAGRILH	AGPRW	PSBMOPH	PMOPH	PSOPH	R^2	$\bar{R}^2$	F
1	2	3	4	5	6	7	8	9	10	11	12
1971-72	1a	86.25	-84.98***	0.46***	-0.00009**	0.34**	-	-	0.68	0.55	4.92**
			(-1.96)	(1.96)	(-2.75)	(2.27)					
	1b	46.25	-41.45	0.61***	-	0.27	-	-	0.42	0.25	2.43
			(-0.80)	(2.09)		(1.43)					
1971-72	2a	64.49	-52.64	0.41	-0.00008**	-	0.24***	-	0.65	0.50	4.24**
			(-1.27)	(1.62)	(-2.16)		(1.96)				
	2b	34.21	-24.95	0.51***	-	-	0.26***	-	0.47	0.32	3.01***
			(-0.53)	(1.78)			(1.80)				
1971-72	3a	47.78	-34.87***	0.43***	-0.00006***	-	-	0.23***	0.64	0.49	4.09**
			(-1.75)	(1.70)	(-1.79)			(1.87)			
	3b	19.85	-8.52	0.50***	-	-	-	0.29**	0.52	0.38	3.61***
			(-0.19)	(1.79)				(2.12)			
1971-72	4a	67.09	-42.39	0.54***	-0.0000***	-	-	-	0.51	0.36	3.42**
			(-0.91)	(1.97)	(-2.03)						
	4b	34.97	-11.31	0.67**	-	-	-	-	0.31	0.18	2.40
			(-0.23)	(2.19)							

Note: (i) Figures in parentheses are 't' values. (ii) *, **, *** imply significance at 0.01, 0.05 and 0.10 levels respectively.

TABLE 10. SELECTED AGRARIAN FEATURES, AGRICULTURAL DEVELOPMENT AND RURAL POVERTY (POVG): REGRESSION ESTIMATES FOR 1981-82

Year	Eq. No	Intercept	GINOP	POAGRIL H	AGPRW	PSBMOP H	PMOPH	PSOPH	R^2	$\bar{R}^2$	F
1	2	3	4	5	6	7	8	9	10	11	12
1981-82	1a	83.30	-102.90**	0.64	-0.00007**	0.37*	-	-	0.84	0.77	12.07*
			(-1.85)	(3.30)	(-2.69)	(3.56)					
	1b	110.62	-180.87*	0.84*	-	0.33**	-	-	0.72	0.63	8043*
			(-2.99)	(4.06)		(2.52)					
1981-82	2a	58.06	-66.10	0.59**	-0.00006**	-	0.30*	-	0.82	0.74	10.70*
			(-1.48)	(2.81)	(-2.30)		(3.10)				
	2b	85.88	-142.89**	0.82*	-	-	0.29**	-	0.71	0.62	8018*
			(-2.56)	(3.68)			(2.45)				
1981-82	3a	35.64	-36.92	0.57**	-0.00006***	-	-	0.31**	0.78	0.69	8.12*
			(-0.59)	(2.44)	(-2.03)			(2.58)			
	3b	63.43	-112.43***	0.79*	-	-	-	0.29**	0.69	0.60	7.23*
			(-1.97)	(3.20)				(2.16)			
1981-82	4a	55.10	-41.44	0.72**	-0.00005**	-	-	-	0.62	0.51	5.49*
			(-0.53)	(2.54)	(-2.54)						
	4b	80.23	-111.69***	0.92*	-	-	-	-	0.54	0.45	6.37*
			(-1.70)	(3.46)							

Note: (i) Figures in parentheses are 't' values. (ii) *, **, *** imply significance at 0.01, 0.05 and 0.10 levels respectively.

INCOME DISTRIBUTION IN RURAL JAMMU AND KASHMIR AN INTER-TEMPORAL ANALYSIS

M. S. Bhat

The primary objective of this paper is to examine time trends in levels of living (as reflected by consumption pattern) in rural Jammu and Kashmir with special reference to the post-1947 period. The choice of the reference period is primarily motivated by availability of data. The data analysis shows: (i) The differences in the monthly per-capita total consumption expenditure on food and monthly per-capita total consumption expenditure on non-food, at current and constant prices, between the top most fractile class and the lowest fractile class have narrowed down from the base year (1960-61) to the terminal year (1987-88) indicating that consumption distribution has become less skewed during the period under reference; (ii) All the indices of inequality turned out to be very low and exhibit a fair degree of stability across the NSS rounds. These indices increase marginally from the base (1960-61) to the terminal year (1987-88); and (iii) All the indices of inequality for monthly per-capita total expenditure on food turned out to be the lowest compared to the non-food distribution which implies that food distribution is less skewed compared to non-food.

I

OBJECTIVES

The primary objective of this paper is to examine time trends in levels of living (as reflected by consumption pattern) in rural Jammu and Kashmir with special reference to the post-1947 period. The choice of the reference period is primarily motivated by availability of data.

II

DATA AND METHODS

Trends in the levels of living should ideally be analysed with the help of size distribution of income. Since data on size distribution of income for the state are not available we are constrained to press into service consumption data as a proxy for income data. Even at the national level time series data on the distribution of income are not available. Major studies on income distribution and levels of living, with certain exceptions (NCAER, 1962, 1964, 1965), have used consumption expenditure data collected by National Sample Survey Organisation (NSS) since the early fifties.[1]

As such we define the levels of living in terms of monthly per-capita total consumer expenditure (MPTCE). Distribution of population ranked according to MPTCE at current prices is available in the published reports of NSS from 1954-55 to 1987-88. NSS consumption data highlight several indicators of levels of living such as : (i) Monthly Per-capita Total Consumption Expenditure; (ii) Engel Ratios; (iii) Physical Consumption of cereals per-person or per-consumer unit; (iv) Daily intake of Calorie per-person or per-consumer unit. Since time series data about (iii) and (iv) are not available, only (i) and (ii) have been used for the analysis.

NSS data are not free from limitations. Apart from various sampling and non-sampling errors these data 'do not take full account of the changes in the structure of production especially the faster rate of growth of manufactures and services' [Sundaram, 1987]. It is out of the scope of the present study to present a resume of these limitations. An elaborate summary of these limitations is available in : Bhattacharya [1992]; Bhattacharya and Chatterjee [1971]; Gupta and Ramaratnam [1975]; Mahalanobis and Sen [1954]; Minhas *et. al.* [1987]; Mukerjee and Chatterjee [1974]; Radhakrishnan *et. al.* [1974]; Rudra [1974]; Sundaram [1987] and Vaidyanathan [1986]. However, concepts, definitions and procedures have by and large, remained uniform with some notable exceptions. For instance changes have been introduced from time to time in the procedure of data collection. Some of these changes are:

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This paper is a revised part of the research project on 'Rural Poverty in Kashmir Valley', (sponsored by the Expert Advisory Group on Poverty Studies, Planning Commission, Government of India) which the author has completed jointly with Prof. M.L. Misri, former Head, Department of Economics, University of Kashmir. The author acknowledges, with usual disclaimer, suggestions and comments offered generously by Professor Shiela Bhalla of CESP, JNU and Prof. M.L. Misri. Their association has, indeed, been inspiring.

(i) Reference period varies up to the 7th round and thereafter it has been fixed.
(ii) Consumption of home-grown produce was imputed at local retail prices up to 8th round and from the 9th round onwards this imputation was made at ex-farm prices.
(iii) From 19th round the earlier questionnaire became a part of the integrated household schedule which covered besides consumption, the entire range of productive enterprises and of households' aspects like employment/unemployment.
(iv) During the experimentation stage of NSS household consumer expenditure, enquiry was carried out over a shorter period of survey. From 14th round onwards this survey period was extended to full one year to coincide with the agriculture year. This was done to eliminate the effect of seasonality.

The state of Jammu and Kashmir was brought under the purview of NSS expenditure surveys from 13th round onwards. Hence most of the above mentioned changes are unlikely to influence inter-temporal comparisons based on these data. This does not imply that these data provide a uniform concept of consumption, household and other related variables.

Comparisons of levels of living overtime for the same fixed expenditure group or fractile group do not necessarily refer to identical set of households over the reference period. This is not possible as NSS data are not panel data. Even if the panel data were available the possibility of certain households getting sub-divided or going out of panel (due to migration or death of the single member households or due to ladder process) always exists. Consequently ensuring the identity of the households, covered in the time series, is not possible in a panel survey. It is much more difficult in a large scale survey with a single visit to each household with reference period of 30 days preceding the data of interview and universe of the households being covered on a sample basis over each sub-round extending over three months or over the entire survey period [Bhattacharya and Chatterjee 1971]. A question may then be asked as to whose levels of living are being compared. We are in fact comparing over time the real levels of living in average terms of some rank order situated population which happens to be located in a given fractile group. Their identifying characteristics in terms of their rank order are fixed over the time but not the identity of those who are being compared [Jain and Tendulkar, 1989]. Another notable point is that the basic unit of observation is not an individual but a household which is defined as, "a group of persons normally living together and taking food from common kitchen". While computing MPTCE each person is given equal weight regardless of the age-sex composition of the household and intra-household difference in the levels of living. Visaria [1990] opines that inequality indices based on adult equivalent scale adjustment were not much different from those based on per-capita ranking. No firm inferences could be drawn on the basis of a single study. Moreover, a moving reference period is employed for interviews and seasonal variations in consumption are superimposed on the true variations among the households. Lastly, NSS data on MPTCE are mostly available in value terms and the conclusions drawn from these data suffer from an in-built limitation. Against this backdrop we have used NSS data with the underlying assumption that these limitations would not vitiate the comparisons undertaken in this study. In the absence of alternatives "it is better to be vaguely right than to be precisely wrong".

MPTCE gives the summary measure of the central tendency of the size distribution of consumption expenditure. We have employed Gini Concentration Ratio (GC), Theil's Index (TH_1 and TH_2). Theil's Alternative formulation (ATH, ATH_1 and ATH_2) and Atkinson's Inequality Index (ATK) to compare the extent of relative inequality in MPTCE. These indices are based on three different models and have been widely preferred due to their unique properties [Coulter, 1989]. The formula used for GC is:

$$GC = 1 \frac{\sum_{k=1}^{n} (P_k - P_{k-1})(Q_k + Q_{k-1})}{10000}$$

GC = Gini Ratio
P = Cumulative percentage of persons,
Q = Cumulative percentage of expenditure,
N = Number of per-capita expenditure classes.

Theil's Index: (First Method = TH1 and TH2):

$TH_1 = \log n - E(X)$
$TH_2 = \log n - E(Y)$

Where X and Y represent respectively number of persons and expenditure.

$$E(X) = \sum_{i=1}^{n} x_i \log\left[\frac{1}{x_i}\right] \text{and}$$

$$E(Y) = \sum_{i=1}^{n} y_i \log\left[\frac{1}{y_i}\right] \text{and}$$

E(X) and E(Y) are entropies of X and Y and n the number of per-capita expenditure classes.

$$x_i = \frac{X}{X_i} \quad \text{and} \quad y_i = \frac{Y}{Y_i} \qquad i=1,2,\ldots.n$$

x_i = Relative position of the ith observation in the size distribution persons/consumer units.
y_i = Relative position of the ith observation in the size distribution of expenditure.

Theil's Alternative Method (ATH)

$$ATH = \sum_{i=1}^{n} Y_i \log\left[\frac{y_i}{x_i}\right]$$

y^i and x^i are as defined above. Decomposition of ATH has been carried out by working out ATH *between-the-groups* and *within-the-group*. Four broad size groups were formed by graduating the distribution and ATH calculated for these four groups which represents *between-the-groups* index. By subtracting this index from ATH *within-the-group* Index has been estimated [for details see Subramaniam, 1980, Dutta 1980].

Atkinson's Index:

$$ATK = 1 - \left[\sum_{i=1}^{n} \left[\frac{y_i}{Y}\right]^{1-E} f_i\right]^{\frac{1}{1-E}}$$

Where Y_i = Average consumption expenditure in ith size class
Y = Overall mean consumption expenditure
f_i = Proportion of the number of consumer units/ persons in the ith expenditure class
E = Parameter representing the degree of inequality aversion.

We assume that the size distributions of MPCTE are approximately log-normal or log-logistic. GC is accordingly expected to summarize the disparity of these distributions. GC lies between Zero and 1. A value of Zero implies complete equality and that of 1 implies complete inequality. A transfer from rich to poorer one reduces the value of GC. TH lies between Zero and log n where n is the number of size classes. A value of log n is reached when all individuals earn equal income. The closer the value E(X) to Zero the greater the degree of concentration. A transfer from a richer to poorer person lowers TH and ATH. ATH can be decomposed. ATK lies between and 1 and 0. When ATK = 0 there is complete equality and complete inequality when it is equal to 1. It has intuitive appeal. If ATK = 0.3 it means that if incomes are equally distributed, we need only 70 per cent of the present national income to achieve the same level of social welfare according to a particular welfare function [see Coulter, 1989 and Iyenger, 1984].

Following Sen, we have also worked out *Gini-adjusted mean MPCTE*. Sen suggested a method of combining the two characteristics i.e. $\overline{X}$ and GC, into a single indicator [Sen, 1973]. He demonstrates that if MPCTE of each individual is given weight that is inversely proportional to the rank order position, then the distributionally weighted mean $\overline{X}$ is given by $\overline{X}_g = (1 - GC)\overline{X}$ [see Jain and Tendulkar, 1989]. It turns out that $\overline{X}_g$ is simply the average per-capita income weighted by one minus the Gini Coefficient. With absolute equality, i.e., when GC = 0, $\overline{X}_g$ equals the average income per head, and, as the level of inequality increases $\overline{X}_g$ falls more and more below the per-capita income [Sen, 1973].

Kakwani [1980] has proposed a simple relationship between GC of MPCTE distribution and relative shares of food and non-food items in the total expenditure. The relationship is:

$GC = P \cdot GC(f) + (I-P)GC(F)$

GC = Gini Co-efficient of total consumption expenditure

GC(f) = Gini Co-efficient of food expenditure

GC(F) = Gini Co-efficient of non-food expenditure

P = Proportion of total expenditure spent on food.

This relationship necessitates the working out of Engel Ratios since these are involved in the trend of overall inequality [Sundaram, 1987].

For inter-temporal comparisons and estimation of Engel Ratios, size distribution are rearranged whereby relative frequencies in various classes are equalized. The merit of such fractile tabulation have been discussed in a fundamental paper by Mahalanobis [1960]. Various methods have been proposed in the literature to convert fixed expenditure group means into fractile means. The present study utilizes decile group-wise expenditure for each NSS round by converting the fixed expenditure classes of MPCTE, at current prices, into estimates by fractile groups of population -- ranked in ascending order of monthly per-capita total expenditure -- by using linear interpolation technique. Researchers have approximated the NSS observed size distribution of MPCTE by fitting two parameter or three parameter log-normal distribution [Iyenger and Jain, 1976, Murthy and Murthy, 1977, Radhakrishnan and Sarma, 1975, 1976].

Kakwani [1976] proposed four alternatives for fitting a concentration curve with each MPCTE class interval with open-ended class intervals, viz. *Third Degree Polynomial, Fourth Degree Polynomial, Linear Density Function and Quadratic Density Function.* Kakwani found that in case of *Third Degree Polynomial*, the estimates of Gini Coefficient were closest to those calculated from the raw data. However, the relative merits of fitting a *Third Degree Polynomial* are yet to be established firmly by using NSS expenditure data, though of late some experts have employed this type of interpolation device [see Jain, 1989]. We preferred to use linear interpolation as a matter of convenience and simplicity.

The impact of price inflation on living standards is not uniform. For across the spate/time comparisons differential price deflators are needed. For instance to convert decile-specific nominal MPCTE into decile-specific real MPCTE decile-specific price indices are to be utilized. Mahalanobis [1962] was the first to work out the differential impact of prices in his famous study on the distribution of cereals in India. After Mahalanobis a number of studies have been carried out to measure the differential price effect [Iyengar, 1967, Vaidyanathan 1974, Chatterjee and Bhattacharya, 1974, Radhakrishnan and Sarma, 1974, Jain and Tendulkar, 1989, Jain and Minhas, 1991 and Bhattacharya *et. al.*, 1991]. The indices used in these studies are not available for the entire reference period of the present study. The only available series is Consumer Price Indices for Agricultural Labourers (CPIAL). We have, therefore, used CPIAL to convert nominal MPTCE into real MPCTE. Given the limitations of CPIAL, the conclusions derived have to be treated with usual caution and caveat. After graduating the fixed expenditure distribution we computed Engel Ratios and Gini Co-efficients of the fractile distribution. The formula used for GC in this case is:

$$GC = \frac{g-1}{g} - \frac{g}{2}\left[T_1 + T_2 + T_3 \ldots\ldots + \frac{T_{g-1}}{T_g}\right]$$

GC = Gini-Co-efficient

g = Number of fractile groups

T_i = X1 + X2 + ... + Xi (i = 1,2,....g)

X_i = Mean Expenditure of ith fractile group.

The maximum value of GC is {(g-1)/g} and not 1 as is commonly defined. This naturally leads to underestimations since it assumes away the possible intra-group variations that might exist [Prasad and Iyenger, 1987]. With the help of GC, as calculated above, Sen's Adjusted Mean Expenditure has been re-estimated using the formula: $\bar{X}_g = (1 - GC)\bar{X}$.

Jain [1989] has constructed all India rural and urban consumer price indices for 17 fractile groups for four NSS selected survey periods. Since fractile specific price indices for the state are not available nor could be constructed due to

the non-availability of relevant data, we have used these indices to convert nominal fractile distributions of the 28th and 38th rounds into real fractile distributions, After deflation, GC was estimated with the help of above method, both for nominal and real distribution, to study the impact of inflation on consumption inequality (as reflected through GC) with the underlying assumption that Jain's all India fractile specific consumer price indices faithfully represent the changes in prices at the state level during the reference period. This procedure is usually followed in the official estimates of poverty ratios by the Planning Commission at the state level. Minhas *et. al.* [1987, 1991] have convincingly proved the weaknesses of this procedure. We have no reason to disagree with Minhas *et. al.* but have no option in the matter since state-specific and fractile-specific price relatives are not available.

A cursory examination of MPCTE across different fixed expenditure classes for all the NSS rounds utilized in the present study reveals many omissions and overestimation. For instance, MPTCE on consumer durables have been overstated for the top open-ended expenditure class for the year 1977-78. Such omissions and overestimates/underestimates are bound to give misleading results. Hence these were adjusted. There are several methods of adjustment [see Jain and Tendulkar, 1989]. We have followed Sundaram [1986] for making necessary corrections.

III

DATA ANALYSIS

Monthly per-capita total consumption expenditure (total expenditure), monthly per-capita total consumption expenditure on food (food expenditure) and monthly per-capita total consumption expenditure on non-food items (non-food expenditure) have increased in each fractile group and for all fractiles put together both at current and constant prices (see Tables 1 to 6). At current prices the increase is robust both for the lowest and the highest fractile groups. However, at constant prices the increase is modest in each case. Total expenditure, food expenditure and non-food expenditure of the bottom fractile class (i.e. 0-10) have increased by 5 to 10 times from 1960-61 (the base year = BR) to 1987-88 (the terminal year = TR). At current prices corresponding increase for the top most fractile class (90-100) work out to be equally large. At constant prices the changes in the total expenditure, food expenditure and non-food expenditure of the lowest and the highest fractile classes also turn out to be modest. Food expenditure of these two fractile classes has declined during the period 1960-61 to 1987-88. In the case of the middle band of fractile classes the change in food expenditure does not display any trend - it increases for 3rd, 4th, 5th and 6th fractile classes; decreases for 7th and 8th fractile classes and again increases for the 9th fractile class. Non-food expenditure, however, exhibits an increasing trend across the items, fractile groups and rounds with the sole exception of the 17th round.

There is no much difference in the magnitudes of the percentage change in the total expenditure and the corresponding expenditure on food items and on non-food items of the lowest and the top most fractile classes at current prices. However, this difference sharpens at constant prices in case of total expenditure and food expenditure. Compared to the lowest fractile expenditure class the top most fractile expenditure class has witnessed almost double percentage decline in food expenditure while the percentage increase is the same in case of non-food expenditure. This could be taken as a summary indicator of the improvements in the standard of living during the period under reference i.e., 1960-61 to 1987-88.

At current prices differences between total expenditure, food expenditure and non-food expenditure of the lowest and the top expenditure classes work out to be : 203.16 per cent, 145.03 per cent and 510.19 per cent respectively in 1960-61. The corresponding percentages for 1987-88 are : 230.98, 133.83 and 504.52. It is obvious that the differences between food expenditure and non-food expenditure have narrowed down during the period under reference. The respective differences at constant prices also have narrowed down. This trend is no discernible if we compare the difference between the second and ninth fractile expenditure classes or third and eighth fractile expenditure classes. At current prices total consumption expenditure, food expenditure and non-food expenditure for the

distribution as a whole have increased by 733.33 per cent, 608.33 per cent and 974.06 per cent from 1960-61 to 1987-88, respectively. The corresponding percentages at constant prices are 21.49, 6.18 and 7.03 respectively.

For the lowest fractile class Engel Ratios work out to be 84.14 and 74.81 in 1960-61 and 1987-88 respectively showing a decline of 9.38 percentage points. For the top fractile class the corresponding ratios are 75.25 and 53.99 showing a decline of 21.26 percentage points. Engel Ratios have declined in each fractile class as well as for the distributions as whole. For the bottom 20 per cent of the distribution the Engel Ratios work out to be 84.19 and 74.81 in 1960-61 and 1987-88 respectively showing a decline of 9.38 percentage points. For the top 20 per cent of the population the ratios stand at 69.03 and 63.74 in 1960-61 and 1987-88 respectively resulting into a decline of 5.29 percentage points. Engel Ratios for the distribution as whole turn out to be 77.75 in 1960-61 and 61.91 in 1987-88 ending into a decline of 15.91 percentage points, (Ref. Table 7).

A decline in the Engel Ratios indicates improvement in the living standards. Though the percentage of monthly per-capita total expenditure on food for the lowest fractile groups has declined over the NSS rounds but the percentage is still very high. For the top fractiles the Engel Ratio has declined from 63.74 to 46.01. The pattern is well in line with the Engel's law which postulates that the proportion of the total outlay spent on food is the diminishing function of the outlay on total expenditure.

Total expenditure and Gini adjusted total expenditure have persistently increased over the NSS rounds with round 17 being an outlier. For the entire reference period these expenditures turn out to be Rs. 23.860 and Rs 18.275 respectively with 10.260 and 7.856 as the corresponding Co-efficients of variation. This implies that Gini adjusted total expenditure is more consistent compared to unadjusted total expenditure.

Food expenditure and Gini adjusted food expenditure have decreased from 1960-61 to 1987-88. The corresponding non-food expenditures have increased. Compared to non-food expenditure (both unadjusted and adjusted) the distributions of food expenditure (both unadjusted and adjusted) are more consistent due to lower co-efficients of variation.

Gini Co-efficients of food and non-food expenditure distribution (both unadjusted and adjusted) have increased in each case but the values of the Gini Co-efficient are reasonably low. Compared to total expenditure and food expenditure consumption inequalities in non-food expenditure are larger for each NSS round. Low values of GC are indicative of less inequality in the consumption expenditure. Gini Co-efficients (GC) series of food expenditure is more consistent compared to Gini Co-efficients series of non-food expenditure as C.V. of latter. GC for the distributions as a whole have been computed as: 0.232, 0.178 and 0.366 for total, food and non-food expenditures, respectively.

Theil's Indices for the number of consumption units (TH_1) and Theil's Index for expenditure (TH_2) and total expenditure, and non-food expenditures do not follow a particular pattern. Inequality (as reflected by TH_1 and TH_2) is greater in consumption expenditure compared to the number of consumption units in all the three cases. These results are not consistent with GC. This is not surprising since in Theil's Entropy for individual variables more attention is paid to the extent of concentration and not to the overall level of inequality in the distribution of consumption among expenditure classes.

Theil's Alternative Index (ATH) gives consistent results. The computed values of ATH for total, food and non-food expenditures in 1960-61 are : 0.11, 0.0579 and 0.3058 respectively. The corresponding values for 1987-88 are 0.1902, 0.082278 and 0.448196. Between-the-group inequality is greater than within-the-group inequality in food and non-food expenditures as Theil's Alternative Index between-the-group (ATH_1) is greater than Theil's Alternative Index within-the-group (ATH_2) in each round. Moreover, ATH_1 and ATH_2 of food expenditure are lower in relation to ATH_1 and ATH_2 of non-food expenditure. These are consistent with GC, TH and ATH. This means that inequalities in food expenditure are less compared to those of total consumption expenditure and non-food expenditure. Though there is a slight increase in the

values of all the above mentioned indices from 1960-61 to 1987-88 yet their values are very low. Increase in Theil's Alternative Index (ATH) can mostly be attributed to increase in Theil's Alternative Index within-the-group (ATH_2).

A set of Atkinson's Indices (ATK_1, ATK_2, ATK_3 and ATK_4) corresponding to E = 0.5, 1.5, 2.5 and 3.5 have been computed. As E rises value of Atkinson's Index rises showing thereby the sensitivity of index to E (that is the weight given to the inequality aversion). For E = 0.5 the Atkinson's Index (ATK_1) of total, food, and non-food expenditures works out to be 0.0498, 0.0285 and 0.1363 in 1960-61. The corresponding values for 1987-88 are: 0.0820, 0.0376 and 0.18414. When E = 3.5 Atkinson's Index (ATK_4) of total, food and non-food expenditures are: 0.2548, 0.1733 and 0.5187. The values of ATK_4 for 1987-88 are 0.3228, 0.2086 and 0.5241.

It is obvious from the above values of Atkinson's Index that the higher the value of E the more consistent is the series of Atkinson's Index. The values of ATK_1, ATK_2, ATK_3 and ATK_4 are very low indicating low inequality and are in line with the values of GC, ATH, ATH_1 and ATH_2. According to Atkinson's Index (like other indices) inequality in food expenditure is less than the inequality in non-food expenditure.

The social welfare implication of consumption redistribution that follows from the estimated values of Atkinson's Index is that the same levels of social welfare could be achieved, as were obtaining at different periods, if only a proportion of consumption (income) were equally distributed. For example, at E = 0.5 the value of Atkinson's Index (ATK_1) for the total expenditure works out to be 0.0498 in 1960-61 and 0.0820 in 1987-88. It can be said that the same level of social welfare could be achieved with only 5 per cent (1-0.0488 = 0.95) of the total consumption in 1960-61 and 8 per cent (1-0.082 = 0.91) in 1987-88 provided the consumption (income) was equally distributed. In other words, if society's total consumption was reduced by 5 per cent and 8 per cent in 1960-61 and 1987-88, respectively and the remainder equally distributed the results would produce the same amount of social welfare as before the reduction and redistribution. The alternative interpretation of ATK_1 would be that the potential gains of redistribution would be equivalent to 95 per cent and 91 per cent increases in the consumption (income) respectively in 1960-61 and 1987-88. The same interpretation could easily be extended to Atkinson's Index at E = 1.5 (ATK_2) and Atkinson's Index at E = 2.5 (Ref. Tables: 8 to 10).

