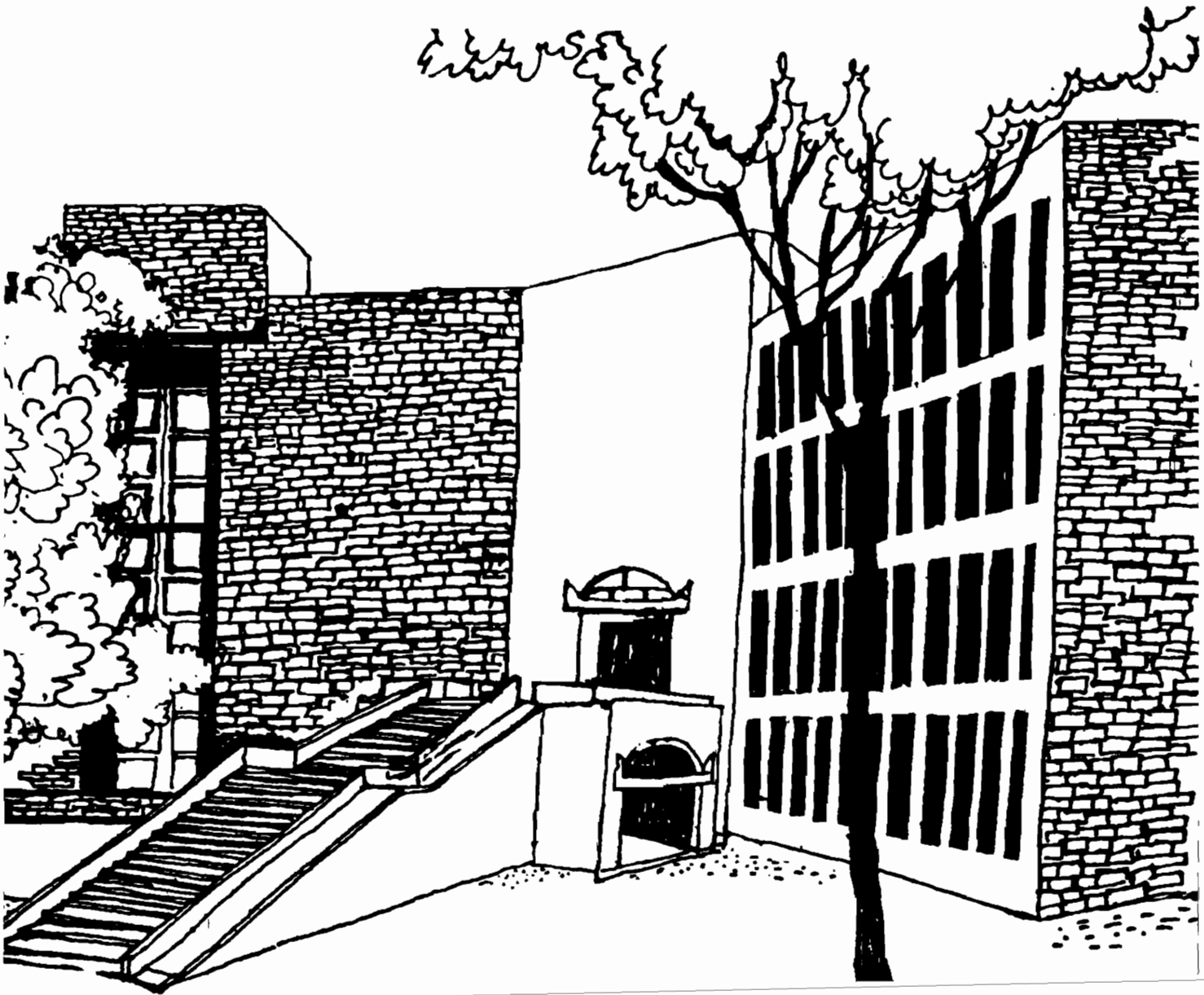




विद्याविनियोगादिकारः

IIT
AHMEDABAD

Working Paper




**PROFILE AND IMPACTS OF
TRACTORIZATION**

By

N.T. Patel
(Research Associate)

Madalsa Gandhi
(Research Assistant)

WP1305

WP
1996
(1305)

W.P. No. 1305
April 1996

The main objective of the working paper series of the IIMA is to help faculty members to test out their research findings at the pre-publication stage.

**INDIAN INSTITUTE OF MANAGEMENT
AHMEDABAD-380015
INDIA**

PROFILE AND IMPACTS OF TRACTORIZATION

N.T. Patel Madalsa Gandhi*

**Centre for Management in Agriculture
Indian Institute of Management, Ahmedabad**

INTRODUCTION

The success of farming depends upon how specifically the requirement of timely field operations are met. It is therefore, necessary that the requisite type of agricultural tractors and other farm equipments are incorporated in the farming system. The use of tractors on farms has resulted in increased demand for labour on mechanised farms and in agro-based industries. India has achieved self-sufficiency in producing tractors, as the total requirements of tractors is met by their domestic production. Exports of tractors and pumps to other countries have also emerged in recent years.

INDIAN AGRICULTURE AND TRACTORIZATION THRUSTS

The importance and utility of tractors was less known in early years of independence, therefore, demand for tractors in agriculture was negligible. The use of tractor in agriculture drew more importance during on set of green revolution.

In 1950-51, the total number of tractors was only 9,000 accounting for seven tractors per 1 lakh hectare of gross cropped area. In 1960-61 the number of tractors increased to 31,000 accounting for twenty tractors per 1 lakh hectare of gross cropped area. All these years, tractors were imported from different parts of the world. The demand for tractors in agriculture gradually increased but the level was significantly low to develop tractor industry in India.

* The authors are thankful to Professors B.M. Desai and Vasant Gandhi for their valuable suggestions and comments.

Trend in Import of Tractors

In 1951 and 1952, Government of India had given licences in an ad-hoc manner to import tractors in India. The imports of tractors were easily allowed up to 1956. In 1957, the foreign exchange position of the country deteriorated. So, the liberal import of tractors was stopped, but the small number of tractors were allowed from time to time. The imports of tractors were made through State Trading Corporation (STC) from Russia and Czechoslovakia. Tractors were allowed to be imported by established importers who were agents of manufacturers of tractors to be imported. In 1959, the quota licences to these established importers were stopped.

The data on the import of tractors in terms of quantity from 1961-62 to 1986-87 and in terms of value from 1969-70 to 1986-87 are presented in Table 1.

On the basis of these data, the rates of growth of import of tractors in quantity and value terms are shown in the following equations:

(1) Import of Tractors in Terms of Quantity

$$\text{Log } y = 9.891 - 0.2639 t$$

$$(0.041)^*$$

$$R^2 = 0.635 \quad N = 26$$

$$\text{Growth Rate} = -23.20 \text{ per cent}$$

(2) Import of Tractors in Terms of Value

$$\text{Log } y = 7.673 - 0.2215 t$$

$$(0.041)^*$$

$$R^2 = 0.641 \quad N = 18$$

$$\text{Growth Rate} = -19.87 \text{ per cent}$$

*Figures in parentheses are standard error of the coefficient.

Table 1 : Total Import of Tractors

Sr.No	Year	Import of Tractors	
		Number	Value (Rs.lakh)
1	1961-62	2997	NA
2	1962-63	2616	NA
3	1963-64	2349	NA
4	1964-65	2323	NA
5	1965-66	1989	NA
6	1966-67	2591	NA
7	1967-68	4038	NA
8	1968-69	4276	NA
9	1969-70	NA	1434.48
10	1970-71	16031	2078.83
11	1971-72	13327	1629.52
12	1972-73	4782	867.91
13	1973-74	1000	NA
14	1974-75	1261	348.03
15	1975-76	635	474.13
16	1976-77	4363	1643.48
17	1977-78	98	439.92
18	1978-79	9	32.92
19	1979-80	923	677.25
20	1980-81	31	184.48
21	1981-82	22	60.37
22	1982-83	26	46.03
23	1983-84	23	62.06
24	1984-85	123	226.07
25	1985-86	5	19.22
26	1986-87	10	73.02

- Source: 1. Shekhar Chaudhari, "Acquisition and Assimilation of Technology in the Tractor Industry in India: The Strategic Perspective", A dissertation submitted in partial fulfilment of the requirements for the FPM of the IIM Ahmedabad (for 1961-62 to 1968-69 data).
2. Monthly Statistic of the Foreign Trade of India (various March issues)

The number of tractors imported was 2997 in 1961-62 and 1989 in 1965-66. It continuously declined during this period of five years. But because of green revolution, the demand for tractors has increased dramatically. Hence, Government of India allowed import of huge quantity of tractors from the rupee payment countries during the period from 1966 to 1972. Consequently, the number of tractors imported was 2591 in 1966-67 which registered 30.27 per cent rise over the import of previous year (1989 tractors). There was significant rise in the import of tractors from 2591 in 1966-67 to 16031 in 1970-71 which indicates an increase of 5 times.

