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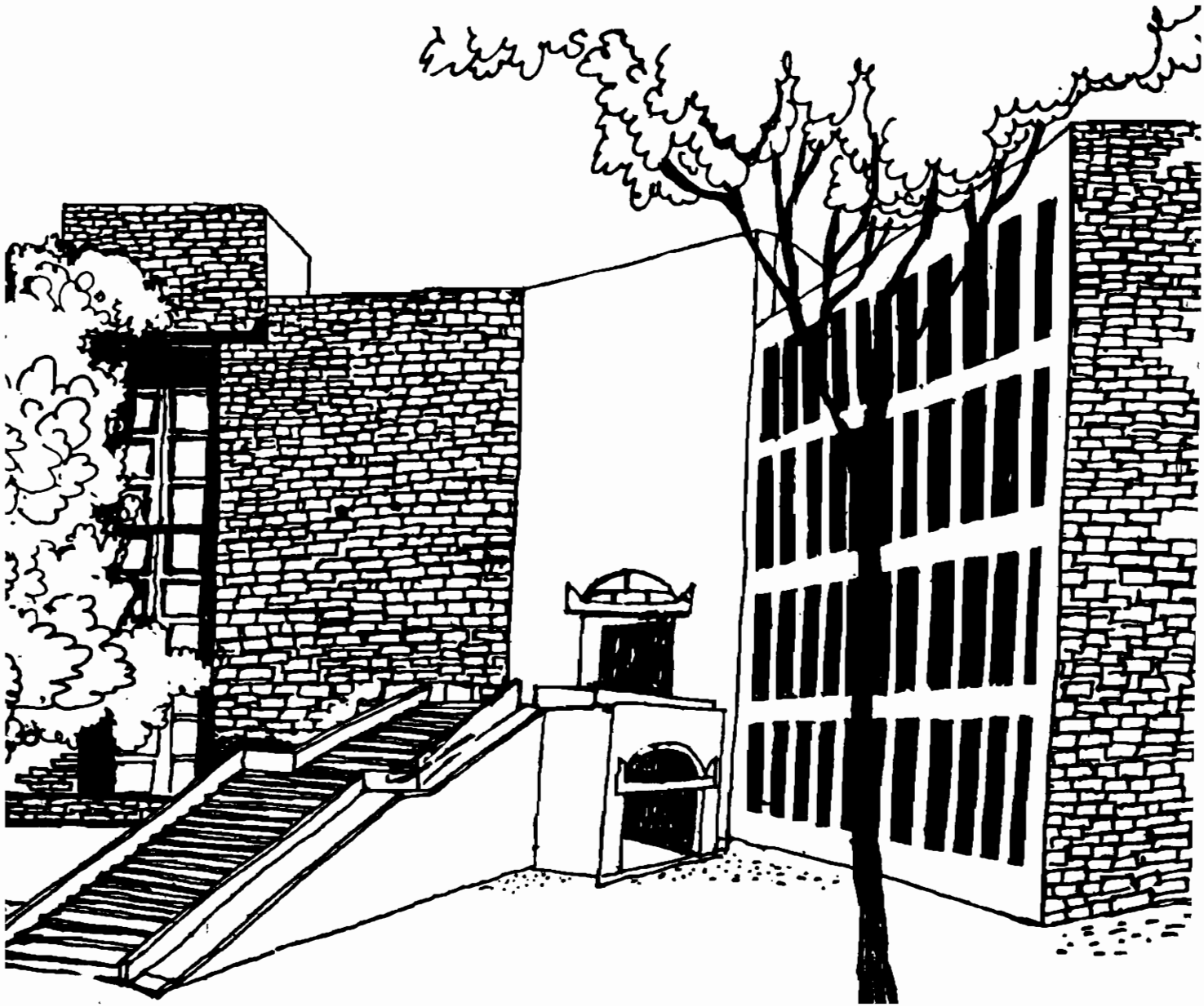

GROWTH AND ECONOMICS OF PESTICIDE USE IN INDIA: OVERVIEW-ANALYSIS OF THE ENVIRONMENT, PATTERNS AND MARKET POTENTIAL

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ABSTRACT

The pesticide industry is the most dynamic agricultural input industry in India, being substantially in private hands. Yet the pesticide use levels in India are among the lowest in the world. This paper presents an overview-analysis of the pesticide scenario in India. It develops a framework of the market environment within which the growth of pesticide use takes place in developing countries. It then uses this framework to study the growth and patterns of pesticide use in India.