Gini Co-efficients and Gini adjusted total, food and non-food expenditures have been worked out by fractile classes so that effect of graduating series from fixed expenditure classes to fractile classes could be gauged. GC for total expenditure, food expenditure and non-food expenditure works out to be 0.2013, 0.1626 and 0.3256, respectively in 1960-61. The corresponding values for 1987-88 are 0.2151, 0.1617 and 0.3246. The mean GCs for the three distributions work out to be 0.1898, 0.1543 and 0.2917 with Coefficients of variation as 7.53 per cent, 7.99 per cent and 11.10 per cent, respectively. Gini Coefficients in all the three cases are very low and have marginally declined in case of food and non-food expenditures. GCs of fractile distributions (as presented in Table 11) are lower than GCs by fixed expenditure groups as given in Tables: 8, 9 and 10.

This comparison needs to be interpreted with caution. Prasad and Iyenger [1984] have referred to the problem of using grouped size distribution data and pointed out that when the Lorenz Ratio is calculated from fractile distribution using the formula: $GC = \frac{g-1}{g} - \frac{g}{2}\frac{(T_1 + T_2 + \ldots\ldots + T_{g-1})}{T_g}$ the maximum value of GC is $\frac{g-1}{g}$ and not 1 as in the case of GC computed from the formula: $GC = 1\frac{(P_k - P_{k-1})(Q_k + Q_{k-1})}{10000}$. This naturally leads to underestimation of GC since it assumes away the possible intra-group variations that might exist. With comparatively low values of Gini Coefficients adjusted, total expenditure, food expenditure and non-food expenditure increase a little compared to their corresponding values computed after adjusting with the GCs of the fixed expenditure class distributions. Gini Coefficients of food expenditure distribution (both unadjusted and adjusted) are more consistent compared to the corresponding series of non-food

expenditure. Food expenditure inequality is lower compared to non-food expenditure inequality. All this reinforces the conclusions drawn in the preceding pages.

Fractile-Specific Gini Ratios of nominal and real total, food and non-food expenditures of 28th round (1973-74) and 38th round (1983) are presented in Table 12. Gini Co-efficients of total, food and non-food expenditures at nominal prices have declined from 28th to 38th round by 9.38 per cent, 9.38 per cent and 31.01 per cent, respectively. Gini Co-efficients of these expenditure groups, at constant prices, have declined from 28th round to 38th round by 20.85 per cent, 17.36 per cent and 26.79 per cent, respectively. Thus decline in consumption inequalities is more sharp at constant prices. In the 28th round GCs increase from current prices to constant prices while reverse happens in the 38th round. However, in all cases the values of GCs are very low suggesting thereby low consumption inequality. Inequality in food expenditure is less in each case compared to that of non-food expenditure. Though the scope of this two time point comparison is limited yet it could be safely concluded that the distribution of total consumption has moved in the egalitarian direction with a more appreciable decrease in GC at constant prices. However, this conclusion is subject to one rider, i.e., fractile specific price indices used for deflation are for all India and not for the reference area. Given the higher rates of inflation for the state our conclusion could be an overestimate of the decline of consumption inequalities. But nothing final could be concluded in the absence of state specific fractile price indices.

IV

CONCLUSIONS

From the preceding the following inferences can be deduced:

(I) Monthly per-capita total consumption expenditure, both nominal and real, has displayed an increasing trend across the fractile classes and NSS rounds. But the improvement is not much appreciable. The Increase is more sharp at current prices compared to constant prices. This is in line with the impact of price inflation on the purchasing power of money incomes;

(II) Nominal per-capita monthly total expenditure on food also increased across the fractile classes and NSS rounds but the real monthly per-capita total consumption expenditure declined both across the five out of ten fractile groups and across the NSS rounds for the period under reference;

(III) Real as well as nominal monthly per-capita total consumption expenditure on non-food items increased across the fractile classes and NSS rounds;

(IV) Engel Ratio has declined both across the fractile classes and NSS rounds. This implies an improvement in the living standards. The pattern is well in line with the Engel's law;

(V) The differences in the monthly per-capita total consumption expenditure, monthly per-capita total consumption expenditure on food and monthly per-capita total consumption expenditure on non-food, both at current and constant prices, between the top most fractile class and lowest fractile class have narrowed down from the base year (1960-61) to the terminal year (1987-88) indicating that consumption distribution has become less skewed during the period under reference;

(VI) All the indices of inequality turned out to be very low and exhibit a fair degree of stability across the NSS rounds. These indices increase marginally from the base (1960-61) to the terminal year (1987-88);

(VII) All the indices of inequality for monthly per-capita total expenditure on food turned out to be the lowest compared to the non-food distribution which implies that food distribution is less skewed compared to non-food;

(VIII) Between-the-group inequality (as measured by Theil's Alternative Formulation) is greater than within-the-group inequality in all the cases, i.e., food + non-food, food and non-food distributions. The values of within-the-group inequalities are almost negligible. This is a significant result which demonstrates the nature of given consumption distributions used in this analysis;

(IX) Gini Co-efficients of the consumption expenditure distributions by fixed expenditure classes figured out to be a shade higher than the Gini Co-efficients of the same distributions by the fractile classes. This proves that graduation of consumption expenditure distribution from fixed expenditure classes to fractile classes does not alter much the inequality as measured by Gini Co-efficient;

(X) Sen Gini-Adjusted Mean Per-capita total consumption expenditure $\bar{X}_g$ shows an increasing trend except in the case of food expenditure where it decreases from the base to the terminal year;

(XI) Since the GC values turned out to be low the difference between monthly per-capita total consumption expenditure ($\bar{X}$) and Gini adjusted $\bar{X}(\bar{X}_g)$ is not much (It is 23.42 per cent, 17.84 per cent and 37.21 per cent in the case of food + non food, food and non-food expenditures). These results are in consonance with the other measures of inequality. Compared to $\bar{X}$ series of total expenditure, food expenditure and non-food expenditure $\bar{X}_g$ series of these expenditures are more stable;

(XII) Food expenditure distributions are as more consistent compared to those of non-food distribution as is reflected by the low values of standard deviations and Co-efficients of variation.

NOTE

1. Ahmad [1965]; Ahmad and Bhattacharya [1974]; Bardhan [1971, 1974]; Bhattacharya and Chatterji [1972]; Bhattacharya and Mahalanobis [1967]; Dev *et. al.* [1991]; Dutta [1980]; Iyenger [1967]; Iyenger and Bhattacharya [1965]; Iyenger and Jain [1973, 1974]; Iyenger and Mukerjee [1961]; Govt. of India [1969]; Jain and Tendulkar [1989]; Lydal [1960]; Mahalanobis [1962]; Mazumdar [1969]; Mueller and Sarma [1965]; Mukerjee [1969]; Mukerjee and Ghosh [1961]; Nayyar [1991]; Ojha [1964]; Ojha and Bhatt [1964 and 1974]; Radhakrishnan and Sarma [1974, 1975, 1976]; Ranadive [1965, 1973]; Rudra [1961, 1972, 1974]; Sarma [1970]; Sundaram [1987]; Swamy [1965, 1967] and Vaidyanathan [1977].

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TABLE 1. AVERAGE CONSUMPTION EXPENDITURE IN RS PER 30 DAYS BY FRACTILE GROUPS OF POPULATION AND BY NSS ROUNDS: ALL JAMMU AND KASHMIR, RURAL [AT CURRENT PRICES]

Year	NSS Round Number	Average CE in Rs per 30 days by fractile groups										General Population
		0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100	
1960-61	16th	13.075	13.607	15.493	17.035	18.835	21.081	23.751	27.026	31.637	39.641	24.42
1961-62	17th	12.730	13.060	15.070	16.680	18.370	20.340	22.860	26.030	30.740	40.050	24.64
1963-64	18th	14.386	15.157	17.457	19.836	22.357	25.053	27.713	31.419	36.561	45.933	27.89
1964-65	19th	15.868	16.248	19.347	21.610	23.411	25.345	27.343	30.791	35.758	43.907	30.67
1965-66	20th	18.486	18.966	22.489	25.404	28.599	31.183	33.767	37.518	41.385	50.227	33.67
1966-67	21st	19.773	20.293	24.309	27.306	30.113	32.863	36.386	40.454	46.340	55.698	35.96
1967-68	22nd	21.148	21.381	23.713	27.175	30.356	33.407	36.656	39.953	43.555	50.896	37.46
1968-69	23rd	20.588	21.078	25.259	28.860	31.762	34.891	38.783	42.674	49.452	59.515	38.12
1969-70	24th	21.231	21.883	25.847	29.426	32.546	35.864	39.356	42.847	49.935	61.657	39.12
1970-71	25th	21.409	21.833	25.752	29.349	32.969	36.968	41.117	46.547	53.042	66.933	43.84
1972-73	27th	26.050	26.724	31.378	35.270	38.691	42.113	46.982	52.358	61.069	73.006	47.47
1973-74	28th	29.455	30.063	35.445	39.541	43.777	48.773	53.769	61.578	70.305	86.542	52.89
1977-78	32nd	42.110	42.787	49.550	54.992	60.335	65.592	71.165	78.385	90.375	114.093	73.04
1983	38th	74.582	75.937	87.776	96.157	104.837	113.770	122.704	136.873	156.515	193.004	129.22
1986-87	42nd	89.665	91.481	107.635	122.018	135.211	148.093	168.611	190.456	218.918	257.219	171.24
1987-88	43rd	97.435	99.454	116.909	131.602	146.897	163.220	183.349	207.708	248.902	322.449	203.50

Source : Computed from Round-wise NSS Consumption Expenditure Data.

TABLE 2. AVERAGE CONSUMPTION EXPENDITURE [FOOD] IN RS PER 30 DAYS BY FRACTILE GROUPS OF POPULATION AND BY NSS ROUNDS: ALL JAMMU AND KASHMIR, RURAL [AT CURRENT PRICES]

Year	NSS Round Number	Average CE (Food) in Rs per 30 days by fractile groups										PCE per Total Population per 30 days
		0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100	
1960-61	16th	11.007	11.44	12.48	13.72	14.60	17.09	19.25	20.06	21.83	27.07	17.79
1961-62	17th	10.62	10.88	12.19	13.50	14.24	15.77	17.61	19.86	21.31	24.45	17.42
1963-64	18th	11.36	11.97	13.57	15.27	16.96	18.85	20.15	22.85	25.28	30.22	19.81
1964-65	19th	12.64	12.94	15.85	16.89	18.30	19.52	21.05	23.64	24.44	28.41	20.90
1965-66	20th	14.70	15.07	17.12	20.63	22.67	24.72	26.77	29.30	32.32	36.39	25.33
1966-67	21st	16.21	16.64	19.19	21.55	23.67	25.84	27.64	30.73	32.95	37.69	26.66
1967-68	22nd	17.33	17.52	19.43	21.96	24.28	26.72	28.82	31.42	32.01	37.41	28.44
1968-69	23rd	16.68	17.18	19.97	22.32	24.57	26.17	29.09	32.01	34.003	38.29	27.42
1969-70	24th	16.89	17.41	20.41	22.97	25.40	27.31	29.97	32.65	35.44	43.78	28.30
1970-71	25th	17.37	17.72	20.29	22.83	25.64	28.52	31.72	64.98	39.86	44.94	30.32
1972-73	27th	20.36	20.89	24.31	26.94	29.56	32.17	34.95	38.95	40.52	48.44	32.98
1973-74	28th	23.77	24.26	28.66	31.97	34.94	38.93	42.91	43.29	49.43	53.62	38.08
1977-78	32nd	33.49	34.03	39.41	42.69	46.04	50.05	52.37	57.68	62.62	70.41	51.01
1983	38th	58.21	59.26	67.96	74.45	79.03	85.77	92.50	97.16	103.67	127.84	89.97
1986-87	42nd	68.44	69.82	81.88	92.83	101.21	110.86	119.88	135.41	143.15	146.64	116.16
1987-88	43rd	72.89	74.40	86.51	100.01	105.7	114.18	126.05	142.79	158.62	174.09	126.00

Source: Computed from Round-wise NSS Consumption Data.

TABLE 3. AVERAGE CONSUMPTION EXPENDITURE [NON-FOOD] IN RS PER 30 DAYS BY FRACTILE GROUPS OF POPULATION AND BY NSS ROUNDS: ALL JAMMU AND KASHMIR, RURAL [AT CURRENT PRICES]

Year	NSS Round Number	Average CE (Non-Food) in Rs per 30 days by fractile groups									PCE Per Total Population per 30 days
		0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100	
1960-61	16th	2.06	2.15	3.01	3.31	4.22	3.98	4.49	6.96	9.79	12.57	6.64
1961-62	17th	2.11	2.18	2.88	3.18	4.13	4.57	5.25	6.17	9.43	15.60	7.21
1963-64	18th	3.01	3.17	3.88	4.55	5.39	6.20	7.55	8.56	11.27	15.71	8.07
1964-65	19th	3.22	3.30	3.49	4.72	5.11	5.82	6.29	7.15	11.31	15.49	7.44
1965-66	20th	3.80	5.22	5.36	4.77	5.92	6.46	6.99	8.21	9.06	13.83	8.33
1966-67	21st	3.56	3.65	5.11	5.75	6.44	7.02	8.74	9.72	13.39	18.008	9.27
1967-68	22nd	3.81	3.86	4.28	5.21	6.07	6.68	7.83	8.53	11.54	13.48	9.07
1968-69	23rd	3.90	3.89	5.28	6.54	7.19	8.72	9.69	10.66	15.44	21.22	10.67
1969-70	24th	4.38	4.47	5.43	6.45	7.14	8.55	9.38	10.19	14.49	23.22	10.91
1970-71	25th	4.03	4.11	5.46	6.51	7.32	8.44	9.39	11.56	13.18	21.99	11.58
1972-73	27th	5.69	5.83	7.06	8.33	9.13	9.94	12.03	13.40	20.54	24.56	14.48
1973-74	28th	5.68	5.80	6.78	7.57	8.83	9.84	10.85	18.28	20.87	32.92	14.83
1977-78	32nd	8.62	8.75	10.14	12.30	14.29	15.54	18.79	20.70	27.75	43.68	22.02
1983	38th	16.37	16.67	19.81	21.70	25.80	28.00	30.20	39.71	52.84	65.60	39.19
1986-87	42nd	21.22	21.66	25.75	29.18	34.001	37.23	48.73	55.04	75.76	110.57	56.05
1987-88	43rd	24.54	25.05	30.39	31.59	41.19	49.04	57.29	64.91	90.25	148.35	77.44

Source: Computed from Round-wise NSS Consumption Data.

TABLE 4. AVERAGE CONSUMPTION EXPENDITURE IN RS PER 30 DAYS BY FRACTILE GROUPS OF POPULATION AND BY NSS ROUNDS: ALL JAMMU AND KASHMIR, RURAL [AT 1960-61 CONSTANT]

Year	NSS Round Number	Average CE in Rs Per 30 days by fractile groups									General Population
		0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100	
1960-61	16th	13.075	13.607	15.493	17.035	18.835	21.081	23.751	27.026	31.637	39.641	24.42
1961-62	17th	8.32	8.53	9.85	10.90	12.00	13.29	14.94	17.01	20.09	26.18	23.7
1963-64	18th	12.295	12.955	14.921	16.954	19.109	21.413	23.686	26.854	31.249	39.259	23.84
1964-65	19th	12.113	12.403	14.769	16.496	17.871	19.347	20.873	23.505	27.297	33.517	23.41
1965-66	20th	12.083	12.396	14.699	16.604	18.692	20.381	22.070	24.522	27.049	32.828	22.01
1966-67	21st	11.171	11.465	13.733	15.427	17.013	18.566	20.557	22.855	26.181	31.468	20.32
1967-68	22nd	12.514	12.652	14.031	16.080	17.962	19.767	21.690	23.641	25.772	30.116	22.17
1968-69	23rd	13.457	13.777	16.509	18.863	20.760	22.805	25.348	27.892	32.322	38.899	24.91
1969-70	24th	13.270	13.677	16.155	18.391	20.341	22.415	24.591	26.779	31.209	38.535	24.50
1970-71	25th	12.820	13.074	15.420	17.574	19.742	22.137	24.621	27.873	31.761	40.079	26.25
1972-73	27th	12.77	13.10	15.382	17.289	18.966	20.644	23.031	25.666	29.936	35.787	23.27
1973-74	28th	11.20	11.431	13.477	15.035	16.645	18.545	20.445	23.414	26.732	32.906	20.11
1977-78	32nd	12.313	12.511	14.488	16.080	17.642	19.179	20.808	22.919	26.425	33.361	21.36
1983	38th	13.967	14.220	16.437	18.007	19.632	21.305	22.978	25.632	29.310	36.143	24.2
1986-87	42nd	14.509	14.803	17.417	19.744	21.879	23.963	27.283	30.818	35.424	41.621	27.71
1987-88	43rd	14.203	14.498	17.042	19.184	21.414	23.793	26.727	30.278	36.283	47.004	29.67

Source : Computed from Round-wise NSS Consumption Data.

TABLE 5. AVERAGE CONSUMPTION EXPENDITURE (FOOD) IN RS PER 30 DAYS BY FRACTILE GROUPS OF POPULATION AND NSS ROUNDS: ALL JAMMU AND KASHMIR, RURAL [AT 1960-61 CONSTANT PRICES]

Year	NSS Round Number	Average CE (Food) in Rs per 30 days by fractile groups										PCE per Total Population per 30 days
		0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100	
1960-61	16th	11.007	11.45	12.48	13.72	14.60	17.09	19.25	20.06	21.83	27.07	17.79
1961-62	17th	6.94	7.11	7.96	8.82	9.30	10.30	11.51	12.98	13.93	15.98	17.08
1963-64	18th	9.70	10.23	11.60	13.05	14.50	16.11	17.22	19.53	21.61	25.83	15.98
1964-65	19th	9.65	9.88	12.10	12.89	13.97	14.89	16.07	18.04	18.66	21.69	15.95
1965-66	20th	9.60	9.90	11.19	13.48	14.82	16.16	17.49	19.15	21.12	23.79	15.64
1966-67	21st	9.16	9.40	10.84	12.17	13.37	14.60	15.61	17.36	18.61	21.29	13.89
1967-68	22nd	10.25	10.37	11.50	12.99	14.37	15.81	17.05	18.59	18.94	22.13	15.80
1968-69	23rd	10.90	11.23	13.05	14.59	16.05	17.11	19.01	20.92	22.22	25.02	17.36
1969-70	24th	10.55	10.88	12.75	14.35	15.88	17.07	18.73	20.39	22.15	26.21	16.95
1970-71	25th	10.40	10.61	12.15	13.67	15.35	17.07	18.99	20.94	23.86	26.91	17.43
1972-73	27th	9.98	10.24	11.91	13.21	14.49	15.77	17.13	19.09	19.86	23.74	15.20
1973-74	28th	9.04	9.22	10.89	12.15	13.28	14.80	16.31	16.46	18.79	20.38	13.27
1977-78	32nd	9.79	9.95	11.52	12.48	13.46	14.63	15.31	16.86	18.30	20.59	13.75
1983	38th	10.90	11.09	12.72	13.94	14.80	16.06	17.32	18.19	19.41	23.94	15.38
1986-87	42nd	11.07	11.29	13.25	15.02	16.37	17.93	19.39	21.91	23.16	23.37	17.21
1987-88	43rd	10.62	10.84	12.61	14.57	15.40	16.64	18.37	20.81	23.12	25.37	16.69

Source : Computed from Round-wise NSS Consumption Data.

TABLE 6. AVERAGE CE (NON-FOOD) IN RS PER 30 DAYS BY FRACTILE GROUPS OF POPULATION & NSS ROUNDS: ALL JAMMU AND KASHMIR, RURAL (AT 1960-61 PRICES)

Year	NSS Round Number	Average CE (Non-food) in Rs per 30 days by fractile groups										PCE Per Total Population per 30 days
		0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100	
1960-61	16th	2.06	2.15	3.01	3.31	4.22	3.98	4.49	6.96	9.79	12.57	6.64
1961-62	17th	1.38	1.42	1.89	2.08	2.70	2.99	3.43	4.03	6.16	10.20	6.94
1963-64	18th	2.58	2.71	3.32	3.89	4.60	5.29	6.45	7.32	9.63	13.42	6.90
1964-65	19th	2.46	2.52	2.66	3.60	3.89	4.45	4.80	5.46	8.63	11.82	5.68
1965-66	20th	2.50	2.54	3.50	3.12	3.87	4.22	4.58	5.37	5.92	9.03	5.45
1966-67	21st	2.01	2.06	2.89	3.25	3.64	3.96	4.94	5.49	7.57	10.17	5.24
1967-68	22nd	2.29	2.28	2.53	3.09	3.59	3.95	4.64	5.05	6.83	7.98	5.33
1968-69	23rd	2.55	2.54	3.45	4.27	4.71	5.69	6.33	6.97	10.10	13.87	6.98
1969-70	24th	2.72	2.79	3.40	4.04	4.46	5.34	5.86	6.38	9.05	13.86	6.82
1970-71	25th	2.42	5.46	3.27	3.90	4.39	5.06	5.63	6.93	7.90	13.16	6.94
1972-73	27th	2.79	2.86	3.47	4.07	4.47	4.87	5.90	6.57	10.07	12.04	7.10
1973-74	28th	2.16	2.11	2.58	2.88	3.36	3.74	4.13	6.95	7.94	12.52	5.64
1977-78	32nd	2.52	2.56	2.96	3.60	4.18	4.54	5.49	6.05	8.12	12.77	6.44
1983	38th	2.06	3.13	3.71	4.06	4.83	5.24	5.65	7.44	9.9	12.20	7.34
1986-87	42nd	3.43	3.51	4.16	4.42	5.50	6.66	7.89	8.90	12.26	17.90	9.07
1987-88	43rd	3.58	3.65	4.43	4.64	6.01	7.15	8.35	9.46	13.16	21.63	11.29

Source : Computed from Round-wise NSS Consumption Data.

TABLE 7. PERCENTAGE OF FOOD AND NON-FOOD ITEMS IN AVERAGE CONSUMPTION EXPENDITURE PER-30 DAYS BY FRACTILE GROUPS POPULATION AND BY NSS ROUNDS: ALL JAMMU AND KASHMIR, RURAL

Year	NSS Round Number	0-10		10-20		20-30		30-40		40-50		50-60	
		F	NF	F	NF	F	NF	F	NF	F	NF	F	NF
1960-61	16th	84.19	15.81	84.19	15.81	80.56	19.44	80.56	19.44	77.55	22.45	81.08	18.92
1961-62	17th	83.47	16.44	83.33	16.67	80.91	19.09	80.91	19.09	77.52	22.48	77.52	22.48
1963-64	18th	79.02	20.98	79.02	20.98	77.75	22.25	77.02	22.98	75.89	24.11	75.26	24.74
1964-65	19th	79.67	20.32	79.67	20.32	81.94	18.05	78.19	21.80	78.19	21.80	77.02	22.97
1965-66	20th	79.45	20.55	79.45	20.55	76.13	23.87	81.94	18.06	79.29	20.71	79.29	20.71
1966-67	21st	82.0	18.00	82.00	18.00	78.95	21.05	78.95	21.05	78.63	21.37	78.63	21.37
1967-68	22nd	81.98	18.02	81.98	18.02	81.98	18.02	80.83	19.17	80.01	19.99	80.01	19.99
1968-69	23rd	81.02	18.90	81.53	18.47	79.09	20.91	77.36	22.64	77.36	22.64	75.03	24.97
1969-70	24th	79.57	20.43	79.57	20.43	78.98	21.02	78.07	21.93	78.07	21.93	76.16	23.84
1970-71	25th	81.17	18.83	81.17	18.83	78.83	21.17	77.79	22.21	77.79	22.21	77.15	22.85
1972-73	27th	78.17	21.83	78.17	21.83	77.48	22.52	76.41	23.59	76.41	23.59	76.41	23.59
1973-74	28th	80.72	19.28	80.72	19.28	80.87	19.13	80.87	19.13	79.82	20.18	79.82	20.18
1977-78	32nd	79.54	20.46	79.54	20.46	79.54	20.46	77.63	22.37	76.32	23.67	76.32	23.67
1983	38th	78.05	21.95	78.05	21.95	77.43	25.57	77.43	25.57	75.39	24.60	75.39	24.60
1986-87	42nd	76.33	23.67	76.33	23.67	76.08	23.92	76.08	23.92	74.86	25.14	74.86	25.14
1987-88	43rd	74.81	25.19	74.81	25.19	74.00	26.00	72.99	27.01	71.96	28.04	69.96	30.03

(Contd.)

TABLE 7. (CONCLD.)

Year	NSS Round Number	60-70		70-80		80-90		90-100		All Population	
		F	NF	F	NF	F	NF	F	NF	F	NF
1960-61	16th	81.08	18.92	74.26	25.74	69.03	30.67	68.29	31.71	72.85	27.14
1961-62	17th	77.04	22.96	76.31	23.69	69.34	30.66	61.06	38.94	70.69	29.31
1963-64	18th	72.74	27.26	72.74	27.26	69.17	30.83	65.81	34.19	71.02	28.98
1964-65	19th	77.02	22.97	76.79	23.20	68.37	31.62	64.72	35.27	68.14	31.85
1965-66	20th	79.29	20.71	78.10	21.90	78.10	21.90	72.47	27.53	75.23	24.77
1966-67	21st	75.97	24.03	75.97	24.03	71.11	28.89	67.68	32.32	74.13	25.87
1967-68	22nd	78.65	21.35	78.65	21.35	73.51	26.49	73.51	26.49	75.92	24.07
1968-69	23rd	75.03	24.97	75.03	24.97	68.76	31.24	64.34	35.66	71.93	28.07
1969-70	24th	76.16	23.84	76.16	23.84	79.98	29.02	65.42	34.58	72.34	27.65
1970-71	25th	77.15	22.85	75.15	24.85	75.15	24.85	67.15	32.85	69.16	30.83
1972-73	27th	74.41	25.59	74.41	25.59	66.36	33.64	66.36	33.64	69.47	30.53
1973-74	28th	79.82	20.18	70.31	29.69	70.31	29.69	61.96	38.04	71.99	28.00
1977-78	32nd	73.59	26.41	73.59	26.41	69.29	30.71	61.72	38.28	69.83	30.16
1983	38th	75.39	24.60	70.99	29.00	66.24	33.75	66.24	33.75	69.62	30.37
1986-87	42nd	71.10	28.90	71.10	28.90	65.39	34.61	57.01	42.99	87.83	32.16
1987-88	43rd	68.75	31.25	68.75	31.25	63.74	36.25	53.99	46.01	61.91	38.08

Source : Computed from Round-wise NSS Consumption Data.
Note : F =Food Items, NF = Non-food Items.