Since 1972 to meet the increasing demand for tractors and to make the country self-reliant in manufacturing of tractors, Government of India tried to reduce the import of tractors. As a result, the import of tractors declined by 64.12 per cent in terms of quantity and 46.73 per cent in terms of value during the year 1972-73. In 1973-74, the imports further declined; it being 79.09 per cent. During 1976-77, because of sudden increase in import of tractors from Yugoslavia, by about 50 times, the total import of tractors from all countries together increased by 587 per cent in terms of quantity. But in 1977-78, the import of tractors from Yugoslavia again declined by 98.77 per cent in terms of quantity. Hence, the total import of tractors from all the countries combined went down by 97.75 per cent in quantity during this year.

Since 1977-78, the import of tractors in India fluctuated though its overall trend remained downward. The total import of tractors in India was only 5 in 1985-86 and 10 in 1986-87. Since 1987-88 the import of tractors was totally stopped as the country had sufficient domestic production.

Direction of Imports of Tractors

According to the data presented in Table 2, in 1969-70 tractors were imported from 14 countries, which in 1970-71 declined to 12 countries. The number of tractors imported from USSR, Czechoslovakia and Canada together accounted for 62.37 per cent of total imports. In terms of value, U.K. Czechoslovakia and Poland combined accounted for 57.37 per cent in 1970-71.

Countries		Imports of Tractors in																	
		1969-70		1970-71		1971-72		1972-73		1974-75		1975-76		1976-77		1977-78			
		Qty.	Value	Qty.	Value	Qty.	Value	Qty.	Value	Qty.	Value	Qty.	Value	Qty.	Value	Qty.	Value		
Czechoslovakia	NA	203.56	3247	385.08	1000	115.67	756	85.22	324	123.65	1	0.45	-	-	-	-			
Japan	NA	0.37	2	0.52	52	13.05	30	4.55	11	13.08	41	92.67	1	0.15	3	37.14			
U.K.	NA	117.54	2845	449.53	3039	382.10	965	304.65	182	43.00	28	36.07	21	75.55	4	13.16			
U.S.A.	NA	166.08	81	14.64	259	117.63	136	52.22	49	19.84	41	24.85	7	47.11	23	97.05			
U.S.S.R.	NA	374.00	3621	245.13	3743	370.26	625	48.33	17	23.18	411	119.98	-	-	7	16.64			
Kenya	-	-	-	-	-	-	-	-	2	0.16	-	-	-	-	-	-			
Yugoslavia	NA	149.63	874	142.73	826	102.31	153	20.55	648	120.32	84	192.60	4318	1517.09	53	263.21			
Australia	NA	1.09	-	-	9	0.88	1	0.11	27	4.59	2	2.58	2	1.62	3	2.23			
Germany	NA	201.25	149	63.71	20	13.97	252	86.39	1	0.21	27	4.93	3	0.28	1	0.63			
Italy	-	-	2	2.64	-	-	-	-	-	-	-	-	1	0.06	-	-			
Bulgaria	NA	34.54	335	77.66	-	-	-	-	-	-	-	-	-	-	-	-			
Poland	NA	0.39	3131	358.07	4359	511.45	1004	110.81	-	-	-	-	4	0.77	-	-			
Roumania	NA	117.98	1743	338.87	-	-	600	118.25	-	-	-	-	-	-	-	-			
Singapore	NA	0.69	1	0.25	-	-	-	-	-	-	-	-	-	-	-	-			
Netherlands	-	-	-	-	-	-	260	36.83	-	-	-	-	-	-	-	-			
Switzerland	NA	1.21	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
Hungary	NA	6.15	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
Canada	-	-	-	-	20	2.18	-	-	-	-	-	-	6	0.85	4	9.86			
Sweden	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
Total	NA	1434.48	16031	2078.83	13327	1629.52	4782	867.91	1261	348.03	635	474.13	4363	1643.48	98	439.92			

.... cont'd.

Countries	Imports of Tractors in																			
	1978-79		1979-80		1980-81		1981-82		1982-83		1983-84		1984-85		1985-86		1986-87			
	Qty.	Value	Qty.	Value	Qty.	Value	Qty.	Value	Qty.	Value	Qty.	Value	Qty.	Value	Qty.	Value	Qty.	Value		
Czechoslovakia	-	-	754	184.66	-	-	-	-	-	-	-	-	2	6.73	-	-	-	-	-	
Japan	-	-	1	0.60	14	91.82	2	8.57	-	-	1	0.29	-	-	-	-	-	-	-	
U.K.	3	16.24	102	400.00	6	13.85	8	24.00	-	-	3	6.39	-	-	-	-	-	-	-	
U.S.A.	-	-	44	69.78	2	13.89	-	-	-	-	10	33.45	-	-	5	19.22	9	70.16	-	
U.S.S.R.	-	-	22	22.21	9	64.92	12	27.80	-	-	1	0.52	-	-	-	-	-	-	-	
Kenya	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Yugoslavia	-	-	-	-	-	-	-	-	10	15.45	-	-	-	-	-	-	-	-	-	
Australia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Germany	-	-	-	-	-	-	-	-	-	-	7	19.47	4	38.23	-	-	1	2.86	-	
Italy	1	0.13	-	-	-	-	-	-	-	-	-	-	115	170.02	-	-	-	-	-	
Bulgaria	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Poland	1	0.47	-	-	-	-	-	-	-	-	1	1.94	-	-	-	-	-	-	-	
Roumania	1	4.16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Singapore	1	0.11	-	-	-	-	-	-	16	30.58	-	-	-	-	-	-	-	-	-	
Netherlands	-	-	-	-	-	-	-	-	-	-	-	-	2	11.09	-	-	-	-	-	
Switzerland	1	0.11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Hungary	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Canada	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Sweden	2	11.81	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Total	9	32.92	923	677.25	31	184.48	22	60.37	26	46.03	23	62.06	123	226.07	5	19.72	10	73.02	-	

Source: Compiled from various issues of Monthly Statistics of the Foreign Trade of India, March

In 1971-72, the market for the import of tractors was reduced from 12 to 10 countries. During this year the import of tractors from Czechoslovakia and Germany declined by 69.20 per cent and 93.29 per cent respectively. But it increased by 6.82 per cent, 219.75 per cent and 33.22 per cent from U.K, USA and Poland, respectively. Nonetheless, the share of USSR and Poland together in the total imports remained high at 60.79 per cent.

In 1972-73, Government of India changed its strategy towards indigenous tractors which in turn reduced the imports. The import of tractors went down significantly, from almost all the countries, except Germany. From UK, USSR, and Poland, it reduced by 68.25 per cent, 63.30 per cent and 76.94 per cent respectively. In 1974-75 the tractors were imported from nine countries, but the share of Yugoslavia alone was 51.39 per cent of total imports.

In 1975-76, the number of tractors imported from USSR was 411 which was 64.72 per cent of total imports.

In 1976-77, the import of tractors from USSR went up by 23 times and that from Yugoslavia went down by 0.87 times. But Yugoslavia accounted for 98.97 per cent of total imports.

In 1977-78, the total imports was 98 tractors from eight countries. But Yugoslavia alone accounted for 54.08 per cent. The number of tractors imported from USA was the second highest.

Since 1978-79 (except for 1982-83), the import of tractors from Yugoslavia was totally stopped.

During 1980-81 and 1981-82, tractors were largely imported from Japan and USSR. But in 1982-83, most of the tractor imports were from Singapore and Yugoslavia.

Since 1983-84 the import of tractors was totally stopped from Yugoslavia and Singapore. USA and Germany together constituted 73.91 per cent of total imports.

In 1984-85 about 93.50 per cent of the total imports was only from Italy. In 1985-86, all the five tractors imported were from USA only. In 1986-87, out of ten imported tractors, nine were from USA and one was from Germany. The history of import of tractors ended in 1986-87, as no tractor has been imported thereafter.

INDUSTRY PROFILE

Before independence Volkart Brothers have first introduced tractor in India in 1920. There are about 19 licensed tractor manufacturing companies. But out of them only eleven companies were producing tractors in 1990-91. A brief profile of seven of these companies is discussed below.

Mahindra and Mahindra Limited (MML)

MML was founded in 1945. Responding to the call of "Green Revolution" through mechanised farming in the year 1963, International Tractor Company of India Limited (ITCI) was formed in technical collaboration with International Harvester Company of Great Britain and Voltas Ltd. to manufacture international range of tractors and implements. The first production of tractor was started in 1965 with B-275 model (35 HP). In 1978, ITCI merged with the parent company MML

MML is the largest manufacturer of tractors in India. This company manufactures seven different models of tractors, namely, Mahindra - 255 of 25 HP, Mahindra B-275 of 35 HP, Mahindra - 595 of 50 HP, 225 - DI of 25 HP, 265 DI of 25 HP, B - 275 DI of 35 HP, and 575 - DI of 45 HP capacity. The other four models are 444-MICO, 444-CAV, 350-DI and 450 - Exp. The model 450-Exp is meant for export only.

Capacity and Production

In 1959 company's production capacity was 3500 tractors but, due to increase in the demand for tractors, the Government of India (GOI) allowed the company to increase production capacity in two stages of 3500 and 3000 tractors per annum in 1964-65. In 1970 the production capacity of the company rose to 10000 tractors per annum and

in 1973 the GOI permitted the company to increase its production capacity to 2000 tractors per annum.