It finds that pesticide use in India is highly concentrated by crop and geographic area, and is therefore showing declining growth rates. A major reason appears to be very limited market development efforts by the firms leading to poor conversion of a large potential into effective demand. Output markets/prices, input prices, high yielding varieties and wage rates play important roles in determining use. However, many non-price factors are also very important. Pesticides are also seen as an insurance by the farmers and therefore higher than optimum use is frequently reported. The new economic environment in India will offer ample opportunities for growth. However, the industry will need to look at the market environment more comprehensively and will need to play a proactive role in market development.

INTRODUCTION

The pesticide industry is at once the most complex and the most dynamic agricultural input industry in India. It comprises of over 650 firms of many different sizes and kinds selling over a thousand formulations with about 50 different active ingredients across thousands of villages and towns (David 1995, Srivastava and Patel 1990). It has shown tremendous development in the last three decades, with growth based primarily in the private sector, unlike in other input industries. Nearly 70 percent of the products sold by the industry go to the agriculture sector where they play a significant role in helping technological transformation, yield increase and growth.

The paper uses available information to examine the past pace and patterns of growth in the pesticide market in India, identifying major characteristics and important determinants. It examines the relevant changes in the macro-economic environment, and the emerging scenario under which the environment and policies for agriculture will take shape in the future. It analyzes, in turn, how the environment and policies are likely to influence the market environment for pesticides.

A FRAMEWORK FOR UNDERSTANDING THE MARKET ENVIRONMENT FOR PESTICIDES

The experiences across developing countries indicate that the growth of input markets is influenced by a large number of price as well as non-price factors (Desai and Gandhi 1988, Mellor and Ahmed 1989). The framework of neo-classical economics is usually unsuitable for explaining this growth because the market is in almost perpetual dis-equilibrium. For

understanding and analysis of this complex and dynamic market environment, a more comprehensive analytical framework would be extremely useful. Studies in the wake of explaining the growth and fluctuations of fertilizer consumption in India, China and Sub-Saharan Africa (eg. Desai and Stone 1987, Gandhi and Desai 1992) have indicated the relevance of a more comprehensive framework which can be used for understanding the market environment for agricultural inputs in developing countries. Based on this, a framework has been developed here for understanding the market environment for pesticides. The framework, being described below, has the following major components:

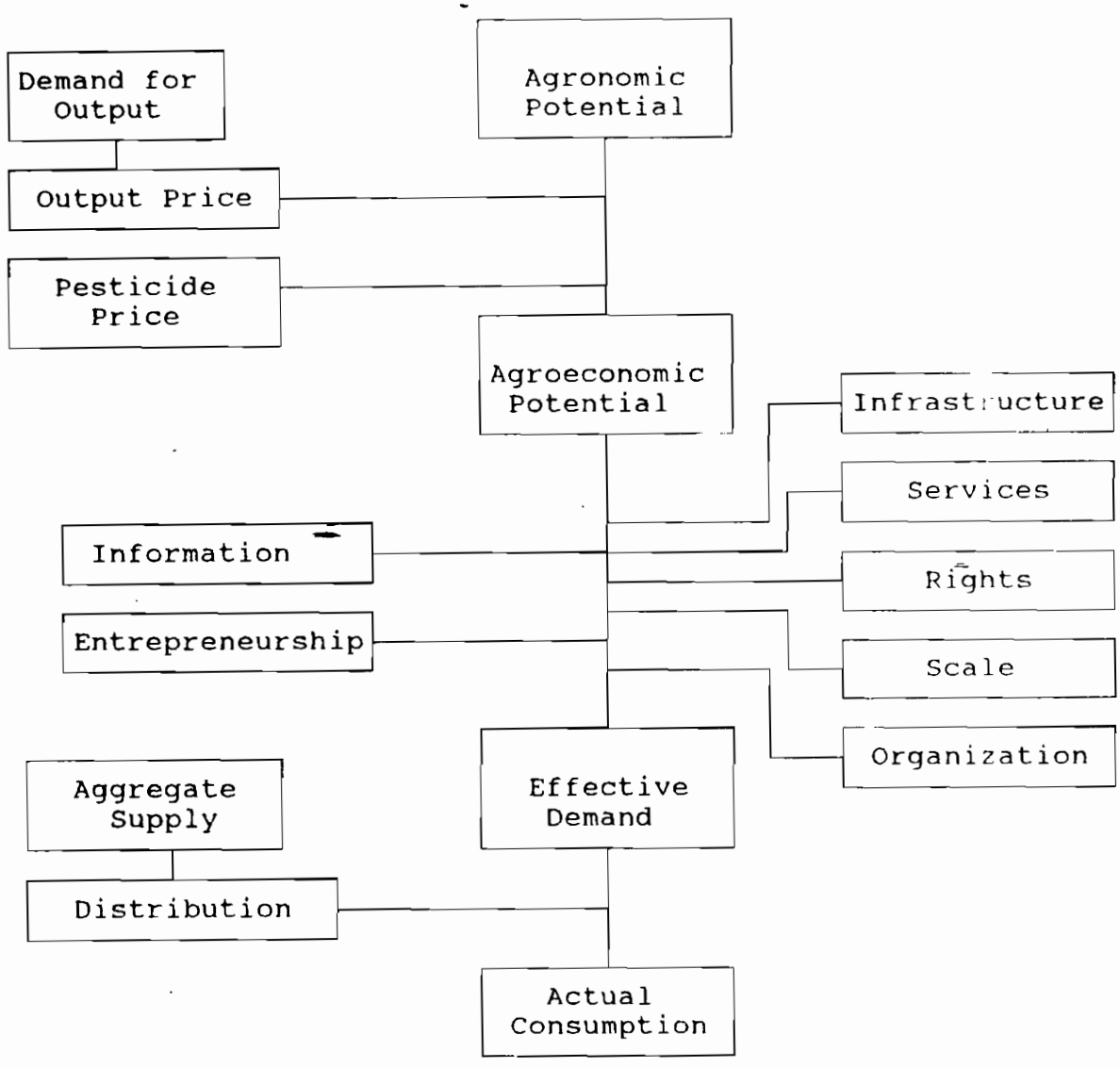
1. The Agronomic Potential
2. The Agro-Economic Potential
3. The Effective Demand
4. The Actual Consumption

The market environment can be conceptualized as unfolding through the developments within and the inter-relationship between these components. Figure 1 gives a graphical outline. The framework is being described below:

Agronomic Potential: Pesticides can be considered to be primarily yield saving inputs. Their basic usefulness to the farmer, and therefore their potential, comes fundamentally from the quantity of yield they are able to save. This gives their agronomic potential. They may also help to improve quality. They also help to reduce the uncertainty or risk of obtaining good yields, especially if they are used at the onset or for prevention. If no appropriate molecule is available for control, there is no agronomic potential. Research and development work is typically necessary for the creation of new agronomic potential for pesticides. However, given the toxic nature of most chemicals, the new molecules have to go through a process of screening and approval of the government - compliance with government regulations is necessary before the new potential can come on line. Pest resistance destroys the agronomic potential, and succeptibilty raises it. If the pest incidence/ infestation is low, the potential is low. Expansion of cropped area also expands the potential. The agronomic potential varies by crop and therefore cropping pattern influences the potential. Expansion of irrigation and adoption of high yielding varieties which are susceptible, also raises the agronomic potential.

Agro-economic Potential: The existence of an agronomic potential is not enough. Pesticides are typically expensive inputs. Unless the output that is lost (or can be saved) is of substantial value, farmers will not use pesticides. The price of the output must be significantly high relative to the price of the pesticide for the agronomic potential to be transformed to agro-economic potential. Thus, output markets and demand become important determinants. Pesticide use is typically more in marketed high-value cash-crops and commercialization of agriculture expands the potential for pesticides. Output price support programmes, and input prices can play a significant role. Herbicides save labour and labour shortage/ high wage rates enhance the agro-economic potential for herbicides.

Elements Determining the Market Environment for Pesticides



Source: Based on Gandhi, Vasant P. and Gunvant M. Desai (1992).