TABLE 8. PCE AND ADJUSTED PCE IN RS PER 30 DAYS AND GINI, THEIL AND ATKINSON INDICES OF INEQUALITY BY NSS ROUNDS AT 1960-61 PRICES: ALL JAMMU AND KASHMIR, RURAL (FOOD + NON-FOOD)

NSS Round	MEAN	ADMEAN	GINI	TH_1	TH_2	ATH	ATH_1	ATH_2	ATK_1	ATK_2	ATK_3	ATK_4
16th	24.42	18.3996	0.2465	0.2398	0.2340	0.110	0.0896	0.0171	0.0498	0.1328	0.1995	0.2548
17th	23.70	17.7181	0.2524	0.2790	0.2226	0.1115	0.0489	0.0626	0.0844	0.1664	0.2301	0.2812
18th	23.84	18.0507	0.2428	0.2863	0.3202	0.0971	0.0814	0.0157	0.0470	0.1305	0.2009	0.2596
19th	23.41	18.3918	0.2144	0.4217	0.4122	0.0825	0.0632	0.0193	0.1108	0.1708	0.2202	0.2622
20th	22.01	17.1272	0.2218	0.4846	0.5348	0.0931	0.0577	0.0354	0.0435	0.1159	0.1774	0.2330
21st	20.32	15.9711	0.2140	0.4989	0.5777	0.0786	0.0394	0.0392	0.0383	0.1085	0.1732	0.2340
22nd	22.17	17.9350	0.1910	0.6190	0.6808	0.0653	0.0417	0.0236	0.0913	0.1451	0.1944	0.2412
23rd	24.91	19.4239	0.2202	0.5225	0.6081	0.0848	0.0523	0.0325	0.0405	0.1132	0.1780	0.2375
24th	24.50	19.0105	0.2241	0.5437	0.6220	0.0886	0.0510	0.0376	0.0421	0.1160	0.1800	0.2369
25th	26.25	19.8810	0.2426	0.5055	0.6120	0.1018	0.0585	0.0433	0.0844	0.1652	0.2334	0.2935
27th	23.27	17.9594	0.2282	0.7023	0.6670	0.1034	0.0678	0.0356	0.0467	0.1206	0.1814	0.2360
28th	20.11	15.5995	0.2243	0.7484	0.7473	0.0882	0.0612	0.0270	0.0419	0.1145	0.1756	0.2283
32nd	21.36	16.6638	0.2199	0.5951	0.5627	0.0956	0.0523	0.0433	0.0433	0.1108	0.1657	0.2224
38th	24.20	19.0333	0.2135	0.6042	0.5585	0.0852	0.0625	0.0227	0.0567	0.1208	0.1737	0.2206
42nd	27.71	20.6107	0.2562	0.3864	0.4495	0.1220	0.0995	0.0225	0.0562	0.1456	0.2150	0.2729
43rd	29.67	20.6261	0.3048	0.1983	0.3086	0.1902	0.1215	0.0687	0.0820	0.1931	0.2666	0.3228
MEAN	23.87	18.2751	0.2323	0.4772	0.5074	0.0997	0.066	0.0341	0.0599	0.1356	0.1978	0.2523
S.D.	2.45	1.436	0.025	0.1588	0.1584	0.0269	0.021	0.015	0.0220	0.0251	0.0273	0.0275
C.V.	10.26	7.8564	10.7219	33.2730	31.2205	26.9867	32.719	43.2970	36.7600	18.5352	13.8214	10.9037

TABLE 9. PCE AND ADJUSTED PCE IN RS PER 30 DAYS AND GINI, THEIL AND ATKINSON INDICES OF INEQUALITY BY NSS ROUNDS AT 1960-61 PRICES: ALL JAMMU AND KASHMIR, RURAL (FOOD)

NSS Round	MEAN	ADMEAN	GINI	TH_1	TH_2	ATH	ATH_1	ATH_2	ATK_1	ATK_2	ATK_3	ATK_4
16th	17.79	14.4677	0.1868	0.2398	0.2358	0.0579	0.0525	0.0054	0.0285	0.0811	0.1291	0.1733
17th	17.08	13.9240	0.1848	0.2790	0.2433	0.0569	0.0489	0.0080	0.0490	0.0998	0.1466	0.1900
18th	15.98	12.8079	0.1985	0.2863	0.3298	0.0621	0.0547	0.0074	0.0309	0.0916	0.1490	0.2014
19th	15.95	13.2134	0.1716	0.4217	0.4179	0.0520	0.0379	0.0140	0.0248	0.0702	0.1114	0.1496
20th	15.64	12.7447	0.1851	0.4846	0.5547	0.0591	0.0427	0.0164	0.0292	0.0850	0.1385	0.1898
21st	13.89	11.4405	0.1763	0.4989	0.5805	0.0519	0.0549	0.0030	0.0256	0.0778	0.1314	0.1868
22nd	15.80	13.2135	0.1637	0.6190	0.6902	0.0468	Q.0328	0.0140	0.0716	0.1149	0.1584	0.2027
23rd	17.36	14.3557	0.1731	0.5225	0.6015	0.0523	0.0352	0.0171	0.0256	0.0760	0.1269	0.1802
24th	16.95	14.0021	0.1739	0.5437	0.6210	0.0509	0.0345	0.0164	0.0254	0.0746	0.1227	0.1697
25th	17.43	14.1537	0.1880	0.5055	0.6076	0.0568	0.0417	0.0151	0.0286	0.0857	0.1424	0.1982
27th	15.20	12.6979	0.1646	0.7023	0.7146	0.0503	0.0338	0.0165	0.0244	0.0696	0.1142	0.1604
28th	13.27	11.1134	0.1625	0.7484	0.7712	0.0458	0.0314	0.0144	0.0229	0.0671	0.1108	0.1545
32nd	13.75	11.6769	0.1508	0.5951	0.6020	0.0381	0.0268	0.0113	0.0191	0.0558	0.0926	0.1304
38th	15.38	12.9485	0.1581	0.6042	0.5887	0.0454	0.0340	0.0114	0.0327	0.0728	0.1113	0.1506
42nd	17.21	13.8567	0.1948	0.3864	0.4404	0.07	0.0555	0.0146	0.0332	0.0911	0.1415	0.1875
43rd	16.69	13.1946	0.2094	0.1983	0.2571	0.0823	0.0578	0.0245	0.0376	0.1021	0.1576	0.2086
MEAN	15.96	13.1132	0.1776	0.4772	0.5160	0.0549	0.0422	0.0127	0.0318	0.0822	0.1303	0.1770
S.D.	1.35	0.9930	0.0154	0.1588	0.1677	0.0102	0.0100	0.0060	0.0123	0.0146	0.0183	0.0220
C.V.	8.47	7.5726	8.6856	33.2732	32.4940	18.4994	23.6706	46.9998	38.5331	17.7161	14.0200	12.4008

TABLE 10. PCE AND ADJUSTED PCE IN RS PER 30 DAYS AND GINI, THEIL AND ATKINSON INDICES OF INEQUALITY BY NSS ROUNDS AT 1960-61 CONSTANT PRICES: ALL JAMMU AND KASHMIR, RURAL (NON-FOOD)

NSS Round	MEAN	ADMEAN	GINI	TH_1	TH_2	ATH	ATH_1	ATH_2	ATK_1	ATK_2	ATK_3	ATK_4
16th	6.64	3.9421	0.4063	0.2398	0.2999	0.3085	0.2373	0.0712	0.1363	0.3248	0.4420	0.5187
17th	6.94	4.0050	0.4229	0.2790	0.2503	0.3290	0.2800	0.0490	0.1985	0.3752	0.4728	0.5315
18th	6.90	4.4734	0.3517	0.2863	0.3345	0.2209	0.1726	0.0483	0.1002	0.2477	0.3461	0.4148
19th	5.68	3.7890	0.3329	0.4217	0.4351	0.2078	0.1678	0.0400	0.0931	0.2253	0.3117	0.3715
20th	5.45	3.6329	0.3334	0.4846	0.5270	0.2489	0.1196	0.1293	0.1042	0.2331	0.3177	0.3883
21st	5.24	3.5512	0.3223	0.4989	0.6025	0.1882	0.0119	0.1763	0.0854	0.2181	0.3143	0.3866
22nd	5.33	3.7640	0.2938	0.6190	0.6772	0.1647	0.0948	0.0699	0.1839	0.2799	0.3466	0.3993
23rd	6.98	4.5975	0.3413	0.5225	0.6622	0.2055	0.1161	0.0894	0.0943	0.2419	0.3451	0.4178
24th	6.82	4.4044	0.3542	0.5437	0.6727	0.2345	0.1122	0.1223	0.1056	0.2573	0.3616	0.4401
25th	6.94	4.3755	0.3695	0.5055	0.6831	0.2585	0.1127	0.1458	0.1139	0.2702	0.3696	0.4441
27th	7.10	4.4522	0.3729	0.7023	0.6246	0.2902	0.1933	0.0969	0.1209	0.2724	0.3652	0.4316
28th	5.64	3.4741	0.3840	0.7484	0.7504	0.2680	0.1916	0.0764	0.1206	0.2899	0.3897	0.4519
32nd	6.44	3.9945	0.3797	0.5951	0.5575	0.3146	0.1488	0.1658	0.1272	0.2767	0.3647	0.4252
38th	7.34	4.8181	0.3436	0.6042	0.5346	0.2260	0.1646	0.0614	0.1290	0.2609	0.3450	0.4050
42nd	9.07	5.5726	0.3856	0.3864	0.5144	0.2771	0.2315	0.0456	0.1387	0.3086	0.4236	0.5198
43rd	11.29	6.0960	0.4601	0.1983	0.4748	0.4482	0.2808	0.1674	0.1814	0.3736	0.4668	0.5241
MEAN	6.86	4.3089	0.366	0.4772	0.5376	0.2619	0.1647	0.0972	0.1271	0.2785	0.3739	0.4419
S.D.	1.48	0.6989	0.0398	0.1588	0.1430	0.0662	0.0691	0.0459	0.0330	0.0456	0.0499	0.0516
C.V.	21.52	16.2193	10.8898	33.2732	26.6094	25.2720	41.9668	47.2625	25.9710	16.3732	13.3502	11.6794

Note: ADMEAN = Gini Adjusted Mean. Gini = Gini Ratio. TH_1 = Theil's Index for the number of consumption units. TH_2 = Theil's Index for Consumption. ATH = Theil's Alternative Index. ATH_1 = Theil's Alternative Index between the groups. ATH_2 = Theil's Alt. Index within the group. ATK_1 = Atkinson Index at E = 0.5. ATK_2 = Atkinson Index at E = 1.5. ATK_3 = Atkinson Index at E = 2.5. ATK_4 = Atkinson Index at E = 3.5.

TABLE 11. GINI CO-EFFICIENT AND GINI-ADJUSTED MEAN OF THE FRACTILE DISTRIBUTION OF PER-CAPITA CONSUMPTION EXPENDITURE PER 30 DAYS: ALL JAMMU AND KASHMIR, RURAL 1960-61 PRICES

Survey Year	NSS Round Number	GC			Adjusted Mean			Mean		
		Total	Food	Non-Food	Total (Food+ Non-Food)	Food	Non-Food	Total (Food+ Non-Food)	Food	Non-Food
1960-61	16th	0.2013	0.1626	0.3256	19.50	14.89	4.47	24.42	17.79	6.64
1961-62	17th	0.2061	0.1557	0.3517	18.81	14.41	4.49	23.7	17.08	6.94
1963-64	18th	0.2070	0.1748	0.2944	18.90	13.18	4.86	23.84	15.98	6.90
1964-65	19th	0.1792	0.1420	0.2886	19.21	13.68	4.04	23.41	15.95	5.68
1965-66	20th	0.1770	0.1655	0.2161	18.11	13.05	4.27	22.01	15.64	5.45
1966-67	21st	0.1848	0.1529	0.2836	16.56	11.76	3.75	20.32	13.89	5.24
1967-68	22nd	0.1631	0.1420	0.2383	18.55	13.55	4.05	22.17	15.80	5.33
1968-69	23rd	0.1895	0.1514	0.2968	20.18	14.73	4.90	24.91	17.36	6.98
1969-70	24th	0.1880	0.1611	0.2855	19.90	14.20	4.87	24.5	16.95	6.82
1970-71	25th	0.2052	0.1782	0.2882	20.86	14.32	4.93	26.25	17.43	6.94
1972-73	27th	0.1859	0.1544	0.2715	18.94	12.85	5.17	23.27	15.20	7.10
1973-74	28th	0.1950	0.1492	0.3308	16.18	11.28	3.77	20.11	13.27	5.64
1977-78	32nd	0.1761	0.1343	0.2891	17.60	11.90	4.57	21.36	13.75	6.44
1983	38th	0.1689	0.1353	0.2790	20.11	13.29	5.29	24.2	15.38	7.34
1986-87	42th	0.1939	0.1472	0.3038	22.33	14.67	6.31	27.71	17.21	9.07
1987-88	48th	0.2151	0.1617	0.3246	23.28	13.98	7.62	29.67	16.69	11.29
Mean		0.1898	0.1543	0.2917	19.31	13.48	4.83	23.866	15.961	6.863
S.D.		0.0142	0.0123	0.0324	1.80	1.07	0.95	2.449	1.352	1.477
C.V.		7.5324	7.9986	11.1066	9.32	7.93	19.66	10.260	8.471	21.517

Source : Computed from Round-wise NSS Consumption Data.

TABLE 12. FRACTILE-SPECIFIC PRICE ADJUSTED GINI RATIOS OF PER CAPITA CONSUMPTION EXPENDITURE BY FRACTILE GROUPS: ALL JAMMU AND KASHMIR, RURAL

NSS Round	NSS Survey Year	GC at Current Prices	GC at 1970-71 Fractile Specific Constant Prices
28th Round	1973-74		
(i) Total (Food & non-food)		0.1864	0.200
(ii) Food		0.1492	0.1545
(iii) Non-food		0.3288	0.3344
38th Round	1983		
(i) Total (Food & non-food)		0.1689	0.1583
(ii) Food		0.1352	0.1269
(iii) Non-food		0.2597	0.2448
Percentage change Between 1973-74 & 1983			
(i) Total (Food & non-food)		-9.3884	-20.85
(ii) Food		-9.3833	-17.86
(iii) Non-food		-21.01	-26.79

Source : Computed from Round-wise NSS Consumption Data.
Note : Jain [1989] has constructed All India Rural and Urban Consumer Price Indices for 17 Fractile Groups And Four Selected NSS Survey Period. Since fractile specific price indices are not available at the state-level we have used these indices for 1973-74 and 1983 to deflate the fractile distribution of PCE for these years and calculated GC to study the impact of inflation on the magnitude of GC.

WASTAGE AND NON-PARTICIPATION IN EDUCATION A CASE STUDY OF ANDHRA PRADESH

C. Upendranadh

Evidence on wastage and non-participation at primary school level in the districts of Andhra Pradesh is presented, using retention ratios, non-participation rates, and work participation rates among children. Though there is an improvement in retention rates in 1980s, still many districts of the state have high incidence of educational wastage and non-participation. Results from micro level data show that in general the incidence of drop out and stagnation is high among girls, Harijans and backward districts compared to educationally advanced groups and regions. We assessed the linkages between educational wastage, non-participation and the socio economic indicators of households. Andhra Pradesh seems to have higher levels of non-participation in rural areas and among females. The work-participation rates (main workers) among children is also considerable in the districts of the state. A need to arrest these trends is imperative in order to achieve universalization of primary education.

Enrolment of students in schools is an important element of educational progress of any nation. Article 45 of the Constitution of India states that "The State shall endeavour to provide, within a period of ten years from the commencement of this Constitution, for free and compulsory education for all children until they complete the age of fourteen years". This shows a commitment of the Indian State to education. Enrolments at different levels of education increased all over the country during the initial period of Independence. As observed by many policy analysts, the decades of fifties and sixties witnessed a virtual explosion in enrolments in the third world countries. Yet, the aim of Universalization of Primary Education has not been achieved in our country so far. Though primary school enrolments in many states have increased in 1980s, performance of school education sector is far from satisfactory, because of high levels of wastage (drop out and stagnation) and non-participation.

According to the Fourth All India Educational Survey in India, for every three children enrolled at primary and middle schools, one eligible child is missed out. Of the three enrolled, two drop out before reaching class V [Eswara Prasad, 1987 p. i]. From the Fifth All India Educational Survey, it is seen that about 50 out of every 100 students who joined in class I will be out of school before they reach class V. According to Census of 1981, 7.58 per cent of total population of age group 5-14 are recorded as main workers, and 44.73 per cent of male and 61.54 per cent of female children of age group 6-10 are not attending any school [Premi, 1990, p. 5, p. 12].

The picture that emerges from this is that, the educational system has its in-built constraints in achieving universalization of primary education which are in the form of wastage and non-participation. Here, by wastage we mean premature withdrawal of the child from the educational system. Usage of this concept in different contexts and sub-components of it are discussed in detail in the ensuing pages. Identifying the problem of wastage, the Kothari Commission observed;

> "... Wastage and Stagnation like headache and fever are not disease in themselves, they are really symptoms of other diseases in the educational system, chief among which is lack of proper articulation between education and health and the poor capacity of the school to attract and hold students. To these may be added the third ailment, poverty which falls outside the system" [Eswara Prasad, 1987, p. 1].

'Non-participation' in education means the inability of the child to enter the educational system at any time during childhood. This reflects the inability of the educational system in attracting the potential students into its fold and to that extent, it can be considered as a leakage in education.

These issues are of importance in the present stage of economic policy reforms, which are

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I wish to thank Dr.G.N.Rao and Sri Michael Tharakan, for their able guidance at Centre for Development Studies during my M.Phil thesis work, from which this article is culled out. I express my thanks to Prof. Vinod Vyasulu and M.Vijay Basker for their comments and help in preparation of this paper. I am solely responsible for errors, if any.

emphasising the market-oriented approach towards, among other things, social services (which include education) and also in the context of educational equity and efficiency. The question of wastage and non-participation are also to be addressed in the context of socio-economic milieu in which educational process is taking place. To be explicit, the questions really are: Which are the strata of population who are not able to avail themselves of the educational opportunities? What are the socio-economic reasons for the premature withdrawal of children from the educational system even before completion of minimum of five years of education? What are the reasons for the inability of the educational system to attract students and, when attracted, hold them?

In this paper we present evidence on educational wastage and non-participation at primary level in the districts of Andhra Pradesh and attempt to assess the linkages of these with the socio-economic indicators. In section one an analysis of educational growth of the districts of Andhra Pradesh is presented which will be followed by an analysis of educational wastage in section two. In section three a discussion on non-participation in education is presented. Section four presents summary of the findings and the implications of the same.

EDUCATIONAL PROGRESS IN ANDHRA PRADESH'

Enrolments

From a figure of 29,076 primary schools in 1956/57, there are 46,086 primary schools in 1987/88 in Andhra Pradesh covering approximately 70 lakh students at the primary level. All the other stages also recorded growth in number of schools, teachers and also enrolments (Table 1).

The enrolment ratios, defined as percentage of number of enrolled to the number of persons in the relevant age group, in elementary education (primary and middle school) for the state as a whole have increased from 42.6 per cent to 76.8 per cent in the case of boys and from 27.3 per cent to 53.4 per cent in the case of girls during the period 1961/62 to 1987/88. [Upendranadh, 1991, p. 107]. The enrolment ratio at elementary level in the case of boys has remained around 44 to 45 per cent up to the latter part of seventies and then started increasing. Similar is the case with girls' enrolment ratio which remained at 26 to 28 per cent during the late seventies. Also, the combined school educational enrolment ratio (i.e. Primary, Middle and Secondary together) continued to increase throughout the period 1961-62 to 1987-88 [Upendranadh, 1991, p. 107].

Districts also have a positive growth rate in elementary school enrolment ratio for both boys and girls for the period under consideration. There are certain features observable in rates of growth across districts. One, the growth rates in the case of girls is higher than that of boys in all the districts, and secondly the rate of growth of elementary school enrolment ratios in Telangana districts has been higher than that of Andhra districts. Telangana districts have recorded higher growth rate than the state average which stood at 2.5 per cent. The rate of growth of total enrolment ratio (primary, middle and secondary) also shows positive trend throughout the period in almost all the districts. It ranged from 0.69 per cent in Guntur district to 6.5 per cent in case of Anantapur district, with the state average being 2.54 per cent. Here again the districts of Telangana have recorded higher growth rates compared to Andhra districts and were placed above state average. This was due to the low level of base enrolment ratios in case of districts of Telangana [Upendranadh, 1991, p. 116].

Thus, there has been a growth in enrolment ratios in districts, at all levels during the period under consideration albeit, unevenly. The primary school enrolment ratios have fluctuated during the period which was not the case with middle and secondary school enrolments. Also, the rates of growth of enrolments show a consistent disparity across the levels, the growth rate at elementary level being lower than that at secondary level. Higher growth rates in enrolment ratios have been recorded in the case of girls than boys but the disparity in girls' participation has remained the same (the difference between boys' and girls' enrolment ratios). Lastly, the Telangana districts recorded higher growth rates as compared to Andhra districts.

Accessibility

According to the Second All India Educational Survey conducted in the year 1965-66, in Andhra Pradesh, about 60.67 per cent of rural habitations were provided with primary school/sections within the habitation, and for another 26.46 per cent of habitations up to a distance of 1 mile, which was considered as walkable distance.[2] The norm of walkable distance has since been changed to 3 km in later surveys [Upendranadh, 1991, p. 119].

Thus, effectively, about 87 per cent of habitations were provided with primary education within a walkable distance. Telangana districts like Adilabad and Khammam were having lower school accessibility (i.e. longer distance to cover than the norm) than the state average. Many districts have habitations with school facilities at a distance of more than a mile. The proportion of population covered by primary educational institutions within walkable distance comes to about 90 per cent for the state as a whole, and it varies across districts; districts like Chittor cater to only 64 per cent of the school-going population [Upendranadh, 1991, p. 119].

With regard to Upper Primary (UP)/Middle School sections only 10 per cent of the habitations were having middle sections within the habitations in 1965-66. Taking a distance of 3 miles as a walkable distance as suggested by Kothari Commission, it was found that, another 21.77 per cent of the habitations were having middle section accessibility within the walkable distance [Upendranadh, 1991 p. 119]. Thus, about 60 per cent of habitations did not have any access to Middle School in 1965-66. If one assumes a more stringent criterion (say from 3 miles to about 2 miles, say, 3 km.), the accessibility would become very low. Thus, it may be inferred that in the sixties, educational accessibility could be one of the reasons that has retarded the progress in enrolments.

At the time of the Fifth All India Educational Survey in 1986, there had been substantial improvement in the school accessibility, and the proportion covered by primary and upper primary education. Practically, all the habitations were provided with lower primary schools within a walkable distance of 1 km.

The accessibility in the case of Upper Primary/Middle School sections has improved substantially. Over 50 per cent of habitations were provided with UP or Middle sections within habitations and another 40 per cent of habitations were provided within a distance of 3 kms. Also, the population coverage has improved and about 90 per cent of the population were provided with Upper primary school education within a walkable distance [Upendranadh, 1991, p. 122]. Thus, by 1985-86, the State was able to provide the basic educational requirement of the people, namely, a primary school to all the habitations within a walkable distance and substantial number of habitations were provided with UP schools. But if we use a stringent norm in choosing 'walkable distance', the figures would come down very much. Ultimately, on equity grounds, it would be an obligation on the part of the State to provide primary education to all the children within their reach.

But on the quality front the picture is not quite satisfactory. The accessibility in terms of physical presence of a school is a necessary condition for schooling but need not be sufficient for good quality education. In Andhra Pradesh there are still large number (43.40 per cent) of single teacher primary schools, which obviously are not conducive to imparting good quality education. As can be seen from ensuing evidences some of the problems associated with wastage can be traced to lack of proper educational infrastructure such as teachers and other facilities in schools.

WASTAGE IN EDUCATION

Definitions and Measurement

The Hartog Committee in 1928, defined 'wastage' to mean 'the premature withdrawal of children from school at any stage before the completion of the primary course' and 'stagnation' was defined as 'the retention in a lower class for a period more than a year' [Eswara Prasad, 1991, p. 19].

In some earlier works, the terms 'wastage' and 'drop out' were used synonymously.[3] But the nomenclature seems to have changed over time.

Now, wastage includes both the aspects mentioned above in which former one is a component called 'drop out' and the latter one as another component called 'stagnation'. Thus, wastage takes two distinct forms;[4] (i) some pupils leave the system at different points without completing the stage (ii) some repeat the same grade.

Also, there seem to be different opinions as to whether or not the concept of wastage/drop out can be linked to educational objectives of the particular stage. One definition of wastage invokes the concept of 'incremental gains' in learning outcomes. Here, the idea is that every year of schooling leads to partial fulfilment of educational objectives put forward for the stage and the years of study have to be taken into consideration in measurement of 'drop out'. For example, if a child completes three years of schooling out of five years prescribed for a stage, wastage is only 40 per cent according to this definition. The other view does not take this into consideration [Subramaniam and Rama Raju, 1988, p. 20]. It treats any pre-mature withdrawal of student before the completion of the stage (say, primary stage or middle stage) as drop out.

Apparently, both the definitions seem to be logical; and acceptance of any particular definition depends on the particular stage at which the measurement is being considered. For example, if the drop out at primary level is the point in question, then one expects to take into consideration the second definition as appropriate as it is the constitutional obligation on the part of the government to give education to all children of age group 6-14. Also, some of the earlier studies have pointed out that the 'functional literacy' is said to be achieved only with a minimum of four years of schooling for the child [AERC, 1971, Pp. 24-25]. Thus, the problem of drop out at primary level deals with those who "participate in the education without being permanently literate in the regular course of time ".

It has been observed that, for the purpose of measurement, both drop out and stagnation are inter-connected. Sometimes, drop out of any child from school may be manifestation of stagnation and to that extent, measurement of stagnation may be underestimated. Similarly, a child dropped out at a certain grade may enter into the educational system after some years (into the same grade) in which case, it may be treated as both drop out in the first instance and stagnation, later. Thus, the problem of decomposition of wastage into stagnation and drop out involves a close monitoring of specific cohort of students, throughout their career. Nevertheless, the difficulties mentioned do not portray completely the gravity of the problem.

The measurement of wastage in its own components, varies with the definition of 'drop out' one uses. In the case of the definition based on the concept of incremental gain in learning outcomes, the assumption is that, the earlier the child leaves the system, the more would be the wastage in the system due to him. For example, a child leaving the school after class II contributes to a lesser wastage than the one leaving at class I. But, the difficulty found in the method comes from the problem of lapse into illiteracy. The method is questionable in its application to primary stage as we assume a minimum number of years of schooling necessary for attaining functional literacy. Also, the method needs stringent data requirements. The other methods of measuring 'wastage' have been discussed by Subramaniam and Rama Raju [1988]. Following are the three types of measurements subject to the availability of the data and the objectives of the study:

(i) Apparent Cohort method
(ii) Reconstructed Cohort method
(iii) True Cohort method

(i) Apparent Cohort method : In this method, the enrolment in different grades would be compared with enrolment in grade I and the diminution in enrolment in successive grades will be treated as wastage.

When time series data are used, the enrolment in a grade in a year is compared with the enrolment in the successive years. Then

The index of Wastage $I_w = E^{g+1}_{y+1}/E^g_y$

In the case of sectional data, enrolment at a grade in a year is compared with the enrolment at the lowest grade in the same year. This ratio is called 'Ratio of Retention' both in time series and cross sectional analysis.

Obviously, these two measures are deficient as they would not be able to discern the two components of wastage viz., drop out and stagnation. Also this method does not take into account the instances of pre-mature withdrawal due to reasons such as migration and enrolment in higher levels due to multiple entry system. Particularly, in the case of cross sectional data, the measure has severe limitations because it is the previous years' enrolment at lower grade that determines the enrolment at a higher grade. Nevertheless, due to less stringent data requirements, this method can be employed to get a broad picture of wastage or retention ratio.