The installed capacity of the company was 16000 tractors per annum in 1986-87 which increased to 25000 in 1990-91 which shows 56.25 per cent rise. The company's production of tractor was 16151 in 1986-87 and 32925 in 1993-94 indicating an increase of 103.86 per cent during this period.

Marketing and Sales of Tractors

To market the tractors in domestic market, company has adopted one level marketing channel, as tractors are supplied by the company to the dealers and dealers sell to the farmers. Domestic market of tractors is divided into four zones viz. West Zone, North Zone, East Zone and South Zone. Company had four sales offices in each in the North, East and West Zones and three sales offices in South Zone. Tractors and commercial vehicles of this company were marketed by 167 dealers in domestic market. The company has 29 service centres located in different states to provide prompt after sales service to the customers.

In area of sales also MML tops the list. Company's total sales and sales of tractors respectively increased from Rs. 51733 lakh and Rs.13198.74 lakh in 1986-87 to Rs.114405.20 lakh and Rs.42373.33 lakh in 1991-92. This suggests an annual growth of 21.94 per cent and 33.85 per cent in total sales and tractors sale, respectively. This higher rate of growth of sale of tractors was achieved because of improvement in fuel efficiency of tractor by about 20 per cent and the tractors of smaller HP range exempted from excise duty in 1990-91. Hence the share of the sale of tractors in the total sales of the company was 33.13 per cent in 1990-91 and 37.04 per cent in 1991-92.

The sales of tractors, spares and implements in international markets were Rs. 391.00 lakhs in 1989-90 which declined to Rs. 209.00 lakhs in 1990-91 and then increased to Rs. 403.00 lakhs in 1991-92. They accounted for 6.81 per cent, 7.31 per cent and 11.90 per cent of the total exports of the company in 1989-90, 1990-91 and 1991-92, respectively.

Eicher Tractors India Ltd. (ETIL)

Goodearth Company has established an ETIL in 1959 with a financial and technical collaboration with Gebr Eicher Company of West Germany. This company has started its production of tractor in the year 1960. Because of difficulties in getting import licences and lack of technical and managerial skill, the total production of tractors of the company was about 200 per annum in the first few years.

In initial years the functioning of the company was not smooth as Government of India had withdrawn liberal import facilities. But slowly company made a good progress and became totally indigenous in 1974-75.

Escorts Ltd.(EL)

Escorts Ltd. was started as tractor agency house in 1944. It was selling Ferguson tractors up to 1961. In 1961, its agency to sell tractors was terminated. Hence in 1962, EL applied to the Government for an industrial licence to manufacture tractors. EL has planned to manufacture tractors in collaboration with M/S Motoimport of Poland. About 50 per cent of the components were indigenous. The company planned to use an indigenous engine with a transmission imported from the collaborator. But the licence to manufacture 7000 tractors per annum in collaboration with M/S Motoimport of Poland was issued only in 1966.

The first two models of tractor designed by the Company were Escort-37 and Escort-27. Transmissions and gears were manufactured in collaboration with M/S Motoimport of Poland. In 1967 a 50 HP tractor (Escort-47) was designed and put in the market in 1968.

Because of design problems, Escort-37 was discontinued in 1971-72. In 1972-73 an improved model of tractor (Escort-3036) with a water cooled engine was introduced. The Government of India gave permission to the company to import a new model of tractor Ursus-335 from Poland.

Escorts Tractors Ltd. (ETL)

In 1968 a new company ETL was promoted by Escorts Ltd in collaboration with Ford Company of USA to manufacture 6000 Ford tractors of 48 HP per annum. The Company had planned to manufacture Ford 3000 tractor model of 48 HP by the end of 1970. It was introduced in the market in 1971-72 and considered as very good performing tractor in terms of consumption of fuel and reliability.

Farm Equipment Division of Escorts Limited is responsible for marketing of both Escorts and Ford brands of tractors. Escorts has the largest dealer net work in the country amongst all tractor manufacturers. As on April 1, 1991 there were 291 and 204 dealers marketing Escorts and Ford brand tractors respectively. Company has farm training institute at Bangalore which provides training to dealers and Escorts personnel in the areas of sales, service and parts. Escorts and its dealers for tractors and motor cycles have formed Escorts Dealers Development Association Ltd. (EDDAL). EDDAL is responsible for providing support and help to dealers for their business and individual development through education and infrastructure development.

Hindustan Machine Tools Ltd. (HMTL)

HMTL faced the recession problem during 1966-69. Hence, it decided to add new product in its product line in 1965. At the time of exploring opportunities to diversify product line, company felt that tractor industry was a promising field. Thus HMTL entered in tractor manufacturing industry in 1965 in the range of 20-25 HP.

Zetor and Swaraj tractors were examined and evaluated by this company. Finally, company decided to manufacture Zetor tractor. Government appointed National Industrial Development Corporation Ltd. (NIDC) to prepare a project report. NIDC had submitted its report to the Government in 1979. It was recommended by NIDC to produce 12000 Zetor tractors of 25 HP per annum at HMT Pinjore.

Company had foreign collaboration for the transfer of technology i.e. technical know-how to manufacture three models of tractors, Viz, Zetor 2011 of 25 HP, Zetor 4511 of 45 HP and Zetor 5511 of 55 HP.

Prior to 1977, the tractors manufactured by HMT were marketed by Agro-Industries Corporations in all states. In 1977 dealers were appointed all over the country. In 1977-78, Company introduced a new 55 HP tractor model.

Punjab Tractors Ltd. (PTL)

Government of India obtained financial and technical help from Russia to establish a project to manufacture tractors of 20 HP in the country. The Punjab State Industrial Development Corporation (PSIDC) was a main promoter of the company PTL. PTL was incorporated in the year 1970 at Chandigarh and obtained permission to start its business in the same year.

Since 1965 the Central Mechanical Engineering Research Institute was working to develop a Swaraj tractor. Punjab State Industrial Development Corporation Ltd. took help from this Institute to implement the Swaraj tractor project.

PTL got licence to manufacture 12000 tractors per annum and decided to implement the project in two phases. The first phase was to install the project to manufacture 5000 tractors and the second phase was to manufacture the remaining capacity of 7000 tractors per annum. But the first phase was completed with the production capacity of 6400 tractors per annum.

PTL started manufacturing Swaraj 724 (26.5 HP) tractor in 1973. In 1975, company developed a new model Swaraj 735 (18 HP) tractor which was totally indigenous. This economy model Swaraj 735 was tested and marketed in 1978.

The marketing of tractors was done by the company in the adjoining areas of the plant. Company appointed dealers in Punjab, Haryana and Western UP. In 1976-77 the network of dealership was extended to Andhra Pradesh, Maharashtra, Madhya Pradesh and Bihar. The first consignment to export tractors to African

countries was taken by the company in 1977-78.

Kirloskar Tractors Ltd. (KTL)

KTL was established in 1970. Kirloskar Oil Engine Ltd. and Kirloskar Brothers Ltd. were the promoters of KTL. The agreement for technical collaboration was made by KTL with M/S Klockner Humboldt Dentz of West Germany in 1970, for 5 years from the date of first production of tractor. As per agreement, the collaborator company was supposed to supply technical know-how and to provide training to the engineers of KTL.

CAPACITY AND PRODUCTION TREND OF INDUSTRY

Since last 12 years, the installed production capacity of the tractor industry has remained 182300 tractors per annum (Table 3). Actual production of installed capacity remained below 50.00 per cent from 1981-82 to 1987-88. It was as low as 34.34 per cent in 1982-83. In 1988-89, it registered significant rise in the utilization of installed capacity reaching 59.79 per cent. Since 1988-89, the percentage utilization of production capacity of the industry increased continuously and significantly and reached 92.34 per cent in 1992-93.

During 1981-82 to 1985-86, the industry witnessed ups and down in tractors production. But from 1985-86 it geared up rapidly and climbed to as high as 168340 tractors in 1992-93. The rate of growth of production of tractor industry as a whole between 1981-82 and 1992-93 is shown in the estimated equation.

$$\text{Log}^y = 10.981 + 0.0796 t$$

(0.011)*

$$R^2 = 0.829 \quad N = 12$$

$$\text{Growth Rate} = 100 \times (e^{0.0796} - 1) = 8.29 \text{ per cent}$$

* Figure in parentheses is standard error of the coefficient.

Table 3 : Production and Capacity Utilization of Tractor Industry

Year	Installed Capacity (Number)	Production (Number)	Utilization of Capacity %
1981-82	182300	84962	46.61
1982-83	182300	62597	34.34
1983-84	182300	74216	40.71
1984-85	182300	84968	46.61
1985-86	182300	77400	42.46
1986-87	182300	79000	43.34
1987-88	182300	88000	48.27
1988-89	182300	109000	59.79
1989-90	182300	120000	65.83
1990-91	182300	139285	76.40
1991-92	182300	151870	83.31
1992-93	182300	168340	92.34
1993-94	182300	133577*	

Source: Records of TMA, New Delhi
* Total production of tractors of nine companies.

As per above computation, the rate of growth of tractor production in number between 1981-82 and 1992-93 was 8.29 per cent per annum which indicates significant rise in the production of tractor.