Figure - 1

Effective Demand: Typically, in a developing country especially with small farm agriculture, creation of an agro-economic potential may not be sufficient for there to be real demand. The farmer must know about this opportunity and must exhibit entrepreneurship in responding to this opportunity. Thus, dissemination of information and extension work as well as company promotion work becomes very important. Organization and land tenure also play a role. Poor infrastructure and lack of transportation services can seriously affect the conversion of a good agro-economic potential to effective demand, especially for small farmers. Besides, since subsistence agriculture lacks cash, and lags are involved in obtaining output, the provision of credit often becomes very important.

Actual Consumption: Even when effective demand has been created, actual consumption may be strongly restricted unless there is:

a. Aggregate Supply - adequate and reliable supply of the input is there - either through production or import. This is determined among other things, by the investment in production, the investment environment, government policies, foreign exchange situation, and other factors such as trade barriers and intellectual property right protection.

b. Distribution - a large and effective distribution system is developed for catering to small farmers scattered over large areas. This is especially difficult in the early stages when volumes are small.

The changes and developments within each of these components and the transformations across them can strongly influence the market environment and the actual consumption seen, thereby also influencing the pace of growth and patterns.

THE AGRO-CHEMICAL MARKET : PAST GROWTH & STRUCTURE

The growth of pesticide use has taken place under the market environment of the past. This section analyses the pace and patterns of the past growth in pesticide use.

Volume and Growth

Pesticide use levels in India are very low. India has one of the lowest rates of pesticide use per hectare in the world (Farah, 1994 - World Bank). According to one estimate (Mehrotra and Phokela 1995) the technical grade pesticide use level is 10.8 kg/ha in Japan, 6.6 kg/ha in Korea, 1.5 kg/ha in USA and only 0.3 kg/ha in India (see Table 1). On a per capita basis the use level would be extremely low. The market share of India in the world for pesticides is only about 3 percent (David 1995). Typically, such low use levels in a country (such as India) reflect a vast potential which has not been converted to effective demand.

Table - 1 : Area-wise Usages of Pesticides Across Countries

Country	Use Level (kg/ha)
Japan	10.8
Korea	6.6
Europe	1.9
USA	1.5
Thailand	1.4
Indonesia	0.6
India	0.3
L.America	0.22
Africa	0.13
Oceancia	0.2

Source: Mehrotra, K.N. & Amrit Phokela (1995).

It is estimated that the turnover of the pesticide industry in 1993 was about Rs. 1350 crores (David 1995). Imports are very limited. Insecticides account for 70 percent of the pesticide production, and out of insecticides BHC and DDT account for 63 percent - BHC alone accounting for 50 percent. Thus, the use of all other pesticides put together on a per hectare basis is very low. As yet only about 25 percent of the cropped area receives pesticides. This

figure of coverage is close to 50 percent for high yielding varieties, and 70-80 percent for fertilizers. Thus, even on basis of area, a significant growth potential exists for pesticides.

Figure 2 shows the growth of pesticide consumption in India based on the available estimates. Based on different available estimates of pesticide consumption in India the growth rate of pesticide consumption has been estimated to be of the order of 8 to 9 percent per annum between 1950/51-1992/93, 3 to 4 percent between 1970/71-1992/93, 3 to 4 percent between 1980/81-1992/93, and 1 to 3 percent between 1986/87 and 1992/93. The fall in the growth rate is in part due to the expanding volume base of pesticide consumption but also reflects the high concentration of use - continued narrow geographic and crop base of pesticide use.