(ii) Reconstructed Cohort method: This method isolates the two components of wastage viz., drop out and stagnation, using the year grade data on enrolment. In this method, first, the number of promotees is found out and then by subtracting from the total, number of promotees and repeaters one finds the drop out rate.

(iii) True Cohort method: In this method, career of a group of pupils admitted into the initial grade is followed up till they reach the final grade of the stage. In a slight variation, the career of the students at the final grade is traced back to the previous years, going up to the initial year. This method is the most satisfactory, but it involves more stringent conditions of data requirements. Most of the case studies follow this method in ascertaining the wastage in primary education.

Wastage in Primary Education in Andhra Pradesh

Many of the studies at all India level have analysed the wastage at primary level in different States. The Agricultural Economics Research Centre (AERC) of Delhi University presents the retention ratios (the ratio of enrolment of class V to class I) at primary levels for different states in rural India, for boys and girls separately [AERC, 1971, Pp. 25-27]. It was observed that in Andhra Pradesh, the retention ratio at primary level in 1965 happened to be 0.30 for boys and 0.24 for girls [AERC, 1971, p. 26]. The Fifth All India Educational Survey report shows Andhra Pradesh standing at 10 percentage points below the all India average in terms of retention ratio at primary level [NCERT, 1990, p. 88].

A recent study out by the Department of Education, Government of India (hereafter referred to in the text as Eswara Prasad (1987), after the author) took up a district-level survey of four districts of Andhra Pradesh and found the extent of drop out and stagnation in different regions of the state by using true cohort method. The study was conducted in Kurnool, Guntur, Mahbubnagar and Medak districts of Andhra Pradesh. The study by Subramaniam and Rama Raju [1988] analyzed the wastage at primary level in the district of East Godavari using the same method. These two studies, which are case studies, are exhaustive and give more accurate picture of wastage at the primary stage. The results of these studies are analysed in arriving at a micro level picture of incidence of wastage at the primary stage as also the incidence of wastage in different social groups of population and the economic and social reasons for the same.

Macro Evidence

Subramaniam and Rama Raju [1988], in their study on wastage in primary education, have calculated the incidence of wastage at primary stage in Andhra Pradesh as a whole, using time series data by true cohort method. Tables 2 and 3 present the incidence of wastage in primary education in Andhra Pradesh from 1956 onwards. Though there was a decline in the incidence of wastage, still it was quite high in the state even in 1984. They also found that the incidence of wastage among girls was higher than that among boys.

In order to arrive at a broad quantum of wastage, the ratio of retention at primary stage is calculated by using stage-wise enrolment figures of different districts for the recent years. These estimates are inferior to the estimates that are arrived at by using true cohort method. Nevertheless, this exercise would give a broad impression of the order of wastage at primary level among different districts of the state. Class-wise data from the 2nd, 4th and 5th reports of the All India Educational Survey are used in the analysis. The reason for using different data sets (other than those of the

Department of Education) is to get the comparability of retention ratios of districts at the time points. Also, the estimates are comparable with the estimates arrived at by using data of the Department of Education for the state as a whole for the period 1974-1984 (Tables 3 and 5).

The retention ratios have improved over a twenty year period, from 1965 to 1986, from a ratio of 21.85 to 38.88. There was only a marginal improvement in retention ratio between 1965 and 1978. The retention ratio among boys have virtually remained stagnant, and among girls, there was a marginal increase during the period. There is a disparity in retention ratios among boys and girls in many districts

Micro Evidence

Tables 6 and 7 present retention rates for true cohorts of students of sample schools in selected villages of Guntur and Kurnool districts computed by Eswara Prasad [1987], which show the extent of wastage in the two districts of Andhra region.

Out of every 100 enrolled students at class I, 16 and 32 students respectively from the two districts of Kurnool and Guntur remain in class V after five years. It means that the order of wastage is 84 and 68 respectively. There is a wide disparity in retention ratios for boys and girls. Girls had consistently lower retention rates than boys at all the stages.

Let us now consider the rates of drop out and stagnation separately in the two districts as in 1976-81. The extent of drop out and stagnation are high among Harijan students as compared to all students in Guntur district. In Kurnool the differential between rates of drop out and stagnation across Harijan and all students is not very significant, except as between all girls and Harijan girls. The Guntur district, which has lower incidence of 'wastage', has considerable disparity in drop out between all children on the one hand and Harijan children on the other. In Kurnool district, the incidence of drop out is more or less of the same order as between the two sections. (Table 8). Thus, we notice a low wastage in an educationally developed district but the incidence of survival in the educational set-up at the primary level among Harijan and other disadvantaged groups is not commensurate with the general level of development of education. Arresting the withdrawal of these groups should be the concern of planning programmes in education.

Districts do not show much gender disparity in the case of stagnation. But, the gender disparity in respect of drop-out is relatively high in Kurnool district which has a high incidence of drop out. This shows that it is a matter of concern in an educationally backward district with high drop out rate. The drop out and stagnation occur more at class I as compared to the other classes (Table 9).

It will be seen that the extent of drop out is higher in Kurnool at all stages compared to that for Guntur district. However, Guntur district shows higher stagnation rates than Kurnool district at all stages (Table 9).

Tables 10 and 11 present data for true cohort of students in the sample schools of Mahbubnagar and Medak of Telangana region. The extent of retention of students up to class V is very low in these districts compared to the Andhra districts, Guntur and Kurnool.

There is wide disparity in retention rate for boys and girls in Medak district, especially so at the first four grades. Thus the extent of wastage at primary stage in the Mahbubnagar stands at about 84 per cent while in Medak it is as high as 92 per cent. Educational wastage with regard to girls at primary level in both the districts stand at 88 and 96 per cent respectively.

In the case of East Godavari district, taking the base year as 1980-81, the data for true cohort of students obtained from the sample schools of the selected *mandals* are given in Table 12. Evidently the figures are not comparable with those for the districts above as they relate to different periods.

The rate of drop out in the district stands at 37 per cent, and is slightly higher in the case of girls. As in the case of other districts and the state trend, the rate of drop out is higher at the first grade compared to other three, the former constituting more than 38 per cent drop out. The first two grades come to over 55 per cent of the total drop out. By taking students who took more than five years to complete the primary stage and who are still continuing in the grade, it is seen that the

extent of stagnation stands for boys at 33 per cent, for girls 36 per cent and both together at 34.7 per cent. There is no significant gender disparity with respect to drop out and stagnation in the district. Further, it was found that within this district also, there is disparity in drop out rate and stagnation rate.

An attempt was made to compare the degree of incidence of drop out across the regions, more developed and less developed. After identifying the regions of the districts as more developed, less developed and backward, the authors, Subramaniam and Rama Raju, [1988] have selected three *mandals* one each from the three regions viz., up land and agency, eastern delta and central delta. The *mandals* Thondangi, Alamuru and Ravulapalem respectively, represent regions with low (LD), medium (MD) and high (D) literacy levels (Table 13).[5]

The backward regions had higher incidence of drop out. The incidence of drop out declines with development. Also, the disparity in drop out rates among boys and girls is higher in the less developed regions.

From the discussion, it is seen that there have been wide variations across the districts in the incidence of wastage. In general, the districts Guntur and East Godavari show lesser degree of wastage compared to Kurnool, Mahbubnagar and Medak. (Note, however, that data for East Godavari is not strictly comparable with that for other districts as the time period varies).

Now we turn to reasons for the incidence of wastage observed in the districts. Though the analysis pertains to selected districts, probably the situation in the remaining part of the state would be no different in terms of causes of wastage.

Factors Influencing Wastage

Two sets of factors influence wastage in education. One, related to the educational system, and the other related to those outside the educational system. The first group can be termed as 'Internal factors' and the second as 'External factors'. These two sets of factors are, however, mutually inter-dependent.

Internal

It was found in the study by Eswara Prasad [1987] that the extent of wastage (drop out and stagnation) is systematically higher in the schools with single teachers in all the four districts under study, exception being boys in Kurnool in the case of stagnation and all in Medak regarding drop out. The extent of drop out among two types of schools varied, the difference being more than twentyfive percentage points in Guntur district against four percentage points in Mahbubnagar district (Table 14). In East Godavari district, it was found that the extent of drop out is higher in the case of multiple teacher schools. In this district, the drop out rate is found to be more in the single teacher schools in the backward region (Table 15).

It was found that the pupil-teacher ratio in all the districts turned out to be higher than the prescribed norm resulting in a heavy burden on teachers. Moreover, it was found that in many of the schools in the surveyed districts there was a shortage of facilities in terms of good accommodation, sufficient floor space, and other instructional facilities and teachers. In East Godavari district the primary requirement of schools in the backward region was teaching staff and in all the regions there was need for facilities in terms of accommodation and instructional aids [Subramaniam and Rama Raju, 1988, p. 64].

External

Many of the earlier studies have identified economic and social reasons as crucial factors in explaining the wastage and non-participation at primary level. The main economic reasons and social factors identified were family income, land holding pattern, caste, occupation and education of parents. In East Godavari district, the classification of households to which students dropping out belong confirms the influence of income on educational participation (Table 16) Eswara Prasad [1987] also finds similar results in the selected districts [Eswara Prasad, 1987, p. 57].

As for the other reasons for drop out, financial inability of parents, need to depend on children's

labour for domestic work, engaging in agricultural and other productive activities, were mainly responsible for parental indifference to education. In the backward regions of East Godavari district, about 39 per cent of the students dropped out owing to poverty and 24 per cent of the students dropped out to help the family in cattle rearing. [Subramaniam and Rama Raju, 1988, p. 79]. Similar situation prevails in other villages, and the other districts like Kurnool and Guntur to a lesser degree [Eswara Prasad, 1987, p. 79].

It is of interest to note that in the dry district of Mahbubnagar, about 42 per cent of drop outs are due to financial problems of parents and 28 per cent due to engagement of children in agricultural work, while in Medak district about 40 per cent of drop out is due to the engagement of children in labour of an unspecified nature and 20 per cent due to the engagement of children on agricultural work; the rest being the result of the indifference of children to continuing in school [Eswara Prasad, 1987, p. 71].

NON-PARTICIPATION IN EDUCATION

The problem of non-participation in education by the potential students as mentioned above, amounts to leakage in educational efforts. The problem has its origins in the socio-economic milieu, as in the case of wastage. A related feature of the problem is 'child labour'.

According to the Population Census of 1981 in India, the work participation rate of population age group 5-14 stood at 5.96 per cent while in rural areas, it was 7.28 per cent in the case of main workers and 8.97 per cent in the case of all workers. In absolute numbers, 13.6 million children were in the labour force in 1981 (11.2 million of them as main workers and 2.4 millions as marginal workers). Estimates from other sources like the Planning Commission and sample surveys put the figures much higher than the Census figures.[6] The estimates of child labour may in fact differ radically from reality due to the inability of methods and definitions to capture the real incidence [Bordia, 1989, p. 1]. Nevertheless, the incidence seems to be declining over the period from 1961 Census [Premi, 1990, Pp. 1-12].

The Constitution of India provides various measures for the protection of children against being exploited. Various articles like, Article 24, 39(e) and 39(f) provide legal measures against use of child labour and exploitation [Premi, 1990, Pp. 1-12]. Even then, the incidence of child labour is substantial. Incidence of child labour is found to be of a higher order in Andhra Pradesh compared to All India average and that of the Southern states. According to 1971 Census in India, the incidence of child labour is found to be 11.81 per cent in the case of boys and 6.62 per cent in the case of girls [Premi, 1990, p. 11]. The figures have increased to 14.69 per cent in the case of boys and 11.18 per cent in the case of girls in 1981.

The incidence of non-participation in education and child labour Work Participation Rate among Children (WPRC) in the districts of Andhra Pradesh are calculated from the Census of 1981. Table 17 presents districtwise non-participation rates. It would be of interest to see the variations across the districts and across males and females. Firstly, we have to state that these figures correspond with the enrolment figures for the age group 5-14 which have reached 40-50 per cent throughout the state in eighties. As one would expect, female non-participation has been higher in both rural and urban areas in all districts (Table 17).

Table 18 presents the work force participation rate among children (WPRC) for 1981. It is high among boys compared to girls. This is so though the non-participation rate among girls is high compared to boys (Table 17). This only shows that many of the non-participants among girls were not recorded as main workers. Many of them may be working as domestic helpers and looking after the younger ones. The inclusion of marginal workers not attending school would in fact increase the estimates for girls.

The incidence of child labour varies very much over districts, both rural and urban areas. The WPRC in rural boys varies from 21 per cent in Mahbubnagar and Karimnagar to 13 per cent in Prakasam district. The corresponding variation for rural girls ranges from 5 per cent in East Godavari to 19 per cent in Karimnagar and Nizamabad districts. The WPRC in rural areas in general do not show as much variation as in urban areas (Table 18).

As argued earlier, the incidence of wastage and

non-participation in education are closely linked to the economic conditions of the population, especially that of the lower stratum. Micro level evidence has been presented showing high correlation between incidence of drop out and child labour. The Rural Labour Enquiry Committee, [1974/75] highlighted the fact that for the landless agricultural labour households, the average annual number of wage-paid employment for children was higher than that for women, and compared favourably with men. On an average, children earn about 50 per cent of what adult men earn.

The non-participation in education across the income groups of population in rural and urban areas of the country reveal that the percentage of those never enrolled among the age group 6-11 and 11-14 is consistently high among the lower two fractile groups (fractile groups are computed based on consumer expenditure) as compared to the others, both in the rural and urban areas. It is seen that the proportion of those never enrolled in the age group 6-11 is highly concentrated at 0-20 fractile group, 32 per cent in the case of rural male and 50 per cent in the case of urban males. The respective figures for females are 33 and 52 per cent respectively. In the population never enrolled in each fractile group, a large proportion belongs to 6-11 and 11-14 groups. About 19 per cent of rural males and 20 per cent of urban males in fractile group 0-20 are belonging to the age group 6-11. Similar is the situation in the case of females also. The situation obtained in the state of Andhra Pradesh may not be different from that of the national scene [Upendranadh, 1991, Pp. 155-56].

CONCLUSION

To conclude, Andhra Pradesh has recorded high levels of educational wastage at the primary stage. The ratios of retention reveal that there is an improvement in levels of retention over the period, particularly between 1978 and 1986. Also, wide variations in the retention rates across the districts and among male and female students are observable. The total wastage at primary level in Andhra Pradesh computed by apparent cohort method shows a decline from 72 per cent in the sixties (average of 1956/57 to 1960/61) to 54 per cent by 1980s (average of 1980 to 1984).

The case studies of five districts reveal that the incidence of wastage is higher in the Telangana districts of Medak and Mahbubnagar as compared to Guntur and Kurnool districts. Also broadly it can be inferred that the East Godavari district which is an educationally advanced district, shows on the whole lesser wastage than the other four districts. Even within a district, a wide variation in the incidence of wastage is observed; the less developed regions are more prone to the incidence of drop out and stagnation.

As regards the influencing factors, lack of educational requirements in terms of availability of teachers and of other amenities is hindering the participation rates at the primary level. On the economic front, poverty is one of the main factors influencing parents to withdraw their children from schools. Many of the children are being engaged in household work and in agricultural and other activities. Thus, the opportunity cost of child's participation in education seems to be high in rural areas. As regards the non-participation in education, Andhra Pradesh has higher incidence of child labour and non-participation in education.

What are the policy options to reverse the trend? Though the government is committed to free and compulsory education, it does not seem to have taken measures in that direction both in terms of providing adequate educational infrastructure and enforcing the laws effectively. As argued by Myron Weiner, the policies of the government toward enforcing compulsory education seemed to be of the nature of giving an incentive rather than that of taking it as a duty [Weiner, 1991].

The role of economy in determining the educational participation is inferred from the available micro evidence. It can be observed that educational participation by rural children crucially depends on the dispensation of the family, of the income of the child from employment (main/subsidiary), etc. Thus participation in education at the primary and middle stages can be taken as a function of the economic well-being of the population both at macro and micro levels. Evidence points out that in Andhra Pradesh, the rural poverty levels had negative impact on enrolments at primary level for both boys and girls

(statistically significant in case of girls) [Upendranadh, 1991, Ch. V, Pp. 201-208].

Thus, apart from educational intervention to improve enrolments, a multi-pronged strategy encompassing programmes which would not only improve enrolments, but sustain the same by reducing the drop out rate would be required. As enrolments at lower levels are closely related to economic well-being of the rural people, education in rural areas has to be incorporated into the whole gamut of rural development packages wherein raising of family incomes is also a crucial component. The educational participation of children, better health and nutrition would be the targets of policy in this context.

NOTES

1. Findings presented in this section are taken from Upendranadh, [1991, Ch 3, sec 1, Pp. 103-123]

2. Kothari Commission [1964-66] recommends 1 mile to 3 miles as walkable distance for opening of new schools. 'Walkable distance' norms have been assigned in some of the studies of NCERT, and the educational surveys conducted by NCERT would give the number of institutions according to the distance. These can be used to measure mean educational distance of habitations in districts and states. See Raza, *et.al.*, [1985], for detailed analysis on educational accessibility in districts of India based on IV All India Educational Survey [1978] data.

3. Eswara Prasad [1987] seems to be using the words 'wastage' and 'drop out' interchangeably meaning 'premature withdrawal of child from educational system' which in fact means drop out. The author uses 'stagnation' meaning retainment of child in the same grade for more than one year.

4. See Subramaniam and Rama Raju, [1988] for a detailed discussion on definitions and measurement of wastage.

5. It was found that *mandal*-wise literacy levels explain variations in the socioeconomic and demographic factors across the *mandals*. So literacy was taken as an indicator. See Subramaniam and Rama Raju, [1988], Pp. 43-44.

6. See Pravin Nangia, in William E Mayers, [1989], (Ed). The estimates vary from 44 million found by ORG, Baroda, based on All India Sample Survey conducted in 1980-81 to 17.36 million projected by Planning Commission in 1982.

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TABLE 1. STAGE-WISE ENROLMENT IN ANDHRA PRADESH: 1956-1987.

Year	Primary (I to V Stag)					Upper Primary (VI & VII Stage)					High School (VIII to X Std)				
	Schools	Teachers	Students(Lakh)			Schools	Teachers	Students(Lakh)			Schools	Teachers	Students(Lakh)		
			B	G	T			B	G	T			B	G	T
1956/57	29,076	77,053	15.44	9.10	24.54	372	4,421	1.84	0.48	2.33	733	16,165	1.77	0.32	2.09
1960/61	34,050	74,386	18.40	11.35	29.76	1,466	13,352	2.30	0.70	3.00	1,124	24,937	1.98	0.44	2.43
1965/66	37,320	79,923	22.45	15.23	37.69	2,578	20,209	3.45	1.31	4.77	2,297	44,823	3.18	0.93	4.11
1970/71	37,013	79,172	23.25	15.57	38.82	3,123	24,937	3.49	1.54	5.03	2,914	49,862	3.43	1.22	4.65
1975/76	37,096	79,014	24.56	16.77	41.34	3,917	31,788	4.55	2.14	6.70	3,386	56,075	3.93	1.57	5.51
1980/81	40,611	80,954	31.81	22.35	54.17	4,621	35,424	6.01	3.13	9.14	3,795	58,649	5.72	2.55	8.28
1982/83	41,291	81,722	33.00	23.36	56.36	5,056	36,650	6.72	3.66	10.39	4,331	66,227	6.79	3.26	10.05
1987/88	46,086	97,543	40.89	30.05	70.95	5,724	42,862	9.08	5.25	14.34	5,186	67,951	9.04	4.62	13.66

Notes: B=Boys; G=Girls; T= Total.

Source: Ranga Reddy K.V., 1985: *Growth of Education in Andhra Pradesh: A Review;* SCERT, 1988: *Educational Statistics of AP* 1987/88.

TABLE 2. INCIDENCE OF WASTAGE IN ANDHRA PRADESH, 1956-1984
(PRIMARY LEVELS; BOYS AND GIRLS TOGETHER)

(Per cent)

Mean of	Wastage in Grades				
	I	II	III	IV	Total
1956/57 to 1961/62	45	12	9	6	72
1974 to 1980	37	11	9	5	62
1980 to 1984	33	11	7	8	54
1974 to 1984	36	11	8	4	59

Source: Subramaniam and Rama Raju, 1988, Tables 3.1 & 3.2.

TABLE 3. INCIDENCE OF WASTAGE IN ANDHRA PRADESH, 1974-1984
(PRIMARY LEVELS; BOYS AND GIRLS SEPARATELY)

(Per cent)

Mean of	Wastage in Grades									
	I		II		III		IV		Total	
	B	G	B	G	B	G	B	G	B	G
1974 to 1980	37	37	11	12	8	9	4	6	60	64
1979 to 1984	33	34	11	11	6	8	2	4	52	57
1974 to 1984	35	36	11	12	7	8	4	5	57	61

Source: Subramaniam and Rama Raju, 1988, Tables 3.3 & 3.4.
B = Boys; G = Girls.

TABLE 4. RETENTION RATIOS AT PRIMARY LEVEL IN DISTRICTS, 1965-66

(Per cent)

DIST	BOYS	GIRLS	TOTAL	DIST	BOYS	GIRLS	TOTAL
Srikakulam	29.47	14.79	22.66	Hyderabad*	16.04	7.30	12.77
Visakhapatnam	21.34	9.86	16.64	Medak	16.87	5.96	13.29
E.Godavari	33.11	20.66	27.11	Nizamabad	17.25	8.17	14.58
W.Godavari	27.57	23.83	25.72	Adilabad	11.44	5.68	9.88
Krishna	33.89	30.69	32.37	Karimnagar	23.15	11.98	20.11
Guntur	28.51	25.75	27.31	Warangal	18.77	10.63	16.14
Nellore	25.08	16.71	21.40	Nalgonda	23.88	11.86	19.48
Chittor	28.05	16.90	23.47	Mahbubnagar	19.14	11.42	16.48
Cuddapah	35.90	21.05	29.63	Khammam	17.45	10.28	14.65
Anantapur	22.72	9.27	17.08	AP	25.16	17.13	21.85
Kurnool	28.65	16.97	23.99				

Note: * Hyderabad city and District.
Source: *Second All India Educational Survey Report*, AP, 1965.

TABLE 5. RETENTION RATIOS AT PRIMARY LEVEL IN DISTRICTS, 1978 AND 1986

(Per cent)

	IV All India Educational Survey [1978]			V All India Educational Survey [1986]		
DIST	BOYS	GIRLS	TOTAL	BOYS	GIRLS	TOTAL
Srikakulam	26.98	15.00	20.99	48.60	36.67	43.07
Vijayanagaram	....	....	....	55.14	49.10	52.21
Visakhapatnam	24.37	14.65	19.57	41.12	26.94	34.65
E.Godavari	28.66	24.91	26.78	38.48	38.67	38.57
W.Godavari	26.98	25.48	26.23	48.10	53.62	50.85
Krishna	38.65	37.55	38.10	48.43	44.52	46.55
Guntur	37.13	27.61	32.37	55.89	53.48	54.72
Prakasam	35.46	25.63	30.45	48.74	40.38	44.65
Nellore	21.88	15.44	18.66	56.35	44.87	50.88
Chittor	28.71	18.55	23.63	54.11	42.29	48.36
Cuddapah	40.23	26.19	33.21	63.89	63.00	63.50
Anantapur	23.76	14.67	19.71	42.16	32.05	37.56
Kurnool	27.53	19.86	23.69	47.92	39.80	44.35
Mahbubnagar	15.64	12.49	14.06	21.32	17.70	19.98
Ranga Reddy	....	....	....	30.12	26.57	28.61
Hyderabad*	16.67	11.43	14.05	67.15	90.89	81.33
Medak	13.56	7.95	10.75	27.37	21.35	24.98
Nizamabad	20.33	13.96	17.14	29.45	21.69	26.60
Adilabad	13.01	8.38	10.69	27.51	19.29	24.20
Karimnagar	22.66	13.58	18.12	34.46	26.48	31.04
Warangal	21.12	14.69	17.90	23.89	19.72	22.34
Khammam	18.00	14.82	16.41	32.21	28.89	30.18
Nalgonda	25.24	19.11	22.17	32.72	26.47	30.21
AP	25.57	19.56	22.56	40.30	37.11	38.88

Note: * Hyderabad includes city and district for IV Survey. For V Survey, only Hyderabad city.
Source: Eswara Prasad, 1987, and Selected Educational Statistics of AP, 1989.

TABLE 6. RATE OF RETENTION IN KURNOOL DISTRICT, RETENTION AS A PERCENTAGE OF ENROLMENT IN CLASS I, 1976-81

I			II			III			IV			V		
T	B	G	T	B	G	T	B	G	T	B	G	T	B	G
100	100	100												
100	100	100	47	57	22									
100	100	100	36	48	17	30	38	11						
100	100	100	58	72	38	30	38	17	23	43	11			
100	100	100	50	62	37	32	29	16	27	33	17	16	24	0

Note: The data relate to the five consecutive years beginning 1976/77.
B = Boys; G = Girls; T = Total.
Source: Calculated from Eswara Prasad, 1987, p. 29.

TABLE 7. RATE OF RETENTION IN GUNTUR DISTRICT, RETENTION AS A PERCENTAGE OF ENROLMENT IN CLASS I, 1976-1981

I			II			III			IV			V		
T	B	G	T	B	G	T	B	G	T	B	G	T	B	G
100	100	100												
100	100	100	84	85	82									
100	100	100	83	75	94	62	65	59						
100	100	100	81	88	74	72	70	63	49	55	51			
100	100	100	61	81	79	44	56	42	50	50	50	32	40	24

Note: The data relate to the five consecutive years beginning 1976/77.
Source: Eswara Prasad, 1987, p. 30.

TABLE 8. RATE OF DROP OUT AND STAGNATION IN KURNOOL AND GUNTUR DISTRICTS
(IN SELECTED VILLAGES, AVERAGE OF 1976-81)

(Per cent)

District	All Children				Harijans			
	Drop out		Stagnation		Drop out		Stagnation	
	B	G	B	G	B	G	B	G
Kurnool	35.5	20.1	17.7	35.6	33.8	21.5	14.3	9.4
Guntur	21.7	23.3	34.5	37.6	33.4	34.3	45.1	45.6

Source: Eswara Prasad, 1987, Pp. 32-33.
Note: B = Boys, G = Girls.

TABLE 9. EXTENT OF DROP OUT AND STAGNATION IN KURNOOL AND GUNTUR DISTRICTS
(IN SELECTED VILLAGES; AVERAGE OF 1976-81)

(Per cent)

	Classes									
	I		II		III		IV		V	
	B	G	B	G	B	G	B	G	B	G
Drop Out										
Kurnool	44.9	55.5	35.6	37.8	29.8	30.1	29.8	27.3	34.1	19.5
Guntur	20.5	21.7	30.8	21.8	20.3	25.0	25.5	21.2	22.9	22.7
Stagnation										
Kurnool	26.8	29.6	18.4	20.8	13.2	15.7	9.9	17.0	14.7	17.1
Guntur	38.1	40.4	34.0	37.1	29.6	33.1	34.6	33.6	26.7	26.1

Source: Calculated from Eswara Prasad, 1987, p. 33.
B = Boys; G = Girls.