Out of eleven tractor manufacturing companies seven companies are prominent and efficient (Tables 4,5 & 6). The total production capacity of the tractor industry was 182300 tractors per annum during study period 1990-91 to 1993-94. The data for the year 1992-93 are not available. Among all the tractor manufacturing companies, the highest production capacity was 28000 tractors per annum for Escorts Ltd., followed by that of 25000 tractors for Mahindra and Mahindra Ltd., 24000 tractors for Eicher Tractors Ltd. and 22800 tractors for Tractors and Farm Equipment Ltd. These four companies together accounted for 54.74 per cent of the total production capacity of the tractor industry as a whole.

The total production of tractor industry was 139285 tractors in 1990-91 and 147730 tractors in 1991-92. In 1990-91, Mahindra and Mahindra Ltd. reported the highest production of 26852 tractors followed by that of 22533 tractors by Escorts Ltd. and 21100 tractors by Tractors and Farm Equipment Ltd. (Table 4). These three companies together constituted 50.60 per cent of the total production of the industry.

In 1991-92 the production of Mahindra and Mahindra Ltd. was 32300 tractors which was highest. Kirloskar Pneumatic Co. Ltd. produced only 3 tractors (Table 5). The total production of tractors of Mahindra and Mahindra Ltd., Tractors and Farm Equipment Ltd. and Escorts Ltd. together accounted for 54.75 per cent of the total production of tractor industry during 1991-92.

According to the data presented in Table 6, the total production of nine tractor manufacturing companies was 133571 tractors during 1993-94. The production of Mahindra and Mahindra Ltd. remained highest at 32925 tractors. Production of tractors of Tractors and Farm Equipment Ltd. was 24118 and that of Punjab Tractors Ltd. was 18242 in 1993-94. The share of these three companies was 56.36 in total production of tractors of nine companies. On the basis of production of tractors, the share of Mahindra and Mahindra Ltd. remained highest in the tractor industry during these three years. It was second highest for Escorts Ltd. and third highest for Tractors and Farm Equipment Ltd. in 1990-91. But in 1991-92 the position was reverse; Tractors and Farm Equipment Ltd. was second highest and Escorts Ltd. was third highest.

From 1990-91 to 1991-92, the production of tractors increased by 20.29 per cent for Mahindra and Mahindra Ltd., 6.80 per cent for Escorts Ltd, and 16.16 per cent for Tractors and Farm Equipment Ltd. The manufacturing of tractors of Escorts (Ford) Tractors Ltd. declined by 11.55 per cent and that of Hindustan Machine Tools Ltd. declined by 1.38 per cent during the year 1991-92. It remained constant for Gujarat Tractors Corporation Ltd.

Table 4: Capacity and Production of Tractor Manufacturing Companies 1990-91

Company	Production Capacity in Number	Production in Number	Capacity Utilization in %
Capol	NA	2400	NA
Eicher Tractors Ltd.	24000	17721	73.84
Escorts Ltd.	28000	22533	80.48
Escorts (Ford) Tractors Ltd.	15500	12501	80.65
Gujarat Tractors Corporation Ltd.	3600	1821	50.58
Hindustan Machine Tools Ltd.	19000	17414	91.65
Kirloskar Pneumatic Co. Ltd.	3600	11	0.31
Mahindra and Mahindra Ltd.	25000	26852	107.41
Pratap Steels	NA	2123	NA
Punjab Tractors Ltd.	22500	14809	65.82
Tractors and Farm Equipment Ltd. (TAFE)	22800	21100	92.54
Total of Industry	182300	139285	76.40

Source: Records of Tractor Manufacturers Association, New Delhi.

Table 5 : Capacity and Production of Tractor Manufacturing Companies 1991-92

Company	Production Capacity in Number	Production in Number	Capacity Utilization in %
Escorts Ltd.	28000	24065	85.9
Mahindra and Mahindra Ltd.	25000	32300	129.2
Tractors and Farm Equipment Ltd.	22800	24510	107.5
Escorts (Ford) Tractors Ltd.	15500	14134	91.19
Hindustan Machine Tools Ltd.	19000	17656	92.93
Eicher Tractors Ltd.	24000	18185	75.8
Punjab Tractors Ltd.	22500	14746	65.54
Gujarat Tractors Corporation Ltd.	3600	1821	50.6
Kirloskar Pneumatic Co.Ltd.	3600	3	0.1
Others	18300	4450	24.32
Total of Industry	182300	151870	83.31

Source: Records of Tractor Manufacturers Association, New Delhi.

Table 6 : Capacity and Production of Tractor Manufacturing Companies 1993-94

Company	Production Capacity in Number	Production in Number	Capacity Utilization in %
Mahindra and Mahindra Ltd.	25000	32925	131.70
Escorts Ltd.	28000	15031	53.68
Tractors And Farm Equipment (TAFE) Ltd.	22800	24118	105.78
Punjab Tractors Ltd.	22500	18242	81.08
Escorts (Ford)Tractors Ltd.	15500	12754	82.28
Hindustan Machine Tools Ltd.	19000	15001	78.95
Eicher Tractors Ltd.	24000	14996	62.48
VST Tillers Tractors Ltd.	NA	504	NA
Kirloskar Pneumatic Co.Ltd.	3600	-	-
Total of nine companies	160400	133571	83.27

Source: CMIE, Market and Market shares for over 300 Industrial Products/Product Groups, February 1995, Page 270.

In the year 1993-94, the production of tractor of Mahindra and Mahindra Ltd. increased by 1.93 per cent and that of Punjab Tractors Ltd. increased by 23.71 per cent. The production of Eicher Tractors Ltd. went down by 17.54 per cent and that of Escorts Ltd. declined by 37.54 per cent. The tractor production of Hindustan Machine Tools Ltd., Tractors and Farm Equipment Ltd. and Escorts (Ford) Tractors Ltd. decreased by 15.04, 1.60 and 9.76 per cent during the year 1993-94 respectively.

In 1990-91, the utilization of installed capacity of Mahindra and Mahindra Ltd. was 107.41 per cent which was highest among all the tractor manufacturing companies. More than 91 per cent of the installed production capacity was utilized by Hindustan Machine Tools Ltd. and Tractors and Farm Equipment Ltd. The lowest utilization of production capacity was 0.31 per cent for Kirloskar Pneumatic Co. Ltd.

It was above 80 per cent for Escorts Ltd. and Escorts (Ford) Tractors Ltd. For the industry as a whole, it was 76.40 per cent in 1990-91.

In 1991-92, the production of Mahindra and Mahindra Ltd. and Tractor and Farm Equipment Ltd. was higher by 29.2 per cent and 7.5 per cent of their respective installed production capacity which indicates over utilization of their production capacity. As noted earlier the production capacity of Kirloskar Pneumatic Co. Ltd. was utilized by 0.1 per cent which shows that production capacity of this company remained almost idle throughout the year 1991-92. About 50.6 per cent of the production capacity of Gujarat Tractors Corporation Ltd. was utilized in 1991-92. The utilization of production capacity of the tractor industry was 83.31 per cent which was significantly high. From 1990-91 to 1991-92, the percentage utilization of production capacity remained same for Gujarat Tractors Corporation Ltd. For the industry as a whole, it increased by 6.91.

During the year 1993-94, the capacity utilization of Mahindra and Mahindra Ltd. went up to 131.70 per cent which gives indication to the company to expand its production capacity. Tractors and Farm Equipments has also over utilised its production capacity by 5.78 per cent. In the case of Punjab Tractors Ltd, it increased by 15.54. The percentage utilization of production capacity of Escorts Ltd., Eicher Tractors Ltd., and Hindustan Machine Tools Ltd. declined by 32.22, 13.32 and 13.98 from 1991-92 to 1993-94 respectively.

TREND IN TRACTORS SALES

To examine the trend in sales of tractors, the compound rate of growth is computed and given below:

$$\text{Log } y = 10.915 + 0.086 t$$

$$(0.007)^*$$

$$R^2 = 0.945 \quad N = 11$$

$$\text{Growth Rate} = 100 \times (e^{0.086} - 1) = 8.98 \text{ per cent}$$

* Figure in parentheses is standard error of the coefficient.

According to the data presented in Table 7, the lowest sales of tractors was 63157 in 1981 and the highest sales of tractors was 150170 in 1991-92. The sales of tractors have continuously increased from 63157 in 1981 to 80263 in 1984 and then declined to 78966 in 1985. But 1985 onwards, they increased continuously and significantly. During the period from 1981 to 1991-92, the rate of growth of sales of tractors was 8.98 per cent per annum.

Table 7 : Sales of Tractors

Sr. No.	Year	Actual Sales in Number
1	1981	63157
2	1982	66746
3	1983	74849
4	1984	80263
5	1985	78966
6	1986-87	80668
7	1987-88	91095
8	1988-89	108668
9	1989-90	121189
10	1990-91	139409
11	1991-92	150170

- Source: 1. Girja Sharan and Sandeep Kayastha, "Growth of Tractors in India: Past and Future". Working Paper No. 758 (July 1988), Indian Institute of Management, Ahmedabad (for 1981 to 1985 data).
2. Records of Tractor Manufacturers Association, New Delhi (for 1986-87 to 1991-92 data).