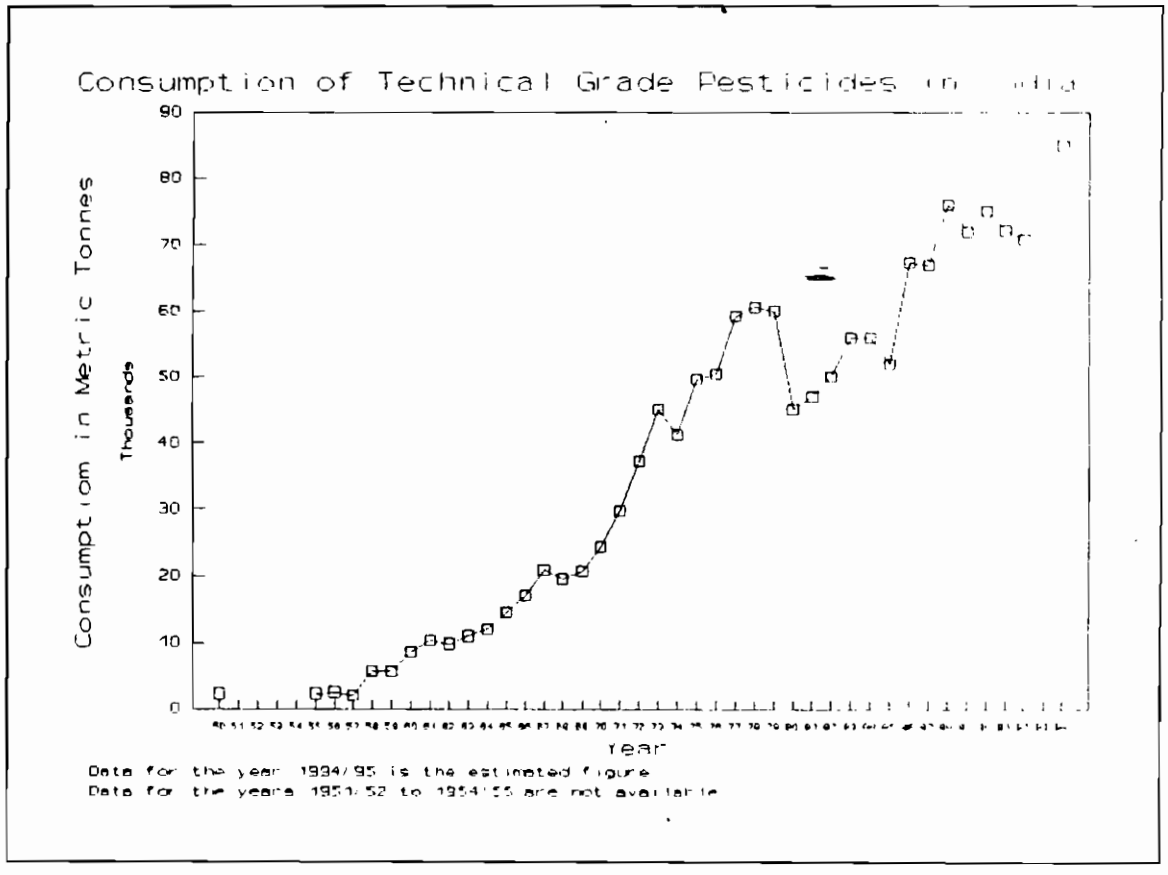


Figure-2

Products and Patterns

There is a very wide difference between the structure of pesticide use in India and the world. The figures in percentages are as given in Table 2. The international structures and patterns in demand are frequently good indicators of long-term tendencies, and national patterns very often move towards international patterns in the long-run as development proceeds. This implies that even though insecticides would continue to be important (especially in the tropical context), a rapid growth would be seen particularly in herbicides, and also in fungicides and other pesticides/ chemicals. Growth rates indicate that this has already begun to happen.

Table - 2 : 1991 Percentage Share of Three Groups of Pesticides in Some National Markets and the world as a whole

Pesticide Group	USA	China	India	World
Insecticide	23.0	59.0	77.0	29.4
Herbicides	64.0	22.0	10.5	45.4
Fungicides	8.0	19.0	10.0	19.4
Others	5.0	*	2.5	5.8

Note: * included in other sectors, not given separately.
Source: Verma, J.S. (1995).