TABLE 10. RATE OF RETENTION IN MAHBUBNAGAR DISTRICT,
RETENTION AS PERCENTAGE OF ENROLMENT IN CLASS I; 1976-1981

(Per cent)

I			II			III			IV			V		
T	B	G	R	B	G	T	B	G	T	B	G	T	B	G
100	100	100												
100	100	100	42	41	38									
100	100	100	36	41	38	24	34	17						
100	100	100	44	48	43	27	30	31	18	28	36			
100	100	100	39	43	26	31	37	27	21	25	39	16	20	12

Note: The data relate to the five consecutive years beginning 1976/77.
B = Boys; G = Girls; T = Total.
Source: Calculated from Eswara Prasad, 1987, Pp. 42-43.

TABLE 11. RATE OF RETENTION IN MEDAK DISTRICT,
RETENTION AS PERCENTAGE OF ENROLMENT IN CLASS I; 1976-1981

(Per cent)

I			II			III			IV			V		
T	B	G	R	B	G	T	B	G	T	B	G	T	B	G
100	100	100												
100	100	100	25	30	16									
100	100	100	33	39	23	16	14	6						
100	100	100	25	27	25	14	14	14	15	16	5			
100	100	100	36	41	23	8	16	13	10	12	6	7	7	4

Note: The data relate to the five consecutive years beginning 1976/77.
B = Boys; G = Girls; T = Total.
Source: Calculated from Eswara Prasad, 1987, Pp. 43-44.

TABLE 12. THE EXTENT OF WASTAGE IN EAST GODAVARI DISTRICT
(In Percentages; in selected villages)

	Boys	Girls	Total
Completed Grade V			
In 5 Years	30.2	25.7	27.8
6 Years	20.8	21.7	21.4
7 Years	4.9	7.6	6.3
Total	55.9	55.0	55.5
Still Continuing			
in Grade I	1.0	0.1	0.6
II	0.6	0.4	0.5
III	1.0	1.5	1.2
IV	1.2	1.0	1.1
V	3.5	3.7	3.6
Total	7.3	6.7	7.0
Drop out in			
Grade I	14.0	13.2	13.6
II	6.5	9.0	7.7
III	8.6	8.5	8.5
IV	5.7	4.9	5.4
V	2.0	2.7	2.3
Total	36.8	38.3	37.5

Source: Subramaniam, S. and Rama Raju, 1988, p. 40.

TABLE 13. REGION-WISE DROP OUT RATE IN EAST GODAVARI DISTRICT
(Per cent)

Mandals	Boys	Girls	Total
Thondangi(LD)	39.4	55.3	46.1
Alamuru(MD)	43.4	29.3	36.7
Ravulapalem(D)	30.3	33.1	31.7

Source: Subramaniam, S. and Rama Raju, 1988, p. 49.

TABLE 14. STAGNATION AND DROP OUT IN SINGLE AND MULTIPLE TEACHER SCHOOLS
(IN SELECTED SAMPLE SCHOOLS AS PER CENT TO ENROLMENT)
(Per cent)

Nature of School	Guntur		Kurnool		Mahbubnagar	Medak
	B	G	B	G	All	All
Stagnation						
Single	47.5	58.2	23.2	44	37.6	43.6
Multiple	31.6	37.0	39.8	40	28.1	71.7
Drop out						
Single	54.5	52.0	39.4	37.2	16.6	4.78
Multiple	27.6	25.2	36.4	29.4	13.21	16.13

Source: Eswara Prasad, 1987, p. 36, p. 48.

TABLE 15. DROP OUT ACCORDING TO NUMBER OF TEACHERS IN SCHOOLS
(IN SELECTED SCHOOLS IN EAST GODAVARI VILLAGES)
(Per cent)

No. Teachers	Thondangi	Alamuru	Ravulapalem
One	43.5	9.1	11.1
Two	34.8	36.4	41.7
Three	2.2	15.1	8.3
Four or more	19.5	39.4	38.9

Source: Subramaniam, S. and Rama Raju, 1988, p. 65.

TABLE 16. ECONOMIC STATUS TO WHICH DROP OUTS BELONG; EAST GODAVARI

(Per cent)

	Poor	Very Poor	Marginally Poor
Thondangi	91.4	79.0	12.4
Alamuru	57.6	28.8	28.8
Ravulapalem	36.4	18.2	18.2
Total	66.5	47.2	19.3

Note: Poverty line is fixed at Rs 100 per capita monthly income and Rs 75 is the norm for identifying marginally poor.
Source: Subramaniam, S. and Rama Raju, 1988, p. 76.

TABLE 17. NON-PARTICIPATION IN EDUCATION IN AP: 1981

(As a Percentage of Population of age 5-14)

	Rural		Urban		Total		Persons		
District	Boys	Girls	Boys	Girls	Boys	Girls	Rural	Urban	Total
Srikakulam	56.27	76.26	33.04	46.96	53.79	72.97	66.27	40.00	63.38
Vijayanagaram	58.32	77.82	33.47	47.98	54.49	73.17	68.07	40.72	63.83
Visakhapatnam	63.29	81.64	30.76	42.37	53.72	69.82	72.47	36.56	61.77
E.Godavari	57.26	64.64	35.26	42.84	52.57	56.91	60.95	39.05	54.74
W.Godavari	51.91	59.50	31.60	40.22	47.84	55.62	55.70	35.91	51.73
Krishna	47.77	59.83	29.37	36.28	41.92	52.52	53.80	32.83	47.22
Guntur	50.31	65.93	35.60	45.56	46.32	60.24	58.12	40.58	53.28
Prakasam	48.21	71.76	31.21	46.46	45.69	68.15	59.99	38.83	56.92
Nellore	49.69	67.23	31.44	39.35	46.12	61.86	58.46	35.40	53.99
Chittor	45.21	68.31	26.97	37.63	42.08	63.12	56.76	32.30	52.60
Cuddapah	49.88	75.38	31.33	46.49	46.41	70.07	62.63	38.91	58.24
Anantapur	55.28	79.50	33.72	48.25	50.90	73.26	67.39	40.99	62.08
Kumool	59.84	80.91	39.22	53.19	55.01	74.21	70.37	46.21	64.61
Mahbubnagar	67.87	85.67	34.52	50.33	64.10	81.66	76.77	42.42	72.88
R. Reddy	56.03	77.03	26.39	40.81	49.39	68.92	66.53	33.60	56.16
Hyderabad	*	*	25.92	32.70	25.92	32.70	*	37.55	59.90
Medak	60.57	84.22	26.64	43.20	56.17	78.85	72.39	29.31	29.31
Nizamabad	63.05	85.93	35.66	49.82	57.86	79.03	74.49	34.92	67.51
Adilabad	69.97	89.36	36.26	56.24	63.63	83.18	79.67	42.74	68.45
Karimnagar	64.51	85.17	31.33	48.24	59.20	79.26	74.84	46.25	73.41
Warangal	60.19	82.16	24.31	41.09	54.31	75.39	71.18	39.78	69.23
Khammam	61.59	77.97	25.57	37.94	55.72	71.52	69.78	32.70	64.85
Nalgonda	58.86	80.00	23.67	39.95	54.54	75.30	69.43	31.75	63.62
Andhra Pradesh							63.74	31.81	64.92

Source: *Census of India*, 1981, Series 2, Andhra Pradesh, Part IV(b)(i).

TABLE 18. INCIDENCE OF CHILD LABOUR (WPRC) IN AP, 1981.
(Main workers as a percentage of population of age 5-14)

	Rural		Urban		Total	
District	Boys	Girls	Boys	Girls	Boys	Girls
Srikakulam	15.87	12.38	5.46	2.89	14.75	11.32
Vijayanagaram	15.63	12.56	5.64	2.12	14.09	10.93
Visakhapatnam	16.88	12.04	3.27	1.06	12.87	8.74
E.Godavari	16.17	4.98	8.61	1.43	14.56	4.22
W.Godavari	17.26	9.47	7.63	2.60	15.32	8.09
Krishna	14.81	11.34	6.99	2.54	12.33	8.60
Guntur	15.45	16.02	6.38	3.30	13.00	12.47
Prakasam	12.72	14.35	5.74	5.44	11.69	13.07
Nellore	13.41	10.30	7.05	2.93	12.17	8.88
Chittor	14.59	11.42	6.04	2.11	13.12	9.84
Cuddapah	13.48	12.46	6.92	3.60	12.25	10.83
Anantapur	16.20	13.56	5.56	2.66	14.04	11.38
Kumool	18.58	18.17	7.77	4.60	16.05	14.89
Mahbubnagar	21.15	14.64	7.82	4.94	19.64	13.54
R. Reddy	19.11	11.57	3.89	1.31	15.70	9.27
Hyderabad	*	*	4.08	0.80	4.08	0.80
Medak	17.56	11.93	4.66	2.90	15.89	10.75
Nizamabad	17.81	19.02	5.45	5.46	15.46	16.43
Adilabad	18.23	14.06	4.10	2.28	15.57	11.86
Karimnagar	21.38	19.39	5.56	6.99	18.84	17.41
Warangal	16.98	12.64	2.99	4.17	14.69	11.24
Khammam	16.89	13.86	3.62	1.48	14.73	11.87
Nalgonda	17.84	11.37	5.38	2.48	16.31	10.33

Source: *Census of India*, 1981 Series, 2 AP, Part IV(b)(i).

DOCUMENTATION

The purpose of this section is to make available to the readers official documents such as reports of committees, commissions, working groups, task forces, etc., appointed by various ministries, departments, and agencies of central and state governments which are not readily accessible either because they are old, or because of the usual problems of acquiring governmental publications, or because they were printed but not published, or because they were not printed and remained in mimeographed form. It will be difficult and probably not worthwhile to publish the documents entirely. We shall publish only such parts of them as we think will interest our readers. The readers are requested to send their suggestions regarding official documents or parts thereof for inclusion in this section.

In the present section we publish:

1. Report of the Committee on Foreign Collaboration (May 1967) Government of India Ministry of Industrial Development and Company Affairs (Department of Industrial Development).

REPORT OF THE COMMITTEE ON FOREIGN COLLABORATION (MAY 1967)
Government of India Ministry of Industrial Development and Company Affairs (Department of Industrial Development)

The Government of India in their Office Memorandum No. IP&FC-5(1)/66, dated the 19th February, 1966, constituted a Committee, with composition as indicated below, to recommend to Government some guide lines regarding the utilisation of indigenous know-how and the types of cases in which foreign collaboration may be allowed.

Composition

1. Dr. A. Ramaswami Mudaliar	Chairman
2. Dr. S. Hussain Zaheer (Dir. Gen. CSIR)	Member
3. Shri P.C. Kapoor (Director General, Technical Development	Member
4. Shri K.J. George (Director, Ministry of Industry)	Member-Secretary

Terms of Reference

2. The terms of reference were:

(a) to examine the extent to which, at the present stage of our economic development, import of technical know-how from abroad can be dispensed with;
(b) to examine the general conditions subject to which indigenous know-how can be deemed to be capable of commercial exploitation; and
(c) to suggest general guidelines regarding the type of cases in which foreign collaboration may be allowed.

Though the question of adequacy or otherwise of the encouragement being given to the development of indigenous know-how is not covered by the terms of reference, as this is a connected issue, the Committee has given some thought to this and has also made some recommendations in this regard.

Number of Meetings etc.

3. The Committee held seven meetings and met representatives of various Chambers of Commerce and Industry in Calcutta, Bombay and Madras. Written Memoranda were also received from some Associations and individuals. A list of these is given at the Appendix to this Report.

Ingredients of Know-how.

4.1 Before proceeding to an examination of the issues involved, it is desirable to define the essential ingredients constituting "know-how". In essence, "know-how" consists of

(a) process know-how or product design;
(b) design and engineering of the plant;
(c) erection and commissioning of the plant.

It may often be the case that in respect of a particular product, one or more constituents of the "know-how" may be indigenously available. While considering problems relating to know-how, it is necessary that we should have a clear concept as to whether only a particular ingredient of the know-how or whether all the main aspects are being considered. The observations in para 4.2 to 4.5 below are essentially meant to apply to the process know-how or product design only.

4.2 With reference to the first of the three terms of references, while it is desirable and necessary that indigenous know-how should be developed and utilised to the fullest extent practicable, no country, leave alone a developing country like India, can afford to close its doors to technological developments in the rest of the world. In fact, one of the most remarkable developments in the more industrialised countries has been the increase of international exchange of know-how. Consequently, research and development - and production itself - has, to some extent become more and more specialised in each country. Britain, which has sometimes been referred to as the home of the machine tool industry, currently imports more than Rs 40 crores of machine tools in an average year and she exports comparable quantities to other highly industrialised countries such as France and the U.S.A. This unrestricted exchange and competition, both at home and

abroad, keeps the machine tool manufacturers in each country keenly conscious of the need for constant research and development. Each manufacturer is compelled, as a condition of survival, to introduce still better designs and production techniques and so to improve quality, delivery and customer service, while keeping prices to the minimum.

Technological Gap between India and the More Developed Countries.

4.3 There is today a big gap between India and the more developed countries in the field of technical know-how - a gap which has to be narrowed over a period of time by (a) adequate development of indigenous know-how and (b) import, in suitable cases, of foreign know-how and the building up of further know-how based on the imported know-how. Our investment in research and development today is comparatively very small. We are not as yet generating or investing even a small fraction of the resources required to keep pace with the research and development which is taking place in the more industrialised countries. In the context of our present technological gap, industries may be categories into two broad groups (a) industries already well-established in India and (b) the newer and more sophisticated industries. In the case of the former category, while a view may be taken that we should be independent of foreign know-how, it is at the same time necessary that these industries should not blind themselves to the research that is being conducted abroad. There may be occasions when important developments may render it neccssary to import technology even in these fields. In the case of the newer and more sophisticated industries, the major effort so far has been concentrated in establishing manufacturing capacity. For these newer and more sophisticated industries, a fairly liberal import of know-how initially, combined with a research effort on the re-inforcement of existing technology and its adaptation to Indian conditions, would, in the Committee's view, be the appropriate course to follow.

Need for Positive Approach to the Problem of Import of Know-how.

4.4 The Committee would, therefore, like to emphasise the need for a positive approach to the problem of import of foreign process know-how. India's technical base is as yet slender. On the other hand, our industrial base is large and fairly diversified. If we adopt a restrictive approach to foreign technology without at the same time ensuring that indigenous technology is able adequately to serve the industrial development of the country, economic growth would be hampered. In fact, it has been often urged that a liberal import of foreign know-how is an essential part of a programme to promote indigenous know-how, and that the aim should not be self-sufficiency in technical know-how, but an international exchange of indigenous and foreign know-how.

4.5 The Committee's conclusion, therefore, on this aspect is that import of know-how, particularly of process know-how or product design, should continue to be allowed on a discriminating basis, so that Indian industry is able to keep in touch with the world technological mainstream. After importing foreign technology wherever this is necessary, it should be the endeavour of Indian research and development to build and develop it to suit Indian conditions, Indian environments and Indian raw material availability. This in fact is what Japan has done with great advantage to her economy.

Import of Know-how has Accelerated Industrial Development of India.

5. The following have been cited as some of the main disadvantages following from a liberal import of foreign know-how:

(a) There is a tendency to purchase foreign know-how indiscriminately.
(b) Foreign collaboration agreements often entail purchase of machinery and equipment from abroad, at high prices.

(c) Foreign collaboration makes us dependent on imports of raw materials and components. Specifications for these are often so laid down that they restrict purchases from alternative and cheaper sources.
(d) While enabling us to accelerate the tempo of industrialisation, foreign collaboration has killed indigenous initiative.

It may be that there may well have been individual cases in the past in respect of which some of these allegations may be valid, but with greater experience on the part of Indian entrepreneurs, there is less risk of such instances repeating themselves. Apart from this, taking a broader view, there will probably be no two opinions on the issue that industrial development accelerated by the importation of foreign know-how. Every case of foreign collaboration requires Government's prior approval and this is normally given after a detailed scrutiny. Where the entrepreneur is himself new and the project involves large investment there may be a case for closer governmental scrutiny. In any case, there is no ground at all for taking the extremist view that import of foreign know-how should be dispensed with.

Different Forms of Obtaining Technical Know-how - Comparative Merits.

6. The different ways of importing foreign technical know-how may be categorised as follows:-
i) Through outright purchase of design, know-how, etc.
ii) By engaging foreign technicians as direct employees.
iii) Through royalty or licensing agreements.
iv) Through foreign capital participation. In many cases, a combination of these is also involved.

The relative merits of these different methods of importing know-how have often been the subject of discussion.

Agreement (i) is appropriate where the product or process is long-established and is unlikely to be overtaken in the near future by technological obsolescence. From Government's point of view, this arrangement has the advantage that the foreign exchange outlay in obtaining the know-how is pre-determined. Provided the product or process selected under this arrangement is chosen with care, this could be a satisfactory arrangement and can also serve as an incentive to self-sufficiency in the development of indigenous substitutes or processes.

Arrangement (ii) is somewhat limited in scope.

Arrangement (iii) has the advantage of the feature of "pay as you earn", since payment for know-how is only made after the product has been successfully produced. It has also often been stated that a royalty arrangement provides an incentive to the licensor to ensure that the licensee goes into full production as quickly as possible, so that earnings by way of royalty are enhanced.

Arrangement (iv), it is generally recognised, has many features to commend it, the first being that know-how payment only commences when the Indian venture becomes profitable and makes payment of dividends. Further, the overseas collaboration is directly interested in the progress of the Indian venture and can be expected to take an active interest to ensure that progress according to planned programme takes place. It has also been held that transmission of know-how is more complete in the case of joint ventures involving financial participation than in the other types of collaboration. On the whole, in all industries where substantial import of capital goods is involved and where Government's policy allows foreign capital participation, joint ventures involving equity participation would appear to be most beneficial from the country's point of view.

Indigenous Know-how versus Imported Know-how.

7.1 A primary question which of late has been increasingly arising in dealing with the proposals for import of foreign know-how is whether there is an alternative indigenous technology available to the entrepreneurs. Some of the basic questions which have to be taken into account in assessing the suitability of indigenous know-how are:

i) Has the indigenous know-how been commercially processed or is at least capable of commercial exploitation within a reasonably short period?

ii) Is the know-how economical from the point of view of the investor and from the national point of view?

iii) Is it likely to be made available to the new entrepreneur or is the know-how available only to another existing manufacturer, who is reluctant to part with the know-how to a competitor?

Existing Procedures for Examining Foreign Collaborations.

7.2 Under the existing procedures, both the Directorate General of Technical Development and the Council of Scientific & Industrial Research are associated with the consideration of applications for approval of foreign collaborations. The CSIR normally brings to the notice the authorities concerned the existence of indigenous know-how which has either been developed in one of the National Laboratories or is available elsewhere with existing manufacturers. It has been alleged before the Committee by various Chambers of Commerce & Industry that in many cases, CSIR has not been taking a broad view regarding the availability of indigenous know-how, and that even in the cases where the indigenous know-how is restricted to the laboratory stage or its commercial possibilities have not been fully proved, foreign collaborations have not been recommended, with the result that entrepreneurs have had to give up their schemes, resulting in continued import of the product; instances were also cited where entrepreneurs, after attempts to utilise the indigenous know-how, had to give up the projects as not being commercially feasible.

Need for Prior Discussion between DGTD & CSIR before a Recommendation is made to the Foreign Agreements Committee.

7.3 It is of course necessary that indigenous technology, which is capable of commercial exploitation, should be fully utilised. Both at the licensing stage and the Foreign Agreements approval stage, a scheme based on indigenous know-how should normally be given preference to one based on imported know-how. But while insisting on the utilisation of the indigenous know-how to the exclusion of imported know-how, it is important that adequate consideration should be given to the issues raised in para 7.1. The Committee would recommend that in all cases where CSIR is of the view that owing to the availability of indigenous know-how, no foreign collaboration should be allowed, it should be a convention that there should be a prior discussion between the concerned officers of the DGTD and of the CSIR, before a recommendation is made to the Foreign Agreements Committee, instead of as at present, both the agencies expressing their views independently. If, at the normal operating levels, there is a difference of opinion between the two organisations, a discussion should be arranged at the level of the DGTD and the DG, CSIR, if necessary, so that as agreed recommendation is made to the Foreign Agreements Committee. Care should, however, be taken to ensure that such discussions do not lead to avoidable delays in the finalisation of the cases. In case of difference of opinion between the CSIR and the DGTD, the case should promptly be brought up before the Foreign Agreements Committee.

7.4 In the context of the issues raised in the foregoing paragraphs, the Committee would like to refer to certain aspects of the existing procedures for the scrutiny of applications for approval of foreign collaborations. Applications are scrutinised with a view to seeing whether any

indigenous know-how is available and whether the terms proposed are reasonable. No consideration is ordinarily given to the aspect whether the particular technology sought to be imported is the most suitable to our requirements, having regard to the scale of production, raw material availability etc. There is at present no expert agency with adequate knowledge whose views are before Government while taking decisions. To fill this lacuna, the Committee would make the following recommendations:

Constitution of Technical Research Committees.

Pursuant to the 'First Get Together' on Research and Industry organised by the Council of Scientific & Industrial Research in December, 1965, it was agreed that Technical Research Committees consisting exclusively of scientists and technologists should be constituted by the Ministry of Industrial Development Council, in consultation with the CSIR. In the case of industries which are not covered by any Development Council, CSIR, in consultation with the Ministry of Industrial Development & Company Affairs, was to take steps to constitute similar Technical Research Committees. It will be one of the functions of these committees to demarcate areas where indigenous know-how capable of commercial exploitation has been developed and where import of know-how is necessary.

These Technical Committees will also indicate, in general, the type of design and engineering services which could normally be undertaken in India. To avoid repetitive import of know-how, these Committees could also identify industries in which rather than allow individual parties to import know-how to be imported by a consultancy organisation, which could, after importing the know-how, make it available to indigenous entrepreneurs. These Committees should have available to them information not only relating to indigenous know-how available in the country, but also available information about the types of know-how developed elsewhere in the world, in the main fields with which they are concerned. Each National Laboratory could be made responsible for compiling this information in its own field and making it available to the appropriate Technical Committee. With the help of this information, the Technical Committee could also undertake studies, wherever appropriate, of the comparative merits of different types of know-how in the light of Indian conditions and raw material availability.

Copies of studies prepared by these Technical Committees will be received in the Secretariat of the Foreign Agreements Committee in the Ministry of Industrial Development and Company Affairs and made available to DGTD or other technical authorities concerned and to the Administrative Ministries concerned. While applications for foreign collaborations are examined either by the Foreign Agreements Committee or by the individual Ministries in the exercise of delegated powers, adequate consideration should be given to the views expressed by the Technical Research Committees in their reports. It is, however, not intended that consideration of cases should be held up for ascertaining the view of the Technical Research Committees. In cases where the Technical Committees have already expressed a view, due consideration should be given to this while taking a decision.

Limitations of Indigenous Know-how. Need for Design & Engineering Consultancy Services and Provision of Risk Capital.

8.1 It was urged before the Committee by representatives of Industry that CSIR know-how is usually based on laboratory studies and in some cases on pilot plant work but is mostly lacking in design and engineering data. A major investment in industrial research is constituted by pilot plant design and development activities combined with process and product development data and market studies which are essential for the successful commercial operation of an industrial plant. It was urged before the Committee that one of the reason why CSIR know-how has not been readily acceptable to Indian entrepreneurs has been the fact that this know-how has not been tried on a

commercial scale and is not accompanied by any economic guarantees. Since a large number of Indian entrepreneurs do not yet have the financial capacity to take risk and since the CSIR know-how is usually not offered through key project engineering firms who may be able to give a turnkey job, there is obvious reluctance on the part of entrepreneurs to invest in new and untried processes. In respect of some of the know-how licensed by CSIR, Indian entrepreneurs have had to carry out developmental project engineering and feasibility studies which have involved considerable expenditure of time and money and in certain cases have led to commercial losses. It was urged before the Committee by one association of the industry that to get over these difficulties what is essentially required is an independent corporation such as the National Research Development Corporation which should ensure design and engineering services and provide the risk capital for the entrepreneur taking up commercial development of know-how based on Indian research. The Corporation should be prepared to compensate the entrepreneur for any losses sustained on uneconomic and untried processes.

8.2 The representatives of the CSIR on the Committee, while agreeing that part of the criticism from industry was not without foundation and was justified, affirmed that several steps had been taken by the CSIR in overcoming these difficulties. In this connection attention was drawn to the setting up of the Capital Design & Engineering Organisation at the CSIR Headquarters which, while on the one hand, advises the Laboratories on the technical and commercial feasibility of the researches carried out on pilot plant level, at the same time undertakes project design and engineering jobs on CSIR know-how. It was also prepared to undertake turnkey jobs for industry with the usual commercial guarantees. It was emphasised that the cases where CSIR researches had failed to materialise at a commercial level were not as many as were made out and the situation had greatly improved with better contacts with industry. Since representatives of industries were associated with the Scientific Advisory Committees and Executive Councils of the Laboratories, the incidence of non-commercial researches being offered for exploitation was greatly minimised. For pilot plants involving an investment of above Rs. 5 lakhs, the data was scrutinised jointly by the representatives of the CSIR, Industry and DGTD. Every effort was made to invite the industry to participate and share in research and development at various stages. However, the representative of the CSIR readily agreed that much more needs to be done to generate confidence in the industry for successful utilisation of indigenous know-how. It was felt that the National Research Development Corporation had a vital role to play in generating confidence in industry and providing risk and development capital besides its present activity of licensing of the know-how developed in CSIR and other Government Laboratories.

Indigenous Know-how and Role & Functions of National Research Development Corporation.

9. While considering the utilisation of indigenous know-how the committee discussed the present working and role of the National Research Development Corporation and the reasons why it had not so far been able to fulfil to any significant extent its role of promoting the development of industrial research to the commercial stage. It was appreciated that with the resources placed at its disposal perhaps the National Research Development Corporation could not have done much more. The Committee felt that in order to enable it to play the role for which it was set up and which is clearly laid down in its Articles of Association, it was necessary that the National Research Development Corporation should *inter-alia* take the following steps.

(i) The National Research Development Corporation should have a machinery either of its own or in collaboration with consultancy engineering or design engineering firms, for proper screening of the processes, patents and inventions referred to it. It should advertise only those processes which are *a priori* technically and commercially sound. The non-technical notes issued by the

National Research Development Corporation should be more realistic in regard to the capital and recurring investment on the researches.

(ii) The National Research Development Corporation should develop expertise and draw parameters on a scientific basis for the setting of terms of commercial exploitation of researches. These should be based on a technological and economic evaluation of the know-how offered, taking into consideration imports, exports, production, licensed capacity, turnover and the profitability of the invention offered for commercial exploitation.

(iii) The National Research Development Corporation should place greater emphasis on developmental activity and should sponsor industrial and commercial development of process know-how either with (i) its own researches, or (ii) with the participation of industry, or (iii) with the joint participation of research organisations, industry and the National Research Development Corporation. While inviting the industry and the CSIR to share and participate in the developmental activity, it should be prepared to meet the risk. However, before any investment is considered, the National Research Development Corporation should get the project examined and assessed for its technical and economic feasibility by a consulting engineering organisation, either of its own or by an outside project engineering firm.

(iv) The National Research Development Corporation should approach the Government for adequate financial provision for an enhanced investment in risk capital to enable it to meet the expenditure for the 'first' prototype or commercial plant. This would be the best way to generate confidence in industry to utilise indigenous know-how and is widely adopted even by the United Kingdom and other advanced countries. For this purpose, the share capital of the National Research Development Corporation should be substantially raised and the powers of the National Research Development Corporation to write off the losses stepped up.