To examine the trends in sales of tractors of different HP, the sold tractors are classified into three groups on the basis of their Horse Power (HP). The data on sales of tractors for each group of HP and at the aggregate level are presented in Table 8.

Table 8 : Horse Power-wise Sales of Tractors

(In Number)

Year	Below 30 HP	30-39 HP	40 HP & Above	Total
1986-87	30608 (37.9)	37476 (46.5)	12584 (15.6)	80668 (100.0)
1987-88	29555 (32.4)	46098 (50.6)	15442 (17.0)	91095 (100.0)
1988-89	35726 (32.8)	54755 (50.4)	18187 (16.8)	108668 (100.0)
1989-90	41444 (34.2)	59175 (48.8)	20570 (17.0)	121189 (100.0)
1990-91	48332 (34.7)	66761 (47.9)	24316 (17.4)	139409 (100.0)
1991-92	54700 (36.4)	68588 (45.7)	26882 (17.9)	150170 (100.0)
Growth Rate %	13.81	12.78	16.28	13.70

Note: The figures in parentheses are percentages to their respective totals.
Source: Records of Tractor Manufacturers Association, New Delhi.

These data are utilized to compute rate of growth separately for each HP group of tractors and for aggregate level and given below.

- (1) For below 30HP

$$\text{Log}^y = 10.120 + 0.1297 t$$

(0.014)*

$$R^2 = 0.945 \quad N = 6$$

$$\text{Growth Rate} = 100 \times (e^{0.1297} - 1) = 13.81 \text{ per cent}$$

- (2) For 30 - 39 HP Group

$$\text{Log}^y = 10.481 + 0.120 t$$

(0.015)*

$$R^2 = 0.941 \quad N = 6$$

$$\text{Growth Rate} = 12.78 \text{ per cent}$$

- (3) For above 39 HP

$$\text{Log}^y = 9.326 + 0.1519 t$$

(0.007)*

$$R^2 = 0.990 \quad N = 6$$

$$\text{Growth Rate} = 16.28 \text{ per cent}$$

(4) For aggregate (Total Sales of Tractors)

$$\text{Log}^y = 11.181 + 0.1284 t$$

$$(0.007)^*$$

$$R^2 = 0.989 \quad N = 6$$

$$\text{Growth Rate} = 13.70 \text{ per cent}$$

* Figures in parentheses are standard errors of the coefficients.

The sales of tractors of 30-39 HP group remained higher than those of below 30 HP and above 39 HP groups during the period from 1986-87 to 1991-92 (Table 8). The sales of tractors of 30-39 HP accounted for 46.50 per cent, while those of below 30 HP and above 39 HP accounted for 37.9 per cent and 15.6 per cent of total sales in 1986-87 respectively. In the year 1991-92, the sales of tractors of 30-39 HP, below 30 HP and above 39 HP groups were respectively 45.7 per cent, 36.4 per cent and 17.9 per cent of the total sales. The share of sales of tractors of 30-39 HP was more than 50 per cent of total sales in 1987-88 and 1988-89. The percentage of sales of tractors of below 30 HP varied between 32.4 in 1987-88 and 37.9 in 1986-87 and that of above 39 HP ranged between 15.6 in 1986-87 and 17.9 in 1991-92.

According to the data presented in Table 8, from 1986-87 to 1991-92 the sales of tractors of each of the three HP groups and at the aggregate level increased significantly. But the share of the sales of tractors of each HP group in the total sales of tractors changed marginally.

The growth rate of sales of tractors of above 39 HP was 16.28 per cent per annum which was higher than that of 30 - 39 HP (12.78 per cent) and below 30 HP (13.81 per cent). Irrespective of HP of tractors, the total sales of tractors has increased by 13.70 per cent per annum from 1986-87 to 1991-92. Thus, the sales of tractors of three HP groups have formed upward trends and the slopes of the trends are significantly high.

Company's Share in Total Sales of Industry

To examine the trends in sales of tractors of each of the nine important companies and its relative market shares, company wise data on sales of tractors are presented in Table 9 and the compound growth rates are computed for them for the period from 1986-87 to 1991-92.

As per data presented in Table 9 the sales of tractors of Mahindra and Mahindra Ltd. remained highest during the period from 1986-87 to 1991-92. The second highest sales was by Hindustan Machine Tools Ltd. in 1986-87 and 1987-88, Tractors and Farm Equipment Ltd. from 1988-89 to 1991-92 (except 1990-91) and by Escorts Ltd. in 1990-91. The sales of tractors of Escorts Ltd. was the third highest in 1987-88.

According to the data presented in Table 9 about 50.00 per cent of the total sales of tractors in the market was concentrated with three tractor manufacturers, namely, Mahindra and Mahindra Ltd., Hindustan Machine Tools Ltd. and Eicher Tractors Ltd. in 1986-87. But in 1991-92 it was concentrated with Mahindra and Mahindra Ltd, Tractors and Farm Equipments Ltd. and Escorts Ltd.

The sales of tractors of each company, except Hindustan Machine Tools Ltd., increased significantly during the period from 1986-87 to 1991-92. In the case of Escorts Ltd., Escorts (Ford) Tractors Ltd., Tractors and Farm Equipment Ltd. and Gujarat Tractors Corporation Ltd., the sales of their tractors increased by above 100 per cent during this period of seven years. But the increase in the sale of tractors of Hindustan Machine Tools Ltd. was only 19 per cent and that of Mahindra and Mahindra Ltd, Eicher Tractors Ltd, and Punjab Tractors Ltd. was between 66 and 97 per cent.

Table 9 : Company-wise Sales of Tractors

Company	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92	Growth Rate %
Escorts Ltd.	10123 (12.5)	13605 (14.9)	15178 (14.0)	17135 (14.2)	22554 (16.2)	24047 (16.0)	18.58
Escorts (Ford) Tractors Ltd.	6483 (8.1)	8140 (9.0)	9453 (8.7)	10586 (8.8)	12555 (9.0)	14121 (9.4)	16.37
Mahindra and Mahindra Ltd.	15914 (19.7)	16530 (18.2)	19529 (18.0)	21611 (17.8)	26885 (19.3)	31236 (20.8)	15.13
Tractors and Farm Equipment Ltd.	10930 (13.5)	12828 (14.1)	17590 (16.2)	20230 (16.7)	21061 (15.1)	24475 (16.3)	17.55
Hindustan Machine Tools Ltd.	14658 (18.2)	15697 (17.2)	16314 (15.0)	17171 (14.2)	17414 (12.5)	17525 (11.7)	3.65
Eicher Tractors Ltd.	12541 (15.6)	13476 (14.8)	15286 (14.1)	17061 (14.1)	20197 (14.5)	20516 (13.7)	11.42
Punjab Tractors Ltd.	8746 (10.8)	8864 (9.7)	12017 (11.1)	14338 (11.8)	14835 (10.6)	14563 (9.7)	12.98
Gujarat Tractors Corporation Ltd.	597 (0.7)	1221 (1.3)	1710 (1.5)	1500 (1.2)	1817 (1.3)	2003 (1.3)	22.54
Others	676 (0.9)	734 (0.8)	1591 (1.4)	1557 (1.2)	2091 (1.5)	1684 (1.1)	24.55
Total of Industry	80668 (100.0)	91095 (100.0)	108668 (100.0)	121189 (100.0)	139409 (100.0)	150170 (100.0)	13.70

Note: The figures in parentheses are percentages to their respective totals.

Source: 1. Records of Tractor Manufacturers Association, New Delhi.

2. Records of the Company Escorts Ltd. Faridabad, Haryana.

To examine the growth of sales of tractors of important tractor manufacturing companies, their compound growth rates were computed separately. These are:

(1) Escorts Tractors Ltd.

$$\text{Log}^y = 9.108 + 0.1704 t$$

$$(0.015)^*$$

$$R^2 = 0.970 \quad N = 6$$

$$\text{Growth Rate} = 18.58 \text{ per cent}$$

(2) Escorts (Ford) Tractors Ltd.

$$\text{Log}^y = 8.669 + 0.1516 t$$

$$(0.008)^*$$

$$R^2 = 0.989 \quad N = 6$$

$$\text{Growth Rate} = 16.37 \text{ per cent}$$

3) Mahindra and Mahindra Ltd.

$$\text{Log}^y = 9.473 + 0.1409 t$$

$$(0.012)^*$$

$$R^2 = 0.971 \quad N = 6$$

$$\text{Growth Rate} = 15.13 \text{ per cent}$$

(4) Tractors and Farm Equipment Ltd.

$$\text{Log}^y = 9.186 + 0.1617 t$$

$$(0.019)^*$$

$$R^2 = 0.945 \quad N = 6$$

$$\text{Growth Rate} = 17.55 \text{ per cent}$$

(5) Hindustan Machine Tools Ltd.

$$\text{Log}^y = 9.581 + 0.036 t$$

$$(0.006)^*$$

$$R^2 = 0.914 \quad N = 6$$

$$\text{Growth Rate} = 3.65 \text{ per cent}$$

(6) Eicher Tractors Ltd.

$$\text{Log}^y = 9.316 + 0.1081 t$$

$$(0.009)^*$$

$$R^2 = 0.975 \quad N = 6$$

$$\text{Growth Rate} = 11.42 \text{ per cent}$$

(7) Punjab Tractors Ltd.

$$\text{Log } y = 8.960 + 0.1220 t$$

(0.025)*

$$R^2 = 0.852 \quad N = 6$$

Growth Rate = 12.98 per cent

(8) Gujarat Tractors Corporation Ltd.

$$\text{Log } y = 6.516 + 0.2033 t$$

(0.061)*

$$R^2 = 0.734 \quad N = 6$$

Growth Rate = 22.54 per cent

* Figures in parentheses are standard error of the coefficient.