Need for Liberal Approach Regarding Import of Process Know-how or Product Design.

10. As indicated earlier, it would be certainly worth while to import foreign process know-how or product design where this is not indigenously available. Protracted discussions about the actual quantum of payments for this part of the know-how may not be worthwhile. The Committee would recommend that a fairly liberal approach should be brought to bear in sanctioning payments relating to process know-how or product design only. Delays in the implementation of a scheme on account of minor differences in the amounts asked for may in the long run only result in greater national loss from the delay in the implementation of schemes.

Time Taken in the Clearance of Collaboration Cases.

11. It was urged before the Committee that the existing procedures for consideration of foreign collaboration cases often take on unduly long time. This is not a matter falling within the terms of reference of this Committee and accordingly no detailed study regarding this has been undertaken by the Committee. It appears that, according to the existing procedures, a major part of the applications fall within the category where powers have been delegated to Ministries to accord approval for the collaboration cases. There is no effective machinery for keeping a watch on the speedy disposal of all applications received in the individual Ministries. From many points of view, it appears to the Committee that there would be some advantage in arranging for a central unit in the Ministry of Industrial Development & Company Affairs which should be responsible for bringing to the notice of the Foreign Agreements Committee cases which have remained undisposed for a period of 3 months from the date of receipt of the application. By a Press Note, applicants might be advised to send applications for foreign collaboration in duplicate - one copy direct to the Administrative Ministry concerned and the other, to the General

Cell in the Ministry of Industrial Development & Company Affairs. Cases which remain undisposed for a period of more than 3 months should, it is suggested, be automatically brought up before the Foreign Agreements Committee for consideration and decision by them, even if they fall within the purview of the delegated powers of the Ministries should be accepted.

Duration of Technical Collaboration Agreements.

12. In the earlier collaborations normally the duration has been fixed for 10 years and as a rule one further extension of, say 5 years or so, appears to have been given in most cases. Of late, the policy appears to have been to limit the initial period of collaboration, normally to a period of 5 years.. The Committee would like to emphasize that any rigid approach in this matter would not be appropriate. In the case of industries where rapid technological changes take place and the investments involved in research and development are very substantial, there may be a case for the original agreement itself being allowed for a period of 10 years. What the Committee would like to stress is that no rigid rule should be followed in this matter, that a period ranging from 5 to 10 from the commencement of production should be the normal duration of technical collaboration agreements and that the duration of the original agreements and subsequent extensions, if any, should be considered on the merits of each case.

Avoidance of Repetitive Import of Technology.

13.1 One point to which the Committee has given considerable thought is the problem of the need for repeated import of the same technology. The issue essentially is whether in cases where a number of collaborations, say 5 or 6, have already been approved in a particular field of industry, what steps could appropriately be taken to restrict further import of the know-how. The Committee has had detailed discussions with various Chambers of Commerce on this issue. It is neither practicable nor desirable to resort to any sort of compulsion on existing manufacturers to part with their know-how to their competitors. It was also pointed out to the Committee that in many cases, and particularly so in the case of joint ventures, the foreign collaborator may be reluctant to part with his know-how to a competing firm seeking to establish production in India. In the case of an existing unit, the know-how which could be passed on by it to a new entrepreneur will normally be only the process know-how of the product design. The design and engineering services cannot ordinarily be given by the industrial unit. Instead of asking the existing unit to part with its know-how to a possible competitor, the more appropriate course would be to consider the likelihood of an existing unit giving the process know-how or product design to a consultancy firm, on the basis of a negotiated agreement. This could be either on the basis of an outright purchase of know-how or on the basis of sharing of the income accruing as a result of future licensing of the know-how. In cases where an existing unit is prepared to give its know-how to a new unit, this should of course be welcomed.

Fiscal Incentives for Passing on Know-how.

13.2 To encourage the transmission of know-how, it is also recommended that some fiscal incentives in the shape of tax relief on the royalties earned by Indian Companies which pass on their know-how to others should be provided.

Need for Greater Stress on Research and Development.

14.1 At present in India, investment in research and development is primarily by Government. While this investment from public resources on scientific and technological research needs to be further augmented to step up the pace of industrial development, there is need for the industry to take more positive measures to set up research and development facilities of their own. The efforts by the industry hitherto in this direction have been inadequate. However, with the increasing tempo

of industrial development, the shortage of foreign exchange and the need to make the country self-reliant and, more so, to enable the country to be in the forefront of advance in at least some fields of industry, it is essential that research and development activity within the industry is stepped up. Industrial research undertaken by the industry has the advantage of growing out of the direct needs of the industry and of immediate applicability for fruitful economic returns. While the responsibility for organising industrial research should primarily rest with industry itself, there is every need for the Government to provide incentives and create the right economic climate and environment to promote investment by industrial units in research and development. The Committee is aware that at present expenditure on research is exempt from income tax. The Committee, however, feels that the Government should go much further and would commend the suggestion made by the industry that they should be given corporate tax relief to the extent of double the expenditure on research and development. The Committee would also recommend a liberal treatment in regard to provision for foreign exchange for import of essential instruments and equipment for research laboratories.

Role of Trade Associations of Industry.

14.2 Industrial Organisations and Trade Associations of industry can play a very useful role in establishing research organisations in their respective sectors of industry and promoting better communications between universities, State-sponsored research establishments and industrial firms. In the industrially advanced countries, well-established trade associations set up research wings of their own which conduct the service of collecting the research problems of their constituent units and of sponsoring them in the universities or research establishments. Alternatively, the associations set up research laboratories of their own, managed under the advice of competent scientists from industry, universities and research establishments. The Co-operative Research Associations of industry have also played a useful role in utilising the limited resources of technical manpower, equipment instruments and library facilities for a community of industrial units, who would otherwise not be able to set up research facilities of their own. At times, they have also functioned as channels for communication of superior know-how to their members and also encouraged sponsored research on behalf of individual units. Co-operative research by industry in India is at present mostly confined to agro-based industries and much more needs to be done to draw in the larger and more advanced sectors of industry into setting up research institutes for individual industries or groups of industries.

The Committee recommends a liberal policy in encouraging and promoting research associations, who should be allotted a larger share of public resources by the Government through the CSIR.

Need for Further Development of Design and Consultancy Services.

15.1 While approving foreign collaboration terms it is important that it should be ensured that, as far as practicable , indigenous design and consultancy services are utilised to the fullest practicable extent. Though Indian industry has developed substantially during the past decade or two, design and consultancy organisations have not kept pace. Substantial gaps do still exist in the consultancy services available in the country. It is of importance that these gaps should be identified and adequately filled. The Committee is aware that the Planning Commission has set up another Committee to go into these aspects. Without, therefore, going into a detailed analysis of our requirements in this field, this Committee would merely recommend that speedy steps should be taken for the establishment of adequate consultancy services in the country, so that the need for importing services in this field is minimised.

15.2 The twin aspects of research and development and of design and engineering underscore an important deficiency in our industrial development plans. We have till now placed emphasis on the physical appurtenances of the productive apparatus such as factory building, civil works, plant and machinery, operating personnel, raw materials, components, etc. But we have not paid adequate attention to the "back room" personnel - in the laboratories and in the drawing and design offices. The stage has now been reached when greater attention has to be paid to these aspects.

Japanese Example.

16. Japan is an example of a country which has very liberally imported technical know-how and also rapidly developed her own research and development. Having, for instance, originally imported petro-chemical know-how from abroad, within the course of a few years, she is now herself in a position to impart fresh know-how to the former very citadels of petro-chemical know-how. The Committee also understands that Japan normally avoids repetitive import of know-how. The remarkable achievements of Japan in the liberal import of foreign know-how and the very rapid development of indigenous know-how is, in the Committee's view, well-worth a detailed study. The Committee has not been able to obtain adequate information regarding this here and accordingly recommends that Government should arrange for a detailed study of the policies followed by Japan in this field.

Role of the Public Sector.

17. It is hardly necessary for this Committee to refer to the important role that the public sector can play in the process of fostering the development of indigenous know-how and design and engineering services. Shri. G.L. Mehta, Chairman, Indian Investment Centre, while giving evidence before the Committee, mentioned that the ICICI, with which he had been associated had supported a number of ventures involving the exploitation of new processes based on indigenous technology as well as on the use of indigenous raw materials. He stated that their experience in this matter had not been uniformly favourable but that some risks had to be taken if we are to encourage indigenous technology. In the matter of the establishment of design and engineering services also, the public sector could well serve as a model.

Need for Liberal Approach to Foreign Collaboration in the Case of Export- Oriented Industries.

18. In respect of industries which are substantially exported-oriented, the Committee would like to stress that a liberal approach in regard to foreign collaboration would be worthwhile. The question of international standards is of paramount importance in connection with our need to expand our export markets. A joint venture arrangement is often able to ensure that the Indian manufacturer has access to the foreign collaborators established overseas network of distributors and agents.

Summary of Recommendations.

19. The following are the principal recommendations of the Committee:

(i) Need for a positive approach to the problem of import of know-how, particularly of process know-how or product design. Distinction between the well-established industries and the newer and more sophisticated industries (Para 4.3, 4.4 and 4.5).

(ii) Generally speaking, in industries where substantial import of capital goods is involved and where Government's policy allows foreign capital participation, joint ventures involving foreign equity participation are more beneficial (Para 6).

(iii) Considerations to be taken into account in assessing the suitability of indigenous know-how (Para 7.1).

(iv) Need for prior discussion between D.G.T.D. and CSIR regarding need for foreign collaboration and terms thereof - unresolved differences of opinion to be promptly brought up before the Foreign Agreements Committee (Para 7.3).

(v) Constitution of Technical Research Committees and the role to be played by them (Para 7.4).

(vi) Limitations of indigenous know-how. Need for design and engineering consultancy services and provision of risk capital (Para 8.1 & 8.2).

(vii) Action to be taken by CSIR to generate confidence in industry regarding indigenous know-how - Role of the National Research Development Corporation (Para 9).

(viii) Need for a Central Co-ordinating Unit to watch the progress of the disposal of applications for foreign collaboration - Cases remaining undisposed of for 3 months to be brought up for consideration by the Foreign Agreements Committee (Para 11).

(ix) No rigid rule to be followed in the matter of the duration of technical collaboration agreements; normally the duration of the original agreement should be between 5 to 10 years from commencement of production (Para 12).

(x) Avoidance of repetitive import of technology - Existing units to be encouraged to give know-how to consultancy firms - Fiscal incentives to existing units which pass on their know-how to others (Para 13.1 & 13.2).

(xi) Need for greater stress on research and development - Fiscal incentives for encouraging research and development - Role of Industrial Associations (Para 14.1 & 14.2).

(xii) Need for further development of design and consultancy services to fill existing gaps (Para 15.1).

(xiii) Need for a detailed study of the Japanese example of combining liberal import of know-how with rapid development of indigenous research and know-how (Para 16).

(xiv) The useful role which the Public Sector can play (Para 17).

(xv) Special approach to foreign collaboration in the case of export-oriented industries (Para 18).

REVIEW ARTICLE*

WATER RIGHTS SYSTEM: IS IT FEASIBLE FOR INDIA?

R. Maria Saleth

1. Introduction

Let us face it. The major threat to the sustainability of our irrigated agriculture is going to come neither from the frequently alluded 'utilisation gap', i.e., the gap between our water resource bounty and the extent of its use, nor from the so called 'irrigation gap', i.e., the gap between our irrigation demand and the irrigation potential created so far, but from the persistence of the 'incentive gap', i.e., the gap between the scarcity value of water and the value underlying the current pattern of water utilisation and management. In fact, both the utilisation gap and the irrigation gap could be reduced, if not eliminated altogether, by correcting the incentive gap which is evidently a product of the existing institutions governing water acquisition, distribution, and utilisation.

What is astonishing is not the fact that the current legal and institutional basis of water management fails to provide sufficient economic incentive, but the fact that it actually engenders a wrong kind of incentive structure! While the farmers' perception of excessively subsidised canal water as a public good induces them to maximise water per unit of output rather than to maximise output per unit of water leading thereby to water over use, the unrestricted 'open access' character of ground water instigates a process of competitive water withdrawals culminating eventually in aquifer depletion. It is this kind of incentive system that underlies the paradoxical phenomenon that unlike other economic goods where scarcity prompts efficiency and conservation, water resources continue to be depleted and misused under the very condition of increasing scarcity. It is abundantly clear that without correcting the fundamental incentive gap through a radical transformation of the existing water laws and institutions, it is certainly not possible to ensure the sustainability of our irrigated agriculture as it ushers into the 21st century.

Our continuing belief that regulatory policies based on well siting and licensing norms, and power tariff and supply manipulations, or even the newly emerging institutions like water markets and user-oriented irrigation cooperatives, are going to provide a durable solution to all the critical problems facing our water economy under the prevalent institutional conditions is going to be too costly not only in economic terms but also in social and political terms. Since the water zonation-based well spacing and licensing regulations are implemented indirectly through credit and power connection policies, they are easily bypassed by well-endowed farmers [Dhawan, 1989, Pp. 44-45]. Apart from their inability to control depletion, they are also inequitable as they restrict the new entrants who are mostly resource-poor farmers and more importantly, offer no protection to the poor farmers relying on traditional water-lifting technologies [Dhawan, 1990, p. 45; Moench, 1992, p. A172]. The effectiveness of regulations based on power tariff and supply policies is severely undermined not only by the availability of diesel pumpset option but also by the presence of a 'kink' in the farmers' power demand.[1] Although water markets are found to improve efficiency and equity in water use [Shah, 1991; Saleth, 1991b], they could, nevertheless, accentuate aquifer depletion especially under the current legal regime governing access to ground water. In the case of surface water resources, neither the usual policies based on water charge and supply manipulations nor the new ones based on rotational water supply system[2] and farmer-managed outlet level cooperatives are likely to generate sufficient impact effective enough to enforce discipline in canal water use. It is now time for seeking harder options to provide a durable solution to our water-

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* *Water Rights and Principles of Water Resources Management* by Chhatrapati Singh, N.M. Tripathi Private Limited, Bombay, 1991, Pp. xv+158, Rs 100/- $ 8.

related problems rather than be content with the politically and administratively easy but ineffective regulatory policies followed thus far. One such option is the institution and administration of a water rights system.

2. *Status of Water Rights Issue in Current Policy and Literature*

To be fair, it is to be noted that the need for something resembling a water rights system has been recognized by the policy-makers, at least, since 1970. For instance, the Model Ground Water (Control and Regulation) Bill of 1970 formulated by the then Union Ministry of Agriculture & Irrigation and circulated among states for its possible enactment has postulated a kind of water permit system [Government of India (GOI), 1970]. The National Commission on Agriculture (NCA) has gone one step further by elaborating on the criteria for specifying the water rights as well as on the administrative system necessary for their enforcement [GOI, 1976, p. 23]. Undaunted by the fact that even though the 1970 Model Bill has not been adopted by any state so far, the Union Ministry of Water Resources has once again come out with another Model Bill in 1992 which is very similar in spirit to its predecessor [GOI, 1992].

While policy-makers have, at least, recognised the significance of water rights system, there is a lamentable overall aversion towards the issue of water rights system among researchers who, though acknowledge its economic and equity significance, consider it as an administrative nightmare and a political impossibility. Fortunately, with the increasing weightage attached to the sustainability, i.e., ecological, economic, and equity, implications of widespread occurrences of ground water depletion, sea water intrusion, land subsidence, and command area loss due to waterlogging and soil salinity, the balance is gradually moving to make the water rights issue both administratively and politically acceptable. Still then, the Indian economic literature on water resources continues to neglect the issue. However, few writers have noted the need for water rights system, though mostly in a mute form and just as a passing reference. For instance, Dhawan [1975], who is one among those who recognised the issue early, has emphasised its need to correct the 'ill-defined ownership arrangements' for countering ground water mining and the attendant external diseconomies. Shah and Raju [1988, p. A23] have alluded to the need for a reform in the structure of water rights so as to correct the existing skewed distribution in well and pumpset ownership. Induced by the general neglect of such an issue of critical significance to the very survival of our agricultural economy, this reviewer has taken the issue to the popular forum not only to underline its need but also to show its technical and administrative feasibility and economic viability [see Saleth, 1991a]. Recently, Moench [1992, p. A175] has noted that without a water rights system specifying individual water withdrawals neither the water markets nor the user groups could function effectively.

It is against this paucity of economic literature on water rights system in India, that the book under review assumes significance, despite the fact that it approaches the issue only from a jurisprudential rather than an economic point of view. Although the economic and administrative aspects of water rights system are important, the legal clarity as to the nature and characteristics of water rights and the basis for their distribution is a necessary first step for establishing an equitable water rights system. Given such a policy relevance of the subject matter, the attempt here is more like a review of the issue in general rather than a mere review of the book *per se*. First, a concise summary of the book is given which is then followed by a critical evaluation of both the theoretical and practical implications of the issues raised in this book as well as those that need to be considered especially from an economic, technical, and administrative viewpoints. The overview of the book given below is organised mostly by chapters, though, at times, chapter boundaries have been transgressed to rally around a significant point.

3. *Water Rights and Principles: An Overview*

This book by Singh is slated as the first among a series of works to be published by the Indian Law Institute, New Delhi as a part of its ongoing

Water Law and Policy project. Given the professional background of the author, it is no wonder that the issue of water rights is essentially approached from a legal point of view. The book aims to study the principles that have been applied so far and those that ought to be applied in the context of access, acquisition, and distribution of water both from the surface and underground sources. It is the right to water as a resource (i.e., as used in drinking and domestic purposes, irrigation, industrial needs, and power generation) and not the right to water-based resources like fishing that forms the substantive matter. Furthermore, the water law being contemplated here involves not passing an act which is just superimposed on the existing legal domain governing water resources but 'a selective reconstruction of legal domain which pertains to acquisition, utilisation, distribution, protection, and conservation of water. It would require bringing together central and state laws, rules, orders, ordinances, customary laws, and court decisions pertaining to water. Such a selection will necessarily cut through constitutional, criminal, civil, and customary laws...' (p. 14).

After having given some preliminary statistical detail about our water resource potential and utilisation status both at the national and state level, a strong case for the urgent need for a water law reform is made in the introductory chapter based on the following rationalities. First, irrigation development under the existing legal regime is not only inequitable as it essentially benefits the rich by usurping the water rights of the poor, but also responsible for the present state of pervasive water resource depletion and degradation. Secondly, the present water laws take no cognizance of the critical need for establishing prioritisation over various water uses like drinking and domestic use, irrigation, industrial needs, and other uses. A clear-cut prioritisation is crucial for minimising water disputes which are likely to increase as we rapidly approach a state of absolute water scarcity. Thirdly, the new requirements for sustainable development, i.e., development rooted in ecological security, economic efficiency, and social equity, necessitate the search for new and more relevant principles of water distribution and use. Fourthly, there exists a fundamental legal inconsistency as the existing water laws are consistent neither with the fundamental human rights enshrined in the Constitution nor with the requirements of land and forest laws. And, finally, but more importantly, the co-existence of a multiplicity of legal regimes with intersecting application domains (like the customary Hindu, Islamic, and tribal laws, British-made statutes, and post-independence laws emerging from the Constitution and the Directive Principles) as well as the lingering vestiges of colonial natural resources laws create an utter legal confusion.

Singh wonders how could the National Water Policy (NWP) of 1987 or, for that matter, the National Forest Policy of 1988 succeed in so far as the operative laws, rules, and administrative orders at the lower echelons of public administration are still rooted in the colonial laws like the Acquisition Act of 1894 and Forest Law of 1927 (p. 12). The author argues that even though our Constitution has provided a major charter for law reform especially those colonial ones that violate the fundamental rights guaranteed in the Constitution and Directive Principles via Article 13, the government is yet to undertake the law reform. Hence, the task of purging out the colonial vestiges in the area of water and other natural resources laws has barely begun (Pp. 12-13).

In order to establish the existence of such an entity called 'water right' and to delineate its true jurisprudential characteristics, chapter two attempts to shed light on the nature and sources of the ubiquitous legal notion of 'rights' in general. Rights can be categorised in terms of either their legal status (like natural or fundamental rights, constitutional and statutory rights, and customary rights) or obligation for their realisation (like positive rights and negative rights) or legal units (like individual or group rights). In general, most rights emerge from either one or more of the following sources: customs, individual or group contracts, constitution, statutes, and the very nature of being humans.

What kind of right is water right? Contrary to what most irrigation acts passed both during and after the colonial period presume, Singh establishes that water rights are essentially *natural negative claim* rights. Notwithstanding the fact

that the natural or fundamental character of water rights emerges mainly from basic needs like combating thirst and producing food, water rights are not absolute rights (i.e., rights without corresponding duties) but correlated rights (i.e., rights with corresponding duties to avoid misuse or wastage). While water rights customarily existed since the ancient times, their customary nature does not lead them automatically to be a contractual rights emerging from some form of social contract. For, any social contract should be preceded by a prior agreement on what constitutes a fair or just contract. But such fairness need to emerge from some principles of *natural* justice rather than from law which has to logically and necessarily follow from the social contract. This proves that water rights are natural rights rather than statutory/contractual rights.

Regarding the location of the legal obligation for their realisation, it is argued that water rights are certainly not positive rights in which the state has the obligation to realise the rights for the people (like the right to education or health) but negative rights where the state has the obligation to keep away so that the people can realise the rights for themselves (like the right to free speech or to choose profession). More importantly, from a legal point of view, a negative right cannot be a property or ownership right. In this respect, it is instructive to note that neither the *Dharmasastras* or Islamic laws nor the Roman or common laws ever mentioned water (including air, energy, and space) as a property of anyone including the king or ruler, but considered it to be common by the law of nature. Besides, in terms of Hohfeldian categorisation, water rights are shown to be claim rights rather than entitlements or deserts since all people have a natural claim over water in the same way as their claim over air to breathe which is independent and irrespective of their qualification or merit.

Although British legislations in India during 1859-77 recognised the natural negative customary rights, with the consolidation of political control, the advent of technology enabling large scale acquisition and control of water through dams, canals, etc., and the increasing requirements to augment revenue, subsequent colonial legislations tend to make water rights not only a positive and statutory right but also an *absolute right* of the state. The radical shift occurred with the Easement Act of 1882 which, though recognised customary rights, gave the absolute right to the state over all rivers and lakes. However, the absoluteness of state's right over water got full consolidation only with the Madhya Pradesh Irrigation Act of 1931 that continues to have its shadow over almost all Irrigation and Water Supply Acts enacted even in the post-independence period. The author notes that even while Articles 21 and 14 of our Constitution do permit the categorisation of rights as natural negative rights which have been, in fact, used in a number of recent public interest litigations to establish water rights as negative rights, there has not been any conclusive legal settlement as yet as to whether water rights are positive or negative rights.

Regarding individual vs. group or collective rights, Singh shows that the pre-capitalistic conception of group rights provided by customary laws continues to co-exist with the post-capitalistic notion of individual rights granted by statutory laws enacted since the British period. While the Limitations Act of 1859 presupposed group rights, the Northern India Canal and Drainage Act VIII of 1873 and the Bengal Irrigation Act III of 1876 implicitly recognised individual rights. Contrary to popular belief that group rights will become gradually insignificant with economic and social development, it is argued that group rights are as much relevant today as in traditional societies and modern law has to necessarily deal with them since the society has found new ways of grouping people based on economic and administrative means in addition to the usual social factors.

The evolution of the existing legal framework governing water rights as reflected in the customary, constitutional, statutory, and case laws and its implications for the state's *vis-a-vis* people's rights form the subject matter of chapter three. Although earlier British legislations and court judgements followed more or less the common law tradition in recognising customary rights, as the colonial legislations got tightly codified which is especially so after the Bengal Irrigation Act of 1876 and Land Acquisition Act

of 1894, the courts began to rely less on customs but more on statutes. The Easement Act of 1882 recognised only the customary *group* rights mostly on the basis of long use or customs or prescriptions. However, individual rights to both surface water and ground water resources were recognised only indirectly through land rights. For instance, the riparian water rights by which a person *owning land abutting upon a stream* could use the water without disturbing a similar benefit to other riparians were accepted as natural rights both by the Privy Council in 1932 and the Patna High Court in 1954. Notably, the riparian rights were recognised only in the case of natural streams, not in the case of artificial canals where rights can be obtained only by express grant or prescription. Thus, turning a river where water is freely available to all into a canal system and collecting fees from those under the canal command by the British amounted to the virtual privatisation of a common property resource (p. 34).

In the context of ground water resource, thanks to the 'dominant heritage' principle implied in the Transfer of Property Act IV of 1882 and Land Acquisition Act of 1894, a land owner can have a right to ground water as it is considered as an *easement* connected to the dominant heritage, i.e., land. Given such a connection between land and ground water, the laws asserted that the easement cannot be transferred apart from the dominant heritage. Instead of attaching ground water as a chattel to land property, Singh argues for the legal separation of the two in order to enable the landless also to have access to water. In this respect, *the Pani Panchayat* System being practised in parts of Maharashtra where water sharing is based on *needs* rather than land ownership which is calculated at about half an acre per person (not family) is shown as an alternative model for an equitable water rights system (p. 35). But for this people's law, the issue of water sharing criteria is conspicuous for its absence in statutory legislations in India. Since water falls in the state list by the Seventh Schedule (List II, Entry 17) of the Constitution, the ground water laws are to be enacted by the states. Unfortunately, no state has so far enacted any ground water legislation with the sole exception of Gujarat and even here, there is no separate law but only an addition of few sections to the Bombay Irrigation (Gujarat Amendment) Act of 1976 (1979) that limit tubewell depth to 45 metres, that too applicable to only one district! (p. 39).

Even though statutory irrigation laws continue to assert the absolute rights of the government, court decisions on water-related public interest litigations, especially in the recent years, tend to uphold the natural rights of the people. For instance, the Madras High Court in 1936 and the Bombay High Court in 1979 have established that government's sovereign rights do not amount to absolute rights. Regarding the right to water quality, the statutory laws starting from the Easement Act have provided for a *usufructuary* or *proprietary* right to pollute water subject to the restrictions provided in the Indian Penal Code and Criminal Procedure Code. In view of the ever growing magnitude of industrial pollution and the consequent ineffectiveness and irrelevance of the penal and criminal sanctions, the Supreme Court in 1980 has invoked a totally new principle derived from Article 21 of the Constitution (i.e., right to life and hence, to water and environment) that resurrected the people's natural rights to water quality. Interestingly, the same principle was also invoked by the Kerala High Court in 1990 when it upheld the rights of the residents of Lakshadweep Islands against the excessive ground water pumping by large farmers. These kinds of new interpretation of the Constitution or conflicting interpretations of existing statutes create an inchoate legal domain open for judicial activism for rectifying statutory laws and promoting the natural rights of individuals and groups (Pp. 38-39).