As per the above computation, the growth rate of sale of tractors of Gujarat Tractors Corporation Ltd. was 22.54 per cent per annum which was highest among all the eight companies and 1.65 times of that of industry as a whole. But for Hindustan Machine Tools Ltd., it was 3.65 per cent per annum which was lowest among all the eight companies and 0.27 times of that of industry as a whole.

The scene of the annual rate of growth of sales of tractors is quite puzzling. The annual rate of growth of sales of tractors of Escorts Ltd. was 18.58 per cent which was higher than that of Escorts (Ford) Tractors Ltd. (16.37 per cent) and Mahindra and Mahindra Ltd. (15.13 per cent). This higher growth rate of Escorts and Escorts (Ford) might be attributed to initial years low share of the sale of tractors which increased to more than double in 1991-92, whereas Mahindra and Mahindra has highest share of the sale during 1986-87 to 1991-92. In case of Tractors and Farm Equipment Ltd., it was 17.55 per cent per annum which was 1.28 times of that of industry as a whole. But the rate of growth of Eicher Tractor Ltd. and Punjab Tractors Ltd., was 11.42 and 12.98 per cent per annum which was 0.83 and 0.95 times of that of tractor industry respectively. Thus, the average rise in the number of tractors sold per annum by each of the eight companies except Hindustan Machine Tools Ltd. was significantly high during the period from 1986-87 to 1991-92.

SPATIAL DISTRIBUTION OF SALES OF TRACTORS

The data on spatial distribution of sales of tractors for 1990-91 are presented in Table 10. About 28.23 per cent of the total sales of tractors in India was concentrated in Uttar Pradesh. The share of Haryana and Punjab together in the total sale, was about 24.78 per cent. Rajasthan, Madhya Pradesh, Maharashtra and Gujarat accounted for 7.39 per cent, 7.36 per cent, 5.41 per cent and 5.47 per cent respectively. Each of the remaining states accounted for less than 5 per cent. This shows that the rate of farm tractorization is comparatively higher in Uttar Pradesh, Punjab and Haryana. It is very negligible in West Bengal, Orissa, Manipur, Kerala, Himachal Pradesh, Assam and Jammu & Kashmir where holdings are much smaller.

FARM TRACTORIZATION AND ITS IMPACT

To study the growth of farm tractorization and its impact on the employment in agriculture, the data on tractor population, gross cropped area, number of tractors per lakh of gross cropped area, total number of labour days employed, and labour days employed on per hectare of gross cropped area are presented in Table 11 for the period from 1950-51 to 1992-93. For each of them the compound rate of growth is computed for the period between 1969-70 and 1992-93.

1) Population of Tractor

$$\text{Log}^y = 0.188 + 0.1163 t \\ (0.003)^*$$

$$R^2 = 0.989 \quad N = 24$$

$$\text{Growth Rate} = 12.33 \text{ per cent}$$

(2) Gross Cropped Area

$$\text{Log}^y = 5.092 + 0.0051 t \\ (0.001)^*$$

$$R^2 = 0.834 \quad N = 24$$

$$\text{Growth Rate} = 0.51 \text{ per cent}$$

Table 10 : State-wise Sales of Tractors During 1990-91

Sr. No.	State/U.T.	No. of Tractors Sold	Percentage to Total
1	Andhra Pradesh	6404	4.59
2	Assam	330	0.24
3	Bihar	6781	4.86
4	Gujarat	7640	5.47
5	Haryana	17269	12.39
6	Himachal Pradesh	151	0.11
7	Jammu & Kashmir	251	0.18
8	Karnataka	3408	2.44
9	Kerala	379	0.27
10	Madhya Pradesh	10260	7.36
11	Maharashtra	7538	5.41
12	Manipur	42	0.03
13	Orissa	735	0.53
14	Punjab	17269	12.39
15	Rajasthan	10295	7.39
16	Tamil Nadu	5043	3.62
17	Uttar Pradesh	39352	28.23
18	West Bengal	1382	0.99
19	Others	4875	3.50
	Total	139403	100.00

Source: Ministry of Agriculture, Government of India.

Table 11 : Farm Tractorization and Employment in Agriculture

Year	No. of Tractors in lakh	Gross Cropped Area in Million Hectares	No. of Tractors per Lakh Hectares of GCA	Total Labour Days in Agril. in Million	Labour Days per Hectare of Gross Cropped Area
1950-51	0.09	131.89	6.82	25656	194.53
1955-56	0.21	147.31	14.26	22998	156.12
1960-61	0.31	152.77	20.29	25775	168.72
1965-66	0.54	155.28	34.78	29318	188.81
1969-70	1.00	162.27	61.63	29928	184.47
1970-71	1.43	165.79	86.25	30082	181.45
1971-72	1.70	165.19	102.91	30238	183.05
1972-73	2.00	162.15	123.34	30394	187.44
1973-74	2.25	169.87	132.45	30601	180.14
1974-75	2.50	164.19	152.26	30806	187.84
1975-76	2.80	171.30	163.46	34787	203.08
1976-77	3.15	167.34	188.24	39280	234.73
1977-78	3.50	172.27	203.17	44354	257.47
1978-79	4.10	174.76	234.61	45014	257.58
1979-80	4.73	169.66	278.79	45679	269.24
1980-81	5.20	172.63	301.22	46353	268.51
1981-82	5.97	177.04	337.21	47040	265.70
1982-83	6.63	173.40	382.35	47734	275.28
1983-84	7.40	180.17	410.72	48441	268.86
1984-85	8.22	176.42	465.93	50701	287.39
1985-86	8.99	178.83	502.71	53065	296.73
1986-87	9.79	176.66	554.17	55536	314.37
1987-88	10.70	171.81	622.78	58116	338.26
1988-89	11.77	180.11	653.49	60817	337.67
1989-90	13.16	182.20	722.28	63642	349.30
1990-91	14.68	185.48	791.96	NA	NA
1991-92	16.19	182.70	886.15	NA	NA
1992-93	18.00	183.00	983.61	NA	NA

Source: 1. CMIE, Basic Statistics Relating to Indian Economy, August 1994, Table 6.14.

2. Ravindra H. Dholakia and Bakul H. Dholakia, "Growth of Total Factor Productivity in Indian Agriculture, *Indian Economic Review*, Vol. xxviii, no. 1, 1993 (for labour days data).

(3) Tractors per Lakh Hectare

$$\text{Log}^y = 4.307 + 0.1112 t$$

(0.003)*

$$R^2 = 0.989 \quad N = 24$$

$$\text{Growth Rate} = 11.76 \text{ per cent}$$

(4) Employment in Million Labour Days

$$\text{Log}^y = 10.214 + 0.0405 t$$

(0.002)*

$$R^2 = 0.950 \quad N = 21$$

$$\text{Growth Rate} = 4.13 \text{ per cent}$$

(5) Labour Days per Hectare of Gross Cropped Area

$$\text{Log}^y = 5.122 + 0.0355 t$$

(0.002)*

$$R^2 = 0.937 \quad N = 21$$

$$\text{Growth Rate} = 3.61 \text{ per cent}$$

* Figures in parentheses are standard error of the coefficient.

The total number of tractors in the country was one lakh in 1969-70 which increased at the rate of 12.33 per cent per annum and rose to 18 lakhs in 1992-93. While the gross cropped area has increased from 162.27 million hectares in 1969-70 to 183.00 million hectares in 1992-93. During this period, the rate of growth of tractors was 12.33 per cent per annum which was 24.18 times of that of gross cropped area (0.51 per cent). Consequently, the number of tractors per lakh hectares of gross cropped area has significantly increased from 61.63 in 1969-70 to 983.61 in 1992-93. During this period of 24 years, the rate of growth of tractors per lakh hectares of gross cropped area was 11.76 per cent per annum which indicates that farm tractorization has increased significantly in the country.

In spite of significant rise in farm tractorization, the total number of labour days employed in agriculture has increased from 29928 million in 1969-70 to 63642 million in 1989-90, though there is a belief that tractor substitutes human labour. During this period of 21 years, its rate of growth was 4.13 per cent per annum. The

rate of growth of total number of tractors in country was 2.99 times of that of total labour days employed in agriculture.

The number of labour days employed on per hectare of gross cropped area was 184.47 in 1969-70 and 349.30 in 1989-90. Between 1969-70 and 1989-90, the rate of growth of labour days employed on per hectare of gross cropped area was 3.61 per cent per annum which was marginally lower than that of total labour days employed in agriculture. This shows that the increase in farm tractorization has not substituted labour but created more employment opportunities.

After the harvesting of kharif crops, the time available for sowing rabi crops is very short. In this short time, it is difficult for farmers to prepare land and do sowing in maximum area. But in this situation, tractor is very useful to prepare maximum land for sowing the next season crops. With the help of tractors, farmers can cover maximum area under the cultivation of rabi and summer crops specifically in the perennial irrigated area. Thus farm tractorization has shown positive impact on gross cropped area. Because of increase in gross cropped area, total labour days employed in agriculture has also increased. But the increase in total labour days employed in agriculture is significantly higher than the increase in gross cropped area. Hence, the labour days employed on per hectare of gross cropped area have increased at a higher rate. Thus, farm tractorization has made positive and significant impact on rate of growth of labour days employed on per hectare of gross cropped area through its direct and positive impact on total gross cropped area of the country.

In many states tractor is also used as prime mover to lift water from wells and canals. Thus tractor indirectly helps increasing area under irrigation and as a result cropping intensity which again increases human employment in agriculture.

Tractor is considerably used for the transportation of main and by products from the farm to the house or/and to nearby markets. It is also used to transport farm yard manure from its storage place to field. Both of these provide good number of employment to human labour. The labour days employed for the transportation of

agricultural products and farm yard manure are not included in total labour days employed in agriculture. Hence, the actual labour days employed on per hectare of gross cropped area would be higher than what is given in Table 11. Thus, farm tractorization has increased human employment directly and indirectly in agriculture. Moreover it has also increased both skilled and unskilled employment in the tractor manufacturing, marketing, and servicing & repairing activities. Some of this even takes place in remote rural areas and towns where employment needs/demand is more. Thus, undoubtedly farm tractorization is land and labour augmenting technical change.

To conform the above findings, the following two multiple regression equations are estimated.

$$(1) \quad \text{Log}^{Y_1} = \text{Log}^a + b_1 \text{Log}^{X_1} + b_2 \text{Log}^{X_2}$$

$$(2) \quad \text{Log}^{Y_2} = \text{Log}^a + b_1 \text{Log}^{X_1} + b_2 \text{Log}^{X_2} + b_3 \text{Log}^{X_3}$$

Where:

Y_1 = Cropping Intensity in percentage

(Gross cropped area x 100/Net cultivated area)

Y_2 = Labour Intensity

(No. of Labour days employed in Agriculture/Net cultivated area.)

X_1 = Tractorization (No. of Tractors/Net cultivated area)

X_2 = Irrigation Intensity (Net irrigated area/Net cultivated area)

X_3 = Interaction of X_1 and X_2

$a, b_1, b_2,$ and b_3 = Constants

The estimated equations are:

$$(1) \quad \text{Log}^{Y_1} = \text{Log}^{5.075} + 0.016 \text{Log}^{X_1} + 0.131 \text{Log}^{X_2}$$

$$(0.009^*) \quad (0.054^*)$$

$$R^2 = 0.956 \quad N = 20$$

$$F\text{-statistics with D.F (2,17)} = 180.24$$

$$D\text{-W statistics} = 2.55$$

$$(2) \quad \text{Log}^{Y_2} = \text{Log}^{8.46} + 0.008 \text{Log}^{X_1} + 2.475 \text{Log}^{X_2} - 0.007 \text{Log}^{X_3}$$

$$(0.523^*) \quad (0.465^*) \quad (0.410^*)$$

$$R^2 = 0.963 \quad N = 20$$

$$F\text{-statistics with D.F (3,16)} = 138.84$$

$$D\text{-W statistics} = 1.32$$

* Standard Error

According to the estimated equation 1, the positive and statistically significant values of the elasticity of cropping intensity with respect to tractorization and irrigation intensity indicate that both of these independent variables are land augmenting.

The estimated equation 2 reveals that tractorization and irrigation intensity are labour augmenting, as their regression coefficients are positive. But the negative sign of the regression coefficient of the interaction of these two variables indicates that the large farmers who have both tractors and irrigation facilities will not be able to complete the harvesting of kharif crops and sowing of rabi crops in short time. So they may go for harvest combine which will substitute labour. However the value of this substitution seems negligible as regression coefficient of interaction variable is very negligible and statistically insignificant.

TREND IN EXPORT OF TRACTORS

Since 1987-88, country became self sufficient in production of tractors. On the basis of data presented in table 12 the compound growth rates are computed. These are:

(1) Export of Tractors in Terms of Quantity

$$\text{Log}^y = 5.0295 + 0.2478 t$$

(0.051)*

$$R^2 = 0.824 \quad N = 7$$

$$\text{Growth Rate} = 28.13 \text{ per cent}$$

(2) Exports of Tractors in Value Term

$$\text{Log}^y = 4.735 + 0.4078 t$$

(0.108)*

$$R^2 = 0.740 \quad N = 7$$

$$\text{Growth Rate} = 50.35 \text{ per cent}$$

* Figures in parentheses are standard error of the coefficient.

The history of export of tractors has begun with the export of 213 tractors worth Rs. 98.50 lakhs in 1987-88. In 1989-90, the export of tractors was 1.61 times

and 7.75 times of that in 1987-88 in quantity and value terms respectively. During 1991-92, it declined by 6.88 per cent in terms of quantity but in value terms, it increased by 31.58 per cent. But in 1991-92, the rise in the export of tractors was about 160 per cent in terms of quantity and 273.82 per cent in terms of value. From 1992-93 to 1993-94, exports went up by 23.20 per cent in terms of quantity but in terms of value it increased by 0.61 per cent only.

As per computation, the rate of growth in export of tractors in quantity and value terms between 1987-88 and 1993-94 has been 28.13 per cent and 50.35 per cent per annum respectively. The growth rate of export of tractors in terms of value is about 1.79 times of that in quantity terms.

Table 12 : Total Export of Tractors

Year	Export of Tractors	
	Numbers	Value Rs. in lakhs
1987-88	213	98.50
1988-89	NA	NA
1989-90	342	763.40
1990-91	349	383.81
1991-92	325	505.00
1992-93	845	1887.76
1993-94	1041	1899.02

Source: Compiled from Various Issues of Monthly Statistics of the Foreign Trade of India, March

Direction of Export of Tractors

Country wise data on exports of tractors are given in Table 13. In 1987-88, tractors were exported to seven countries. Zimbabwe and Nepal together accounted for 92.02 per cent and 80.34 per cent of exports in quantity and value terms respectively.

Table 13 : Country Wise Export of Tractors

(Qty. in Number, Value in Rs. Lakh)

Sl. No.	Countries	Export of Tractors in					
		1987-88		1989-90		1990-91	
		Qty.	Value	Qty.	Value	Qty.	Value
1	Austria	-	-	-	-	-	-
2	Bangladesh	-	-	39	32.57	-	-
3	Benin	-	-	-	-	-	-
4	Bhutan	-	-	-	-	-	-
5	Botswana	-	-	-	-	-	-
6	Canada	-	-	-	-	-	-
7	Cyprus	-	-	-	-	-	-
8	Finland	-	-	-	-	-	-
9	France	-	-	-	-	-	-
10	Germany	-	-	-	-	-	-
11	Ghana	3	3.71	2	2.15	-	-
12	Greece	-	-	3	2.53	-	-
13	Guinea	-	-	-	-	-	-
14	Hungary	-	-	-	-	1	0.72
15	Indonesia	-	-	-	-	-	-
16	Iran	-	-	-	-	-	-
17	Iraq	-	-	5	5.56	-	-
18	Italy	-	-	-	-	-	-
19	Jordan	-	-	-	-	107	106.13
20	Kenya	-	-	-	-	2	2.08
21	Malawi	-	-	12	12.82	12	13.56
22	Malaysia	5	1.96	6	8.18	32	41.84
23	Mali	-	-	8	8.68	-	-
24	Mauritius	-	-	1	1.20	-	-
25	Namibia	-	-	-	-	-	-
26	Nepal	96	59.41	25	28.61	47	44.54
27	Netherlands	-	-	-	-	30	31.80
28	Newzealand	-	-	-	-	-	-
29	Nigeria	4	10.22	14	8.03	-	-
30	Qatar	-	-	-	-	-	-
31	Oman	-	-	-	-	-	-
32	Papua N Gui	-	-	-	-	-	-
33	Philippines	-	-	-	-	1	0.80
34	Poland	-	-	-	-	-	-
35	Singapore	-	-	-	-	20	47.66
36	Sri Lanka	-	-	1	2.52	3	1.65

Contd

Table 13: Contd.....

Sl. No.	Countries	Export of Tractors in					
		1987-88		1989-90		1990-91	
		Qty.	Value	Qty.	Value	Qty.	Value
37	Sudan	-	-	-	-	-	-
38	Syria	-	-	1	0.94	-	-
39	Tanzania	-	-	4	4.34	1	1.81
40	Thailand	-	-	1	1.77	-	-
41	Turkey	-	-	-	-	-	-
42	Uganda	3	2.20	-	-	-	-
43	U.K.	-	-	3	5.88	-	-
44	United Arab	-	-	3	3.55	3	7.31
45	U.S.A.	2	1.29	47	67.37	43	36.54
46	U.S.S.R.	-	-	135	513.01	-	-
47	Yugoslavia	-	-	2	4.58	-	-
48	Zambia	-	-	30	49.10	47	47.37
49	Zimbabwe	100	19.72	-	-	-	-
	Total	213	98.50	342	763.40	349	383.81

..... Contd.