Chapter four attempts at a comparative overview of water laws in other countries focussing on their underlying legal models, comprehensiveness, and the extent of centralized control. As countries move from a state of plenty to that of scarcity, they evince an increasing tendency towards centralized control of water.[3] The Spanish Water Law of 1981, the Ethiopian Law of 1981, and the Jordanian Water Authority Act of 1983 as well as the water laws in many South American countries like Peru and Colombia have all declared water as a state property. While the

Chinese Water Law of 1988 contemplates a completely centralised water resource administration, both the Hungarian Water Law of 1964 and the Czech Water Act of 1973, though emphasise centralised control, allow independent local level decision-making. The interesting aspect of Czech Act is that it provides for the declaration of certain natural water accumulation as 'protected areas' and certain natural water zones as 'protected zones' with a view to conserve both water quantity and quality.[4] All the laws noted above require a water drawing permit or lease for all water uses excluding those for domestic and stocking purposes.

On the other hand, the British Water Act of 1989 as well as the US water laws go in the opposite direction of complete privatisation. In the US, at least four legal regimes governing water resources could be identified. While the riparian rights based on the common law doctrine are prevalent in the relatively water surplus eastern and pacific coastal states, the 'appropriative' rights based on the Colorado doctrine as well as rights emerging from the administratively issued water permits[5] are prevalent in the water scarce western parts of the US. Under the Colorado doctrine, the person who appropriated the water first from a natural stream has a *prior* right (i.e., prioritised right) to the extent of his original water appropriation and its beneficial use. Besides these rights on surface water, one could also add the 'correlative' rights system being used for ground water allocation in most western states of the US. Under this system, farmers' rights are determined in proportion to their farm area [Burness and Quirk, 1980, Pp. 120-121]. What makes the US legal system unique is the fact that all these rights are transferable as they are considered as property rights leading to the emergence of an expanding market for water rights [Saliba et al., 1987]. However, even in the US that upholds private property as sacrosanct, the idea of privatisation of water got a severe set back by the judgement of the California Supreme Court in 1987 which held that private property rights in water are not independent of environmental and public trust values by invoking a new principle of shared ownership based on the 'public trust' doctrine, the historical origin of which is traced to *Manusmriti* and *Arthasastra* (Pp. 49-50). When countries like the US and the UK including India have separate laws for surface water and ground water, countries like Spain, Hungary, and China treat water from both sources alike in their legislations. In the case of Czechoslovakia, Hungary, and France, the idea of integration goes a step further as their water laws incorporate in themselves also the land resource management issues. The legal system related to water in India representing a complex amalgam of both customary laws, colonial legislations, and modern post-independence laws is more comparable to that of most African nations like Nigeria than to those of the US.

Since the Indian water law is considered as a continuum from the past - both colonial and pre-colonial -, the basic features of the customary laws and their implications for modern laws are identified in chapter five. Singh notes that it is the customary laws, not the modern laws, which could support such notions and institutions identified by the Bruntland Commission as essential for achieving sustainable development like inter-generational equity, common title, inalienability, trusteeship, coexistence of mankind and nature, and balance between individual desire and communal obligations. A few significant common traits shared by most customary laws are: (i) recognition of communal rather than individual rights, (ii) origination from formal or informal religious and spiritual values, (iii) dynamic rather than dogmatic nature, and (iv) absence of transmissible or alienable property rights. On the negative side, most customary laws are imprecise both in spatial and qualitative terms and also uncertain as they are not based on any deeds. The author argues that the basic criticisms advanced against customary laws, i.e., they do not have any national obligations superior to the internal obligations of class or castes and they pave way for exploitation of other groups by the dominant groups, apply equally, if not more, to modern laws. One glaring instance here is the indifference shown by the states riparian to most of our river systems to the national or the non-riparians' interests. The author concludes that neither a water law that abolishes the people's water right and vests it with the state nor the one that considers water right as private property and

reduces thereby the role of the state is capable of solving the equity issues in the distribution of water (p. 59).

The jurisprudential basis of water rights and the principles of water distribution, the central issues of the book, are dealt with finer legal details in chapter six. As to the nature of water right, it has already been established in chapter two that it is a natural, negative claim right, not a statutory positive entitlement right. Regarding the issue of establishing priority over various uses of water, the author argues correctly that drinking purpose should get the topmost priority followed by domestic use, irrigation need, industrial use, etc. This prioritisation scheme is slightly different from the one suggested by the NCA where industrial use got the second priority and irrigation use got the third priority [GOI, 1976, p. 25] but very much similar to the one given in the 1987 NWP [see Dhawan, 1989, Pp. 222-223]. One could also argue for further prioritisation within each sector. For instance, since food caps the hierarchy of basic needs, water for food production should receive a higher priority than say, a commercial crop. This kind of finer intra-sectoral prioritisation of water use within the overall inter-sectoral prioritisation scheme suggested by the author is certainly possible and also desirable.

The author then examines seven principles of distribution focussing on their operational and equity implications for water rights allocation. They are: (a) 'finders-keepers' principle, (b) 'first-come first-serve' principle, (c) servitude or territorial sovereignty theory, (d) equitable apportionment theory, (e) equitable utilisation theory, (f) community of interest theory, and (g) 'public trust' doctrine. The principle (a) underlying the discovery doctrine and riparian doctrine, the principle (b) supporting the prior appropriation theory, and the principle (c) tacit in the 'dominant heritage' notion have all emerged from political power and geographical or historical accidents rather than from any basic principle of justice. We fully agree with the author that these traditional principles, some of which still continue to be used in inter-state water disputes in India and elsewhere, should be discredited as they are neither in conformity with the notion of justice nor generate any legally grounded principle of distribution. Of the remaining four modern principles, the basic legal unit in the case of the first two is the individual while in the case of the next two it is the group or community as a whole. All these four principles, unlike the former three, are consistent with some basic notion of justice.

Under the equitable apportionment theory that has its origin in the US court decisions, the water resources of say, a drainage basin (or aquifer) is apportioned in accordance with *needs*, not on merits, making, thereby, water rights a need-based claim right. Despite its intuitive jural appeal, it faces the problem of identifying an impartial adjudicator and the constant need for water reapportionment to cope with the dynamic nature of 'needs'. The equitable utilisation theory emerging from the Helsinki Rules of 1966 resembles very closely to the equitable apportionment theory but with the crucial difference that it does not necessarily require a third party adjudicator and allows bilateral negotiation. The principle tacit in this theory warrants that after having considered all relevant factors such as demography, economic requirements, availability of alternative water sources, and the compensation question, the water resources of an appropriate hydrogeological unit (basin or aquifer) is distributed equitably to ensure optimum water utilisation. Despite its different historical origin, the community of interest principle is shown as a specific version of the equitable utilisation theory when the term 'community' is defined to include all the participating parties (nations, states, or individuals). The formation of such a community of shared interest is necessary so as to replace the negative community presumed in the common law notion of *bonus vacans* (no one's property) and convert it into *public juris* (public property) for common use.

According to Singh, the public trust theory based on the Gandhian or *Dharmasastra* notion of trusteeship is the only genuine communitarian legal theory radically different from the other principles. The two critical jurisprudential implications of this theory are: (i) the state's title is interpreted as one of trusteeship or stewardship rather than ownership, and (ii) the state has an

absolute (natural) *duty* to act in the interests of the public (and that of ecology) since the people have an absolute (natural) right. Notably, under the public trust doctrine neither the duty nor the rights are compromised for each other (p. 76). However, sometimes the state has to take private property for 'public purpose'. This power is given through the principle of 'eminent domain' implied in Article 31A of the Constitution. Unfortunately, no legislation has ever defined 'public purpose'. Although the Mulla Committee's Report has listed various purposes that can be declared as public, it has not gone through the question of who is 'public', i.e., the rich or the poor, the original users or the new users, etc. The author, therefore, advocates an amendment to Article 31A to define 'public purpose' clearly and more importantly, to include, first and foremost, the interests of the original users in the term 'public'. In case the rights of the poor are subjected to the 'eminent domain' power, then, justice would demand a differential compensation as more is taken away from them in comparison to the rich.

In the concluding chapter, the author has outlined a legal framework for a water law conducive for sustainable utilisation of water both from the surface and sub-surface sources. The basic principles proposed by Singh for an equitable water law are (Pp. 95-97):

(1) The law should recognise the natural right to water of all people and living beings,
(2) If such a right is affirmed already, the preamble to the law should explicitly state that it intends to fulfill the right,
(3) The law should establish prioritisation over various uses of water in the following order: drinking water, domestic use, irrigation, industrial uses, etc.,
(4) The law must empower the state to acquire water resources for 'public purpose' but such acquisition should be only in the form of a 'public trust',
(5) The law should explicitly define 'public purpose' and the term 'public' must include first the original users among others,
(6) The law should provide for a differential compensation in proportion to the real loss of economic and livelihood options,
(7) The distribution principle should be based on equitable utilisation theory and consideration of basic needs,
(8) The term 'all concerned' should include ecology as well as the future generation,
(9) Given the legal requirement to create an equivalent ecological habitat to compensate for the ecological damage caused by any water project, the law should mandate the screening of all available technologies and the identification of the best one,
(10) The law should take an integral approach to water by considering cognate forest and land issues which could be best accomplished by incorporating a watershed or basin perspective, and
(11) To ensure that the law is internally integral, it should treat surface water and ground water in a holistic framework.

Since water is in the state list, it is the states that have to formulate and administer the water laws. This could create practical problems especially those emerging from the diversity and variations possible in the water laws of different states. One approach suggested by Singh to solve these problems is to transfer water either into the central list or into the concurrent list so that the centre could provide legislative leadership. Else, the centre has to content with its current advisorial role and continue with the formulation and circulation of model water bills which the states may or may not adopt. But, this advisorial role could not have any effect at all under the current constitutional division of power between the centre and the states. For instance, the Model Ground Water Bill of 1970 has not been adopted by any state so far and the same fate appears to await for the recently formulated Model Ground Water Bill of 1992.

There are two important appendices to the book-one gives the excerpts from various legislations related to water both during and after the British period and the other gives a synopsis of some 19 research themes in the realm of water law proposed to be undertaken by the Indian Law Institute, New Delhi under its Water Law and Policy project. Needless to say that almost all the

identified themes approach the water management issue essentially from a jurisprudential viewpoint. Although this reviewer is so far unable to obtain further information about these research works, it is hoped that they could provide a strong legal basis crucial for the establishment of an equitable water rights system in India.

4. Certain Economic Implications of Legal Principles

This well written book is a clear testimony for an urgent need for water law reform both to purge out the colonial vestiges as well as to make it relevant to the current and future socio-economic requirements of the country. Since lingering legal confusion especially over a critical resource like water is dangerous and costly, it is incumbent upon our policy-makers to come out with an unambiguous legal statement on water resources in the form of a comprehensive water law as early as possible. In this respect, the legal framework suggested by Singh appears to be a good starting point. Although the water rights system should be applicable to all uses, we find it particularly indispensable for irrigation use that accounts for about 70 percent of total water use in India.

The current constitutional division of power that assigns water in the state list does create serious political problems in legislating a water law with a rights system. The author's suggestion for a constitutional amendment to shift water into either the central or concurrent list, which is a difficult task in itself, could not, however, be expected to improve the prospect of water legislations and water rights system in view of the following reasons. First, even the centre itself is not immune to the very political forces that work against water legislations at the state level.[6] Secondly, even if the states are persuaded to pass water laws using either constitutional or financial leverages, it is the states, not the centre, that will have to ultimately establish and administer the rights system. And, thirdly, variations in the water requirements and hydrological potential and its composition across states could be better captured and reflected in the water laws enacted by the concerned states rather than by the centre. Since we believe strongly in the fact that, in the ultimate analysis, it is the economic compulsion rather than any legal compulsion which is going to move the states, there is an immediate need for researchers to venture into the political economy of water law and establish clearly the social benefits from instituting a water rights system as well as identify feasible institutional mechanisms necessary to make the system perform its economic role, i.e., providing incentives for water use efficiency and water conservation. This leads to the next issue, i.e., what is the vital economic requirement that the water rights system should satisfy apart from its legal characteristics discussed by Singh?

In order that the water rights system performs its economic function, the rights should necessarily be transferable or, at least, be amenable to a rental system. That is, under the rental provision, water rights can be rented in/out either in part or in full for shorter or longer durations. Without such a transferability or rental arrangements, there could not emerge a market to reflect the scarcity value of water through the pricing signal and guide water allocation accordingly. But transferability of rights and the resultant price mechanism could not be obtained without establishing first some form of ownership or user rights, if not property rights, system in the resource under consideration. For, what is not owned cannot be priced because prices are just the payments for property rights or rights to use an asset [Dales, 1968, p. 792]. Singh's position on the question of water rights transferability remains somewhat ambiguous. His assertion of water rights as natural or fundamental negative rights precludes ownership or property rights in water as he himself recognised (p. 26). Yet, both the *Pani Panchayat* model and equitable utilisation doctrine favoured by him (see Pp. 35 & 96) hinge critically on the assumption of water rights transferability. While one could agree that water for drinking and domestic use can qualify to be a fundamental human right, water for other uses need not have the same ethical qualification.

The equitable utilisation principle that establishes individual water rights either through an adjudicator or through bilateral negotiation aims at an "optimum or maximum utilisation of the resource" (p. 73). To show that transferability is

indispensable for ensuring optimum water utilisation, let us proceed as follows: the operation of the equitable utilisation principle (or any other distribution principle) can be visualised as a two-stage process. At the first stage, water rights of the individuals are distributed either through adjudication or through mutual agreement to establish the initial water endowment of individuals (or any other legal entities). And, at the second stage, the amount of water specified in the rights is used to obtain optimum utilisation. We note that the notion of 'optimum' cannot be identified without taking a recourse to economic principles which will naturally require us to consider notions like values and prices. In so far as the value of water differs across individuals, an optimum utilisation of the resource at a societal perspective could never be achieved without allowing water transfers at the second stage to equalise water values across individuals. Moreover, when the principle allows bilateral negotiations in the first stage of water rights distribution, why should it exclude the same in the next stage of water utilisation? The above arguments lead us to believe that transferability of rights is indispensable for realising the major aim of the equitable utilisation principle.

We can also argue that with transferable water rights, the final water allocation will be the same irrespective of the particular distribution principle used to establish the initial water endowment pattern. We perceive further that transferability of water rights is also necessary under the *Pani Panchayat* system. The equal sharing principle underlying the *Pani Panchayat* system allows water even for the landless persons. If water rights are not made transferable, then, the water distributed to the landless persons will not be of any economic significance either to themselves or to the society at large. Therefore, to promote economic equity rather than physical equity in water sharing, water rights need to be transferable and hence, they should be made as property or ownership rights. A point immediately connected to the issue of optimum water utilisation is the specific set of legal and economic relationships postulated between water and land. We do agree with the author that there should be a legal separation between land and water in order to enable even those without land to have an access to water. Else, water allocation will further reinforce the already existing land inequality with water inequality. But such a separation should end up at the stage of water rights distribution. At the utilisation stage, neither the legal separation nor the non-transferability issue should be allowed to undermine the economic linkages between land and water. Otherwise, it will not be possible to ensure efficient utilisation of both land and water resources. We note in passing that the equity issue addressed at the stage of water rights distribution and efficiency is ensured at the stage of water utilisation via transferability of rights. Therefore, the legal attribute of ownership and hence, transferability of water rights is critical from an economic viewpoint.

5. Current Ground Water Markets: A Legal Perspective

The issue of property rights in water leads us to an evaluation of the ground water markets as exist today in the light of the legal principles reviewed so far. An enormous amount of empirical literature on ground water markets focussing mainly on their efficiency and equity implications has emerged in the recent years.[7] It has been argued elsewhere [Saleth, 1991a] that given the absence of legally defined property rights in water, it is conceptually and theoretically incorrect to describe them as water markets. For, the market for any commodity could not emerge without a clear-cut property or ownership rights system for it in the first place. An undefined or ill-defined property rights system could never support the operation of an efficient market with its attendant price signal. When all writers on ground water markets do not fail to acknowledge that ground water is a common property or open-access resource, how could we still assert the existence of water markets?

To unearth the fundamental legal inconsistency and economic and social inequity underlying the currently observed water markets that have gone unnoticed in the literature so far, let us proceed as follows: even though we do not contribute to the view of ground water as an easement connected to land, let us take this view just for the

sake of pursuing the argument here. Then, from a legal perspective, ground water as an easement cannot be sold to make a profit. This is so because under the Easement Act of 1882, an easement right is meant essentially to gain certain conveniences but not to make any special profit which is possible only under the *profits a pendre* kind of right (see p. 31). However, the easement can be transferred along with the dominant heritage, i.e., land. Interestingly, the Model Bill of 1992 also takes a position similar to the Easement Act when it states that 'the small and marginal farmers will not have to obtain a permit if the well is proposed to be sunk for *exclusively personal purposes excluding commercial use*' (emphasis added) and the commercial use of water could be a ground for refusing permit to any user [GOI, 1992, Pp. 3-4]. Thus, we see that the non- profit requirement embedded in the easement-related notion of rights system appears to make water marketing a non-legal or extra-legal activity.

Under what kind of rights system, could we then support current water markets? A careful review of the water market literature reveals that it is based on an inadvertently presumed rights system specified by economic power, farm size, and technological edge rather than by any legal means. Under such a *de facto* rights systems, an individual's *potential right* over ground water is determined by his pumping capacity but his *actual* or *realised* right is determined by an interplay of pumping capacity, energy (electric power and diesel) availability, and ground water potential. Without digressing, we note that since the realised rights could actually be enhanced by the water selling possibilities provided other factors are not limiting, water marketing is itself a factor influencing indirectly the water rights system! Thus, under the *de facto* rights system underlying the observed ground water markets, the water rights of farmers are determined essentially by their economic ability to chase the water table [see Moench, 1992]. This kind of right system where water distribution is determined by economic power, historical priority, gall, and force resembles the rights system based on non-judicial principles such as the 'rule of capture', 'finders-keepers losers-weepers' or 'first-come first-serve', all of which are to be discredited from equity and social justice considerations. In this respect, we also note that current ground water regulations like well spacing and licensing norms tend to indirectly reinforce the prevalent *de facto* ground water rights system which is devoid of any legal sanction.

Their legal inconsistency apart, water markets actually foster inequity both from the legal and economic perspectives. To show this, let us contrast the functioning of water markets under the current *de facto* rights system against that under an alternative rights system, say a correlative rights system where water is distributed in proportion to land ownership (of course, after having allowed water also for landless persons). Assuming a strict enforcement of this alternative system, farmers can pump only a fixed amount of water as specified by their farm size. Under this condition, if at all a farmer wants to sell water, he could do so only through water saving effected via efficient use or non-use on his own farm. In contrast, under the *de facto* system, the well-endowed farmers could extract water over and above their own requirements infringing upon the water rights of those without land/well/pumpset and also make a profit by selling water at a price several times higher than the extraction and investment costs particularly to some of the latter groups whose water rights got affected by the sellers' activities. This means that the sellers expropriate either fully or partially the 'rent' emerging from the water rights of the buyers that should have gone legitimately to the latter under the assumed alternative rights system. In addition to its equity implications, the 'rent seeking' behaviour fomented by the water selling activities under the current rights system also precipitates ground water depletion [see Saleth, 1992a]. The ground water depletion has its own secondary equity dimensions. For one thing, when the benefits of such depletion go to the seller, its costs are borne by the buyers in the form of higher water prices in future and by the society in the form of a bursted agrarian economy. And for another, both the less-endowed farmers who fail to compete in the well deepening race and those relying on traditional water lifting technologies will eventually be crowded out of farm business.

Interestingly, the type of rights system postulated also has some conceptual and nomenclatural implications of crucial significance. The same phenomenon described as water markets by many researchers is viewed as 'rental markets for wells/pumpsets' by organisations like the National Council of Applied Economic Research (NCAER) and the National Sample Survey Organisation (NSSO) [NCAER, 1978; NSSO, 1984 and 1985]. This differential perception of both NCAER and NSSO can be explained by considering the kind of correlative rights system proposed by the NCA where ground water is shared in proportion to farm area and 'if a farmer constructs a private tubewell which yields more water than the share of his holding, then it should be possible for the farmers having contiguous holdings to avail of their shares of tubewell water on payment of share cost' [GOI, 1976, p. 23]. That is, on payment of just the pumping cost plus some form of annuity on the investment on well and pumpset, water can be obtained by a farmer under the rights system proposed by the NCA. We can also add that similar condition should also apply under common property arrangements in water where everyone has a right for the resource. In both cases, in so far as there is no payment for water *per se*, there can not be any water markets but only rental markets for wells/pumpsets.

It is instructive to note that the argument advanced in the literature that as the water prices approach the average pumping cost, the water markets tend to be competitive [see Shah, 1991, p. 341] actually amounts to the fact that the water markets under current rights system are essentially a transitional phenomenon tending ultimately (i.e., with increasing competition and the resultant dissipation of 'rent' from water selling) to rental markets for wells/pumpsets on which there exists clear-cut property or ownership rights. Importantly, when we ignore for a moment the private nature of wells/pumpsets and consider water from all sources as common property, then, from a metaphysical viewpoint, the basic principle underlying the water selling activity by a private farmer is not very different from that by a public tubewell or canal system. However, the latter activities are never called as water markets but just as public provision of water supply. The only distinguishing factor between the two activities is the private ownership of wells/pumpsets. Therefore, under a common property arrangement, there can only be rental markets for wells/pumpsets. Saleth and Thangaraj [1993] have noted that the existence or otherwise of a water market depends not only on the assumed property rights system but also on the institutional arrangements (public or private tubewell) and the nature of water supply source (ground water or surface water). We end up this section by reiterating that we are not against water markets *per se* but only against the water selling activities occurring under the present *de facto* water rights system. While water selling activities do have some efficiency and equity effects, they are insignificant as compared to both the fundamental inequity and depletion effects under current rights system as well as the potential efficiency, equity, and ecological effects possible under real water markets based on a well-established water rights system.

6. Towards a Water Institution: Requirements and Potentials

Water institution is concerned with the three inter-related aspects, i.e., water policy, water law, and water administration. Our ultimate goal is to move from water policy to water institution via water legislations. Fortunately, we do have a water policy in place right now. Despite its limitations, the NWP of 1987 does recognise the need for some upper limit on individual water withdrawals and use. However, the NWP has identified neither the mechanism by which such a limit will be established nor the institutions through which its three major planks, i.e., conjunctive use, supplemental irrigation, and water-saving technology and crop pattern, will be achieved. It is too naive to believe that these three critical goals could be realised through the usual credit and subsidy-based mechanisms identified in the NWP. Although the Model Bill of 1992 suggests a kind of water permit system particularly with an added proviso to alter the conditions of the permit including the amount of allowable water withdrawal, it has also failed to explicitly incorporate specific mechanisms to enforce

quantitative restrictions on water withdrawal. While the Model Bill does signify that we are moving marginally towards a water law, there is still a long way to go before realising a legal regime to establish transferable water rights system that could alone provide the economic incentives necessary to achieve the goals of the NWP. This does not, however, discourage us to look still ahead and explore potential administrative mechanisms and the *modus operandi* of a desirable and also technically and administratively feasible water institution.

While the tremendous net social benefit possible from a water rights system is very obvious, we should be realistic and pragmatic enough to appraise whether we do have the technical and institutional potential and capability to establish, enforce, and administer a water institution. At the outset, let us first dispel the commonly held belief that the absence of corporeal quality for and the fugitive character of water which are responsible for the emergence of spatial and temporal externalities present an insurmountable technical obstacle for defining a water rights system. But this view is incorrect as complete physical control over an object is not at all necessary for establishing a ownership system. For, ownership to an asset implies only a bundle of *circumscribed* user rights, i.e., it is rights never objects that are owned [see Coase, 1960, p. 44; Dales, 1968, p. 792]. It is this mistaken perception of an asset as a physical entity rather than a legal entity implying a bundle of user rights (with correlated duties) that militates against the technical feasibility of defining water rights.

The most important and immediate technical requirement for a water rights system is to establish water balance, i.e., the demand for and supply of water, for each appropriately defined hydrological unit. It is also crucial to disaggregate the demand by uses and supply by sources so as to establish the quantum of water and its sources for irrigation requirements. Moreover, uneven distribution of water demand and supply across regions requires the formation of 'water grids'- each representing a fairly uniform agro-climatic and hydrogeological unit-that could also provide a necessary structure to promote inter-basin water transfers suggested by the NWP. This calls for both economic and hydrogeological studies. While economic studies of the kind required in this respect are yet to emerge, the technical and institutional potential for ensuring sufficient progress in the hydrogeological field to establish basin and sub-basin-wise water balance is promising. A network of about 5,200 hydrograph stations spread throughout the country is currently involved in collecting and updating information on climate and precipitation, ground water pumping, and aquifer recharge [Pathak, 1988, p. 87]. This information forms the basis for the model ground water balance studies for selected areas being undertaken by the Central Ground Water Board in collaboration with the National Institute of Hydrology so as to identify the quantum of water that can be safely withdrawn [GOI, 1988, p. 109]. Our capacity to obtain still accurate information about the geological and hydrological characteristics of ground water aquifers will be strengthened further by the continuous progress both in the geohydrological technologies like electric drilling and isotopes as well as satellite and computer technologies [Cano, 1983, Pp. 20-21]. However, we do not fail to recognise the serious gap persisting in the current water balance studies, i.e., the economic aspects of water requirements and supply, which is critical for determining the amount of water available for distribution across uses and users. This gap should be filled so that the water balance studies could provide a strong hydrological and economic information base indispensable for establishing a realistic water rights system.

As to the *modus operandi* of the rights systems, three issues qualify for our immediate attention. They are: the unit of measurement, criteria for rights distribution, and mechanisms for enforcement and monitoring. An ideal unit of measurement will be the one that is independent of time and other spatial considerations. That is, it implies the same amount of water across time and space. This demands a volumetric measure rather than a flow-based measure. Let us also note that the suggestion of a volume-based measure is not new as it has been suggested long before by the National Irrigation Commission of 1972 and has

also been endorsed by the NCA. It is the volumetric measure that could provide the much-needed economic incentive not only for maximising output per unit of water instead of the usual practice of maximising water per unit of output but also for adopting water-saving technologies and crop pattern. The availability of water measuring technologies like the water meter makes the volume-based measure a technical possibility. It can be noted that the Model Bill of 1992 suggests the mandatory installation of water meters by the ground water permit holders [GOI, 1992, p. 8].