Table 13: Contd.....

Sl. No.	Countries	Export of Tractors in					
		1991-92		1992-93		1993-94	
		Qty.	Value	Qty.	Value	Qty.	Value
1	Austria	-	-	-	-	6	9.82
2	Bangladesh	2	5.43	14	15.55	6	15.42
3	Benin	-	-	-	-	1	4.32
4	Bhutan	2	3.84	-	-	-	-
5	Botswana	-	-	-	-	1	2.25
6	Canada	-	-	-	-	4	5.53
7	Cyprus	-	-	-	-	2	1.72
8	Finland	7	8.70	-	-	-	-
9	France	1	0.18	5	54.34	-	-
10	Germany	10	6.74	-	-	-	-
11	Ghana	-	-	20	24.97	72	234.34
12	Greece	-	-	-	-	2	6.61
13	Guinea	-	-	-	-	3	7.20
14	Hungary	24	26.20	20	22.42	-	-
15	Indonesia	-	-	-	-	2	6.33
16	Iran	1	0.78	-	-	-	-
17	Iraq	-	-	-	-	-	-
18	Italy	5	9.63	-	-	-	-
19	Jordan	-	-	-	-	-	-
20	Kenya	-	-	2	4.90	7	12.65
21	Malawi	-	-	-	-	-	-
22	Malaysia	48	61.72	10	12.29	13	88.34
23	Mali	-	-	-	-	-	-
24	Mauritius	1	10.40	-	-	12	27.36
25	Namibia	1	4.01	-	-	-	-
26	Nepal	99	140.27	186	270.68	328	509.78
27	Netherlands	-	-	-	-	-	-
28	New Zealand	1	1.88	-	-	-	-
29	Nigeria	-	-	3	6.17	7	11.20
30	Oatar	-	-	-	-	1	2.51
31	Oman	2	5.21	11	15.90	-	-
32	Papua N Gui	-	-	-	-	6	14.41
33	Philippines	-	-	-	-	2	6.37
34	Poland	-	-	2	3.13	-	-
35	Singapore	-	-	-	-	2	5.07
36	Sri Lanka	33	59.80	259	435.07	250	403.23
37	Sudan	-	-	-	-	10	11.98
38	Syria	-	-	-	-	-	-

Table 13: Contd.....

Sl. No.	Countries	Export of Tractors in					
		1991-92		1992-93		1993-94	
		Qty.	Value	Qty.	Value	Qty.	Value
39	Tanzania	-	-	16	39.59	9	38.06
40	Thailand	-	-	-	-	-	-
41	Turkey	-	-	-	-	3	4.65
42	Uganda	-	-	-	-	-	-
43	U.K.	-	-	-	-	-	-
44	United Arab	-	-	4	12.17	2	4.38
45	U.S.A.	82	118.57	267	465.41	278	449.75
46	U.S.S.R.	-	-	-	-	-	-
47	Yugoslavia	-	-	-	-	-	-
48	Zambia	-	-	26	505.18	12	15.75
49	Zimbabwe	6	41.63	-	-	-	-
	Total	325	505.00	845	1887.76	1041	1899.02

Source: Compiled from various issues of Monthly Statistics of the Foreign Trade of India, March.

In 1989-90, about 342 tractors were exported to 20 countries. USSR, USA and Bangladesh accounted for 64.62 per cent and 80.29 per cent of total exports of tractors in quantity and value terms respectively. Thus, the inter-national market for the tractors has widened and the direction of export of tractors has undergone a change during this period. In 1987-88, Zimbabwe was main importer while in 1989-90, USSR was main importer of our tractors. During 1989-90, the export of tractors to Zimbabwe and Uganda was totally stopped and started in 15 other countries.

The main importers of our tractors changed over the years. In 1990-91 Jordan, Nepal, USA and Zambia were the main buyers with their share accounting for 69.91 per cent in quantity terms and 61.12 per cent in value terms. The countries like Bangladesh, Ghana, Greece, Iraq, Mali, Mauritius, Syria, Thailand, UK, USSR and Yugoslavia have discontinued their imports. But the countries like Hungary, Jordan, Kenya, Netherlands, Philippines and Singapore have imported the tractors during 1990-91.

The export market has widened from 14 countries in 1990-91 to 17 countries in 1991-92. Netherlands, Philippines, Singapore, Tanzania, United Arab, Zambia, Jordan, Kenya and Malawi have discontinued and Newzealand, Oman, Zimbabwe,

Bangladesh, Finland, France, Germany, Iran, Italy, Mauritius and Namibia have started import of tractors from India. About 70.46 per cent of our total exports of tractors in 1991-92 was to Nepal, USA and Malaysia.

In 1992-93, tractors were exported to 15 countries in which Nepal, Sri Lanka and USA together accounted for 84.26 per cent in terms of quantity and 62.04 per cent in terms of value.

The size of international market for our tractors has expanded by 73.33 per cent, as the number of countries importing tractors from India has increased from 15 in 1992-93 to 26 in 1993-94. In 1993-94 Nepal, Sri Lanka and USA were main importers accounting for 82.23 per cent and 71.76 per cent of the total exports in terms of quantity and value, respectively.

CONCLUSION

Modernisation of agriculture cannot take place without the development of agricultural input industries. Tractor is an example of this fact. Tractor, as one of the major agricultural inputs, was not given due importance until the days of green revolution. But as the demand for tractors increased, import was encouraged to facilitate technical change in agriculture. The Government of India reduced control on the import of tractors to meet increased demand from 1966-67 to 1970-71. Since 1972, to develop tractor industry in the country, Government of India put control on import of tractors.

Out of 19 licensed tractor manufacturing companies, 11 companies were producing tractors in 1990-91. The import of tractors has declined with fluctuation from 2997 in 1961-62 to 10 in 1986-87 at the rate of -23.20 per cent per annum.

The total production of tractors has increased at 8.29 per cent per annum. But the production capacity of the industry remained constant. Consequently, capacity utilization has increased from 33.34 per cent in 1982-83 to 92.34 per cent in 1992-93. Among all the companies, the capacity utilization and production was highest for Mahindra and Mahindra Ltd.

The total sale of tractors has increased at the rate of 8.98 per cent per annum. Mahindra and Mahindra Ltd. represented highest share of sales of tractors. In 1990-91 highest number of tractors were sold in the states of Haryana and Punjab.

The positive rate of growth of tractors, gross cropped area, total and per hectare of gross crop area labour days employed in agriculture and multiple regression analysis have undoubtedly proved that farm tractorization is land and labour augmenting technical change.

Since 1987-88, country became self sufficient in production of tractors. From 1987-88 to 1993-94, the export of tractors has increased by 28.13 per cent per annum. The international market for tractors has widened by 3.71 times during this period of seven years. The direction of exports has also changed drastically, as in 1987-88, 92.02 per cent of total exports was to Zimbabwe and Nepal, but in 1993-94 Sri Lanka, Nepal and USA were the main importers accounting for 82.23 per cent of total exports of tractors.

References

1. Chaudhari Shekhar, "Acquisition and Assimilation of Technology in the Tractor Industry in India: The Strategic Perspective". A dissertation submitted in partial fulfilment of the requirements for the FPM of the IIM Ahmedabad.
2. CMIE (1994), Basic Statistics Relating to Indian Economy, Centre for Monitoring Indian Economy Pvt. Ltd., August.
3. CMIE, 1995), Market and Market Shares for over 300 Industrial Products/ Product Groups, Centre for Monitoring Indian Economy Pvt. Ltd., February.
4. Dholakia Ravindra H. and Dholakia Bakul H. (1993), "Growth of Total factor Productivity in Indian Agroculture". Indian Economic Review, Vol.xxvIII, No.1.
5. Girija Sharan and *et al* (1974), "Characterization of the Process of Mechanization and Farm Power Requirement", CMA Monograph No.45, Centre for Management in Agriculture, Indian Institute of Management, Ahmedabad.
6. Girija Sharan and Sandeep Kayastha (1988), "Growth of Tractors in India: Past and Future", Working Paper No.758, Indian Institute of Management, Ahmedabad.
7. Government of India, Directorate General of Commerce Intelligence and Statistics, "Monthly Statistics of the Foreign Trade of India, Vol.I Export & Re-export", March, (for different years)
8. Government of India, Directorate General of Commerce Intelligence and Statistics, "Monthly Statistics of the Foreign Trade of India ", Vol.II, Imports, March, (for different years)
9. National Council of Applied Economic Research, (1980), Implication of Tractorization for Farm Employment, Productivity and Income. Vol.I, NCAER, New Delhi.
10. The Fertilizer Association of India (1994 & other years), Fertilizer Statistics 1993-94 (and other years), The Fertilizer Association of India, New Delhi.