Regarding the criteria for water rights distribution, we note that in so far as water rights are transferable or amenable to a rental system, economic efficiency is independent of the criteria used since the final allocation of water is independent of initial distribution of water rights. This fact emerges from the familiar result of Coase [1960] that allocational efficiency in a private exchange economy is independent of the property rights system. However, from an equity or income distribution point of view, the choice of the criteria to be used for distributing water rights is a matter of utmost importance because water rights amount to economic assets. While one can think of a variety of approaches including a bidding procedure for rights allocation, here we consider two criteria. The criterion underlying the correlative rights system suggested by the NCA for ground water distribution is *land ownership*. Under the system, the available ground water in a basin, after having allowed for non-agricultural needs, will pertain to land and each holding weighted in terms of its soil quality and its access to surface water will have a legitimate right to a proportionate share of the water [GOI, 1976, p. 23]. Although this model relating water to land holding is appealing from water utilisation point of view, it has the deleterious effect of accentuating rural inequality by combining water ownership with land ownership as has been noted already. The *Pani Panchayat* model provides an alternative criterion by which all persons irrespective of land ownership get an equal share of water. We recognise the fact that when everyone owns land and farm sizes are equal, both the NCA and *Pani Panchayat* models will yield the same pattern of water rights distribution. From an extreme viewpoint, one can also argue for a water rights distribution which is in a reverse order of land ownership in order to counter the existing inequality in land ownership. Neither pretending to have the final answer nor ignoring the possibility of a host of more sophisticated approaches to this tricky issue, we can suggest a hybrid model where certain amount of water which is reserved for landless persons is apportioned in accordance with the *Pani Panchayat* model and the remaining is distributed among land owners in accordance with the NCA model. Another model that can be considered is the one in which the total water available for irrigation purpose is first theoretically distributed across the land owners via the NCA model and then, as a kind of progressive tax, the distributed water rights are proportionately reduced to form a pool for its subsequent distribution among the landless. The landless could augment their income by selling or renting out their water rights. While the government, as a trustee of the water resources, has the responsibility to establish an equitable water rights system, the enforcement and administration of the established rights system should be left to village-level or outlet-level groups. Such a decentralised mechanisms will be the effective means of enlisting people's participation in water management as the water rights system has now created a stake for their involvement. Irrigation cooperatives of various forms are not new to India [see Datye and Patil, 1987]. The major reason for the poor economic and organisational performance of these cooperatives is that in the absence of a water rights system to categorically specify individual claims, the economic and socio-political configurations tend to determine actual water use causing internal conflicts and tensions. Within the context of a water rights system, such cooperatives could certainly perform better than at present. This applies equally to the outlet-level user associations being experimented and promoted in the canal commands of various states [see Rankachari, et al., 1992]. Despite their weakness, the irrigation cooperatives and outlet-level user associations do indicate the existence of a fair amount of institutional potential at the grassroots level that could be tapped to

develop effective and flexible mechanisms for the enforcement and administration of water rights system. Given our farmers' familiarity with the turn-based canal water allocation under the *warabandi* and rotational water supply systems, the NCA has suggested a farmer-managed *warabandi*-type system even for ground water withdrawal. Notably, such a rotation-based system, if adopted within the framework of a water rights system, could avoid the peak-load problem emerging from the simultaneous ground water pumping by innumerable farmers. Since the rotation-based ground water withdrawal allows sufficient time for aquifer recharge, ground water depletion can be greatly minimized. We also add that to infuse some flexibility in the system, farmers can be allowed to exchange their turns through mutual agreement or even on a payment basis. Despite the absence of any declared water law specifying a water rights system, one can find evidence for the operation of rudimentary systems capable of being developed into an effective water rights system. In the case of South Indian irrigation system, Vaidyanathan [1985, Pp. 63-64] notes the existence of an informal prioritised water rights system where the rights are not for individuals but for different distributories and segments of the command area. The 200 year old *Phad* system operating in the Panijhra River area of the Dhule district and the *Pani Panchayat* system operating in the Mula command of Ahmednagar district, Maharashtra [see Datye and Patil, 1987, Pp. 42-123] have the potential for creating a farmer-managed water rights system. In the deltaic regions of Orissa and West Bengal as well as parts of Bihar and Madhya Pradesh, there exists an officially granted non- transferable long-term water lease system to encourage farmers to use surface water [GOI, 1976, p. 65]. More important and interesting of all is the *Shejpali* (water distribution roster) system being practised in the canal commands of western Maharashtra. Under this system, the canal authorities issue 'water passes' on the basis of an application from farmers in the command on a 'first-come first-serve' basis. The duration of these water passes varies from six years (or sometimes more) to a year or a crop season and there is a priority hierarchy among the passes that varies directly with their duration [see Gandhi, 1981; Rath and Mitra, 1989]. But for the non-transferability and quantitative specification of water, the water pass system resembles very closely the water permit system being practised in the mid-western US.

7. Concluding Remarks

The economic rationality and urgency for a water institution based on ownership rights in irrigation water are indeed very obvious. The legal case for a water law reform both to purge out the lingering colonial vestiges in the realm of water laws as well as to make them relevant to current and future socio-economic requirements of the country is inescapable from Singh's work. Our hydrogeological information base and technical skills which are bound to further enhance our capability with technological progress could certainly support a water rights system. The existence of an incipient system of rudimentary water rights in different parts of the country and the ability and maturity of our farmers to manage water allocation by themselves as revealed by the spontaneous emergence and growth of farmer-managed irrigation systems as well as water marketing activities do indicate that our farmers could adapt themselves to the institution of private property rights in water. The NWP of 1987 and the recent Model Bill, though leaving much room for improvement, do signify the movement of policy in the direction of a water rights system.

Although we are far away from it as yet, water rights system can no more be considered an utopian dream. Much economic research is urgently needed to move still further the political and policy thinking in India. The present status of water depletion and degradation casting a shadow over the very survival of our agriculture is a potent reminder for change. The desirable practices like conjunctive use, supplemental irrigation, water saving technologies, water transfers, and water recycling cannot happen in an economic vacuum. They need a strong economic incentive that could emerge only when an individual farmer perceives a water constraint which, in turn, can occur only with a water rights system. It is not time to

enumerate the administrative difficulties, technical snags, or political problems but to identify ways and means by which these problems could be managed to make an efficient and practical water institution a reality.

At least a part of the research money and effort currently allocated to the study of least effective institutions like water markets and regulatory mechanisms based on well siting and licensing, electricity tariff and supply, etc., should rather be invested both in exploratory studies on the various aspects of a water rights system as well as pilot schemes to experiment and field-test different water rights models. It is well to remember that even an imperfect water rights system has the ability to provide a more long lasting solution than a perfectly devised regulation implemented under imperfect institutions. Moreover, water rights system is one of rare policy instruments that can simultaneously address three goals: ecological security, economic efficiency, and social equity. While the ecology and equity could be taken care of at the stage of water rights allocation, efficiency could be achieved at the stage of water utilisation through the transferability of water rights. It is only the water markets emerging within the ecological and equity constraint specified by the water rights system that could provide the real economic incentive for water use efficiency and conservation.

The ultimate significance of a water rights system emerges from the following simple arithmetics. Even if it could succeed in effecting just a 10 per cent improvement in water use efficiency, i.e., instead of the officially assumed average water application rate of 0.67 hectare metre (ham), an application rate of 0.60 ham, we could add an additional 14 million hectares of irrigation potential even under the current level of water utilisation. Surprisingly, the additional irrigation potential emerging from water use efficiency is very close to what we have achieved in the VII Plan with so much of investment. Could we ignore the implications of this simple fact? If one still refuses to believe in the ecological, economic, and ethical need and necessity of a water rights system, we need then to resort to an emotional appeal by just repeating here one of the sentences with which Singh has ended up his book: 'what do we want to leave behind for our children and their progenies, utopia or hell? We may never attain utopia, but in the meantime we can at least strive for the best'.

NOTES

1. The presence of this kink emerging from an interplay of power supply, ground water conditions, and agronomic and economic factors makes the power consumption insensitive to tariff changes in so far as the tariff rates are fixed below the marginal value productivity of a unit of power. As a result, tariff-based regulatory mechanism becomes ineffective to control ground water depletion [see Saleth, 1993].

2. This system is not as new as it is claimed. For instance, Vaidyanathan [1985, p. 73] notes its introduction in North India in the late 19th century with full legislative and administrative support.

3. This trend appears to confirm the Wittfogel's theory that asserts the inherent tendency of hydraulic societies to become centralised, despotic states. A critical comment of this thesis is given in Vaidyanathan [1985].

4. In the immediate aftermath of the 1979 drought, a somewhat similar idea was mooted in India by the Union Ministry of Agriculture to establish 'ground water sanctuaries' where ground water will be extracted only during very dry years when other sources of water get completely exhausted [see Swaminathan, 1982, p. 88].

5. Although these permits are issued by the state administration, they enjoy legal sanction as the courts tend to uphold these administratively issued permits [see Ciriacy-Wantrup, 1956, p. 306].

6. In this respect, it is suffice to recall the centre's continuing inability to declare all river systems as national resources notwithstanding the need underlined repeatedly by growing inter-state water disputes of serious political proportion.

7. A selective review of recent water market literature is given in Shah [1991] and Athreya [1991].

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BOOK REVIEWS

P.G.K. Panikar, *Rural Household Savings and Investment: A Study of Some Selected Villages*, Centre for Development Studies, Trivandrum, December 1992, Pp. 114, Rs 50.00.

This book is primarily the report of a field study carried out from March to December 1986 in two villages each from Kerala and Tamil Nadu to gain some insight into the factors affecting the levels of saving of 445 purposively selected rural households and the pattern of its disposition during the calendar year 1985. The study was sponsored and financed by NABARD. When one considers the dates of field study and publication of the book, one wonders why it has taken the author six years to publish it.

The selection of the states, districts, villages and households was entirely purposive, because the main purpose of the study was not to obtain estimates at any level but to understand the saving behaviour of rural households. Hence the greater weightage given to comparatively better-off groups in the selection of households.

The Income Accounting Method and the Balance Sheet method were both used for working out the annual saving. However, the subsequent analysis of data showed that the latter method was more dependable. In fact, the saving estimates derived from the income accounting method were subsequently revised by asking the respondents to reconcile the discrepancy between the two estimates. The reconciliation process revealed that under-reporting of incomes by households was more important than over-reporting of expenditure for explaining the lower saving estimates from the income accounting method (p. 52).

The finally corrected estimates, which yield uniform levels of savings from the two methods (p. 50), show that the average saving per household varied between the four villages from Rs 402 to Rs 4,784, the corresponding variation in the saving-income ratio (average propensity to save) being 2 per cent to 24 per cent. After excluding the top income households (i.e., those whose income was between Rs 25,000 and Rs 50,000 in one village and above Rs 50,000 in the remaining three villages because their saving behaviour deviated from that of the majority of households), the marginal propensity to save varies from 0.42 to 0.73 between the villages. Saving as a proportion of asset value ranged from 0.15 per cent to 2.71 per cent. The proportion of households with positive saving varied from 54 per cent to 73 per cent, the variation in the household income class at which positive saving emerged being from Rs 7,500-10,000 to Rs 20,000 and above. The average income of positive savers as a multiple of the average income of dissavers ranged from 1.61 to 2.44. Thus, the level of income has been found to be a major determinant of saving, since more then 60 per cent of the variation in saving is explained by variations in income alone (p. 84).

How are savings disposed of? Physical assets (purchase of land, investment in buildings, consumer durables, livestock, implements & machinery for agriculture and household industry) account for bulk of the savings, varying from 49 per cent to 100 per cent in the four villages. Investment in jewellery accounted for 2 per cent to 43 per cent of the savings. Financial assets (bank and postal deposits, chit fund, etc.) shared the balance of saving, varying from 8 per cent to 40 per cent in three villages. In the fourth village (Chemmaruthy), there was a dissaving in financial assets to the extent of 85 per cent of the average total saving. It is interesting to note that "the proportion of financial assets seems to vary inversely with the total value of all assets" and that "the percentage share of financial assets among non-cultivator households is higher than that among cultivator households in three out of the four villages" (p. 33). Significantly, deposits with commercial banks appear to be the most important among the financial assets (excluding jewellery) in all villages, far more important than deposits with co-operatives (Pp. 31-32). In the absence of data on borrowings from different credit institutions, the reader is required to speculate on whether the borrowers of loans from co-operatives also preferred to keep their deposits with commercial banks and, if so, why. Incidentally, two other questions also arise in this context: Is it conceptually correct to treat gold and jewellery as a financial asset (p. 30 & Table 3.9)? Second, what is a deposit with "blade companies" (p. 30)?

Conceptually, the study differs from the CSO

and RBI estimates of household sector savings in that the former includes investment in consumer durables but excludes changes in cash holdings and inventories (p. 5) and natural increase in livestock (p. 58). The imputed cost of family labour has been treated as an operating cost for working out the net income from agriculture and probably also from business and household industry (p. 41), but since such imputed cost is retained income it should have been treated as part of household income. Whether this has been done is not clear.

A perusal of the book raises the following questions in the reader's mind:

(1) Estimates of annual savings disguise varying amounts of seasonal income surplus and its disposition.

(2) To what extent is the relatively low saving in financial assets properly explained by the nominal interest rates on deposits with credit institutions being lower than the return from physical investments? Further, to what extent is the saving behaviour and the pattern of saving influenced by the facility with which priority sector loans carrying concessional interest rates were available to rural households? For instance, investments like purchase of land and sinking of wells in violation of spacing and other norms, for which formal credit is not available, might have been indirectly abetted by easy access to institutional credit ostensibly for agriculture.

(3) Is direct investment in incremental plantation of tree crops included in the data on capital expenditure in farm business during the reference year? This doubt stems from the omission of the item from the description of survey methodology on p. 42.

(4) To what extent is the inter-village difference in the estimates of saving explained by the corresponding difference in prices used for the valuation of physical assets? In fact, the method used for such valuation has not been mentioned in the book.

(5) If the study did not aim at estimation, what useful purpose is served by presenting data on saving in fractions of a Rupee?

Notwithstanding these limitations, the book presents the results of the study and discusses some conceptual issues in a succinct and readable manner.

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and Currently Consultant,
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B.R. Sunthankar, *Maharashtra 1858-1920*, Popular Book Depot, Bombay, 1993, Pp. xx+684, Price Rs 400.00.

During more than half a century now the social (economic, political, literacy, etc.) history of Maharashtra has dug itself into a single deep groove with many romantic trappings, discouraging any new incisive analysis of it. The book under review is unexpectedly no exception to this established tradition. The book deals with Western Maharashtra only and not with Maharashtra as we know it today. The traditional groove consists of believing that there was a Renaissance and a Reformation *a la* Europe in the latter half of the nineteenth century and then weaving an account of the happenings and developments in the period around well known personalities who have become stereotyped in the course of years. Every author has naturally favourites among them and gilds these lilies more as compared with others. Generally the later the book is written in the period, increasing is the emphasis on the non-Brahmin and scheduled caste leaders. Sunthankar's book exhibits all these features.

I know that Sunthankar has been studying this subject for many, many years and has an enquiring mind accompanied by a meticulous eye for details and facts. I was, therefore, surprised to find that he was content to follow wonted path and not inclined to climb out of the time old rut. Not that this has not been done by some writers on the subject. Nearer home it was M.N. Roy, Sunthankar's mentor to judge by the books of Roy that he has translated into Marathi, who in the late thirties of this century declared that India badly needed a renaissance even then because it had not occurred before. Given this background I thought that Sunthankar would expose the shallowness

and superficial character of the so-called renaissance in Maharashtra. It would have been a singularly valuable service to tear away the romantic hanging that have developed round this topic during the last half a century. It is a great pity that he does not.

If he had taken a deeper look and a fresher view point he would have easily realised that the triumvirate of Ranade, Tilak and Gokhale, the three glowing products of the so-called renaissance to Maharashtra could not have visualised a secular state for independent India!

Turning to other matters, it is this triumvirate around whom Sunthankar's whole narrative revolves. And these three do not seem to suffer from any shortcomings. On the other hand he gives a long list of what V. Chiplunkar failed to see (Pp. 216-217). He could have realised, if he had the inclination that, for example, Tilak failed to see the rise of the non-Brahmin movement, that he took a wrong stand in the Vedokta controversy or that he merely fiddled with the problem of the untouchables, etc., etc.

Apart from the absence of such critical appraisal there are several places in this narrative where Sunthankar, usually very careful about facts and checking original sources, fails to maintain his own standard. There is no space here to go into all these but I shall content myself with giving one example only. This is in regard to Ranade's alleged pioneer role in starting a Swadeshi movement in India in the latter half of the nineteenth century.

Sunthankar writes: "At the end of 1872 and early 1873, Ranade delivered a series of lectures on economic progress and Indian impoverishment. In these lectures he strongly advocated the cause of swadeshi and urged his audience to use indigenously manufactured goods. The effect of these lectures was electrifying. A wave of swadeshi swept over Pune and the surrounding districts. Joshi [Sarvajanik Kaka] was so much impressed by these lectures that he abandoned using foreign cloth and used only swadeshi cloth for the rest of his life" (p. 122).

On p. 536 the same is repeated with a little variation. "The credit for generating a popular and organised movement of swadeshi in the 1870s goes to Ranade. Two lectures delivered by Ranade in Pune in 1872 on swadeshi under the auspices of the *Vaktritvottejak Sabha* were so persuasive and effective that they set in motion a popular and organised movement, which foreshadowed the Swadeshi Movement of later years" (p. 536).

Let us see how many factual and interpretative untruths these statements confirm. It is possible to do this because these two lectures of Ranade were published in the *Lokakalyanechitre* newspaper at that time and published in a book form by the manager of that paper after getting them corrected by Ranade himself, a total of 63 printed pages of demi size. These were reprinted in 1963 by the Gokhale Institute of Politics and Economics, Pune, and are still available. First, it was not a series of lectures, as stated in the first quotation cited (p. 122), but only two delivered with almost a three month interval in between. Secondly, they were delivered to, and under, the auspices of the *Poona Vyapar Company* and not that of the *Vaktritvottejak Sabha*. Thirdly, the subject of the lectures was not Swadeshi but mainly the foreign trade of India and the tribute that India had to pay to Great Britain every year. The idea of Swadeshi was only indirectly and tangentially referred to and did not get even a paragraph. There is also no avert plea for Swadeshi. Fourthly, the audience of these lectures, considering the places where they were held, could not have exceeded fifty. To say that this started a movement of swadeshi is very economical of the truth. Fifth, Joshi (Sarvajanik Kaka) took the oath of swadeshi in 1809, fully three years before Ranade delivered these lectures and was very active in that cause since them. He did not and need not have taken his inspiration from Ranade. I suspect that Sunthankar has not possibly seen the original lectures and has relied on secondary sources in this regard.

It is of course commendable that Sunthankar has painstakingly compiled this study after years of reading and reflecting. I only wish it had not these shortcomings.

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ANNOTATED INDEX OF BOOKS AND ARTICLES IN INDIA

EDITOR'S NOTE

These abstracts are prepared by the author of each book/article sent to us voluntarily in response to our invitation through the Economic and Political Weekly. These cover publications after 1st January 1986. Only abstracts of books/articles so received are published. The index therefore is not exhaustive and complete.

The limit of 250 words and 100 words for abstracts of books and articles respectively is strictly enforced. Only a minimum amount of copy editing is done in order to bring the abstracts within the prescribed limits. The readers should approach the author of the abstract, not this Journal, for any clarifications.

BOOKS

1992

Jandhyala B.G. Tilak: *Educational Planning at Grassroots*. New Delhi: Ashish Publications, 1992.

This book is on micro level planning in education in India. The study describes the importance of and trends in micro level planning in education along with a conceptual discussion and framework of study of micro level planning in education; it starts with a discussion on educational development in Haryana, identifies Gurgaon district; presents an exercise on district level planning in education in Gurgaon; identifies a developed and a backward block (Sonhna and Punhana) and examines the education situation in the two blocks; forms an education cluster in each block, and attempts at educational planning at cluster level. Besides it presents a large set of estimates on costs of education by levels in two education clusters and at district and block levels. The main contribution of the study is that it demonstrates that educational planning is feasible and desirable at micro level. For this purpose a cluster approach is adopted around a high school in each cluster. The study also identifies all the educational, para educational and other infrastructural facilities that are available within and outside the education sector in the area, and examines how they can be used for educational development.

1993

Dhawan B.D., *Indian Water Resource Development for Irrigation: Issues, Critiques, Reviews:* Commonwealth, N. Delhi, 1993, p. 277, Price Rs 325/-.

The book consists of 20 chapters divided into two parts. The twelve chapters in Part I deal with some important aspects of the present state of Indian irrigation alarming concern about which has been expressed by the World Bank in its recent, second report on the Indian irrigation sector. The eight chapters in Part II are essentially reviews of major reports, studies and documents released in recent years on the subject of water resources, water and irrigation planning, and irrigation research in India by bodies like INTACH, CSE and ICSSR.

The contents of this volume are already published, mostly during 1990-93, in two academic journals, some semi-academic periodicals like

Economic and Political Weekly, and in one economic daily *(Financial Express)* and in one monthly magazine *(Facts For You)*. Basically these writings were addressed to the general reader with keen desire to understand issues and problems pertaining to water resource planning in India. The big dam issue crops up in several places. The raging controversies on Tehri and Narmada dams are commented upon at length. Unreliability of minor irrigation works during drought years is underlined with the help of a fresh set of data. A critique of Indian irrigation in the Eighth Plan is provided.

Mukherjee Neela: *Participatory Rural Appraisal: Methodology and Applications*, Concept Publishing Company, 1993, New Delhi-110059, Pp. 160.

This book presents the principles of Participatory Rural Appraisal (PRA), its methods applied in field situations and selected field experiences in applications of PRA in India and some other countries of the South. The book consists of four chapters in which the first chapter provides a short introduction to the logic of participation and the methodology of PRA, its significance, principles, foundations, kinds and origin. The second chapter analyses the indigenous knowledge sources and discusses the different participatory methods in the light of field experiences. The third chapter describes applications of PRA in the areas of (i) poverty and well being, (ii) rural women and (iii) health. The fourth chapter illustrates some policy measures flowing from such applications, discusses the limitations posed to the use of PRA and the opportunities which PRA offers as a participatory methodology.

The book is meant for planners, policy makers, administrators, NGOs, academicians, scientists, researchers and others engaged in research, planning, policy-making, methodology and practice of rural development.

ARTICLES

1992

Jandhyala B.G. Tilak and N.V. Varghese: 'Discriminatory Pricing in Education'. *Journal of Education and Social Change*, 6 (1) April-June 1992, Pp. 43-67.

The attempt of the paper is to explore the possibilities of moulding the fee as a potential instrument of (a) mobilisation of additional resources, and (b) preventing perverse effects of the public subsidising system. It is argued in the paper that a system of discriminatory fee structure can achieve the twin objectives. The suggested model of discriminatory pricing system, along with a discriminatory incentive system, is based on sound principles of taxation in public finance. Specifically, the argument of the present authors is based on (a) cost of education, (b) paying capacity of the direct beneficiaries of education and (c) the rewarding pattern.

Jandhyala B.G. Tilak: 'Public and Private in Education in India', in: (R.F. Arnove, P.G. Altbach, and G.P. Kelly Eds.). *Emergent Issues in Education: Comparative Perspectives* (SUNY Series in Frontiers in Education). NY: State University of New York Press, 1992, Pp. 173-85; notes: 331-34.

The paper examines household expenditure on education in India and the role of private corporate sector in education. The role of the private sector assumes significance in the present context of economic austerity all over the world. The paper

begins by discussing the need for "mixed" (public and private) support for education, and presents a detailed discussion on household expenditure and the role of private enterprise in education. It has been shown that families invest considerable amounts of resources in education, and that the private corporate sector's contribution is significant neither in terms of finances, nor in terms of socio-economic equity in India. All this leads one to be skeptical on the widely suggested proposal of privatisation of education.

Jandhyala B.G. Tilak: 'Education, Health, Nutrition, and Demographic Changes: A Review of Evidence on Asia', *Indian Journal of Labour Economics*, 35, (2), April-June 1992, Pp. 113-22.

The paper presents a review of the role of education in improving health, nutrition and in influencing mortality and growth of population. On the basis of the experience of the Asian countries as well as review of the literature concerned, the author empirically finds statistically significant effect of education on improving child survival, and health conditions in Asian countries. The effect of education on fertility and population growth is also found to be quite significant.

Jandhyala B.G. Tilak: 'Student Loans in Financing Higher Education in India', *Higher Education* 23 (4) (June 1992) (Ed. M. Woodhall), Special issue on 'Student Loans in Developing Countries' Pp. 389-404.

Confronted with declining public budgets for education on the one hand, and the need for more resources on the other, many developing countries such as India, have been examining alternative methods of financing higher education. One such mechanism is student loans. A student loan programme is not a new phenomenon in India. The National Loans Scholarship Scheme has been in operation since 1963. The paper critically reviews the experience of implementation of the Scheme. It examines the strengths and weaknesses and problems specific to the programme in India, with a view to identifying measures for improvement. The conclusion is that at present student loans make little contribution to either the efficiency or equity in higher education in India.

1993

Jandhyala B.G. Tilak: 'Financing Higher Education in India', in Suma Chitnis and Philip G. Altbach, (Eds.), *Higher Education Reforms in India*, New Delhi, Sage Publication, 1993, Pp. 41-83.

Few significant reforms have taken place with respect to financing higher education in India. But of late, there has been considerable thinking on various issues relating to financing higher education. The policy suggestions that are being made to experiment with alternative methods of funding higher education under the broad umbrella of "privatisation". Specific suggestions made in this context include student fees, student loans, graduate tax, and privatisation in general. The paper critically analyses the pattern of funding higher eduction during the post-independence period, and discusses the pros and cons of the various alternatives available to augment additional resources for higher education, including various forms of privatisation.

Jandhyala B.G. Tilak: 'Investment in Education in East Asia', *The ASIAN Economic* (Singapore), 9 (3), March 1993, Pp. 301-22.

With the help of the most recent data compiled from a variety of sources, this paper presents a brief comparative educational profile of ASIAN

countries, other developing countries and developed countries of the East Asian region. It attempts to present a holistic picture of the region, without at the same time ignoring the inter-country differences. Concentrating on financial conditions in education, the paper analyses the investment in education, priority given to education in the national economies, intra-sectoral priorities, the unit costs, and the present mechanisms of funding education, including the role of the private sector in the same.

The Journal will publish in each issue Annotated Bibliography of Books and Articles on Indian Economy, Polity and Society, published after January 1, 1986. Authors are requested to send their entries with full details of publication and annotation not exceeding 250 words for books and not exceeding 100 words for articles. Use separate sheet for each entry.

INDIAN JOURNAL OF AGRICULTURAL ECONOMICS

Vol. XLVIII	APRIL-JUNE 1993	No. 2

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Annual Subscription Rates

Individual Membership Fee: Rs. 100.00; £ 25.00; $ 35.00.
Institutional Subscription: Rs. 200.00; £ 40.00; $ 50.00.

Please address correspondence to the Hon. Secretary & Treasurer, The Indian Society of Agricultural Economics, 46-48 Esplanade Mansions, M.G. Road, Bombay-400 001 (India).

Journal of Educational Planning and Administration

(ISSN 0971-3859)

Editor: Jandhyala B.G. Tilak

Volume VII Number 1 January 1993

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Volume VII Number 2 April 1993

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National Institute of Educational Planning and Administration
17-B Sri Aurobindo Marg, New Delhi 110 016

FORM IV

(See rule 8)

Statement about ownership and other particulars about newspaper (Journal of Indian School of Political Economy) to be published in the first issue every year after the last day of February.

1. Place of Publication:	'Arthabodh' 968/21-22, Senapati Bapat Road, Pune 411 053.
2. Periodicity of its publication:	Quarterly
3. Printer's Name Nationality: Address:	R.M. Honavar Indian 'Arthabodh', 968/21-22, Senapati Bapat Road, Pune 411 053.
4. Publisher's Name Nationality: Address:	R.M. Honavar Indian 'Arthabodh', 968/21-22, Senapati Bapat Road, Pune 411 053.
5. Editor's Name Nationality: Address:	V.M. Dandekar Indian 'Arthabodh', 968/21-22, Senapati Bapat Road, Pune 411 053.
6. Names and addresses of individuals who own the newspaper and partners or shareholders holding more than one per cent of the total capital:	Indian School of Political Economy, 'Arthabodh', 968/21-22, Senapati Bapat Road, Pune 411 053.

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Date: October 1, 1993

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