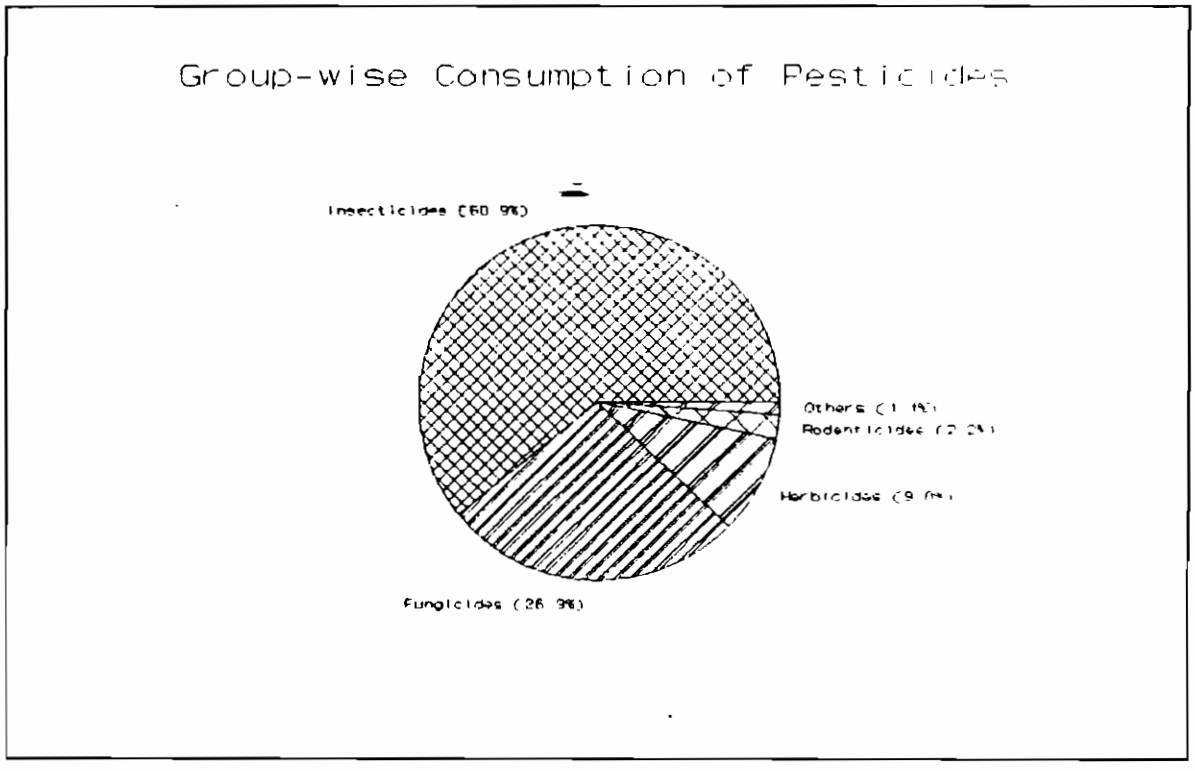


Figure - 3

The product group-wise levels of consumption over a set of available years are shown in Figure 3. Even though insecticides dominate in the volume of consumption, their growth is much less rapid. On the other hand fungicides show a more rapid growth, and herbicides an even more rapid rate of growth. Rodenticides too show a rapid rate of growth. Thus, the product group composition is undergoing a rapid change and is shifting towards herbicides and fungicides.

Since the discovery of the initial group of inorganic pesticides, a succession of new generations of molecular groups of pesticides have been emerging. Detailed figures on pesticide consumption indicate that a very large number of different pesticide molecules are on the market in India - about 34 insecticide molecules, 18 fungicide molecules, 12 herbicide molecules and 2 rodenticide molecules (Mathur 1993) (Space does not permit the giving of details of consumption). Among the insecticides, apart from BHC and DDT which have by far the largest volumes, the other molecules with large volumes are Monocrotophos, Endosulfan, Methyl Parathion, Phorate, Phosphamidon and Dimethoate. Among the fungicides the largest volumes are seen in Sulphur

Dust, Mancozeb, Copper Sulphate and Copper Oxychloride. Among the herbicides, the most important molecules by volume are Isoproturon, 2,4-D, and Butachlor. In the rodenticides, Aluminum Phosphide is relatively more important in volume.

There are far more number of molecules available in the world, and therefore, substantial scope for expansion of the product set. One limitation is the Indian law (Insecticide Act of 1968) which recognizes process and not molecule patent rights, thereby discouraging multi-nationals in introducing new molecules. This restricts the aggregate supply and through it the consumption.

Crop-wise and Regional Patterns

Crop-wise figures on pesticide consumption are difficult to obtain. Available figures (Figure 4) indicate very high concentration in pesticide use (Srivastava and Patel 1990). Cotton leads with an enormous 44.4 percent share in the pesticide consumption even though only about 4-5 percent

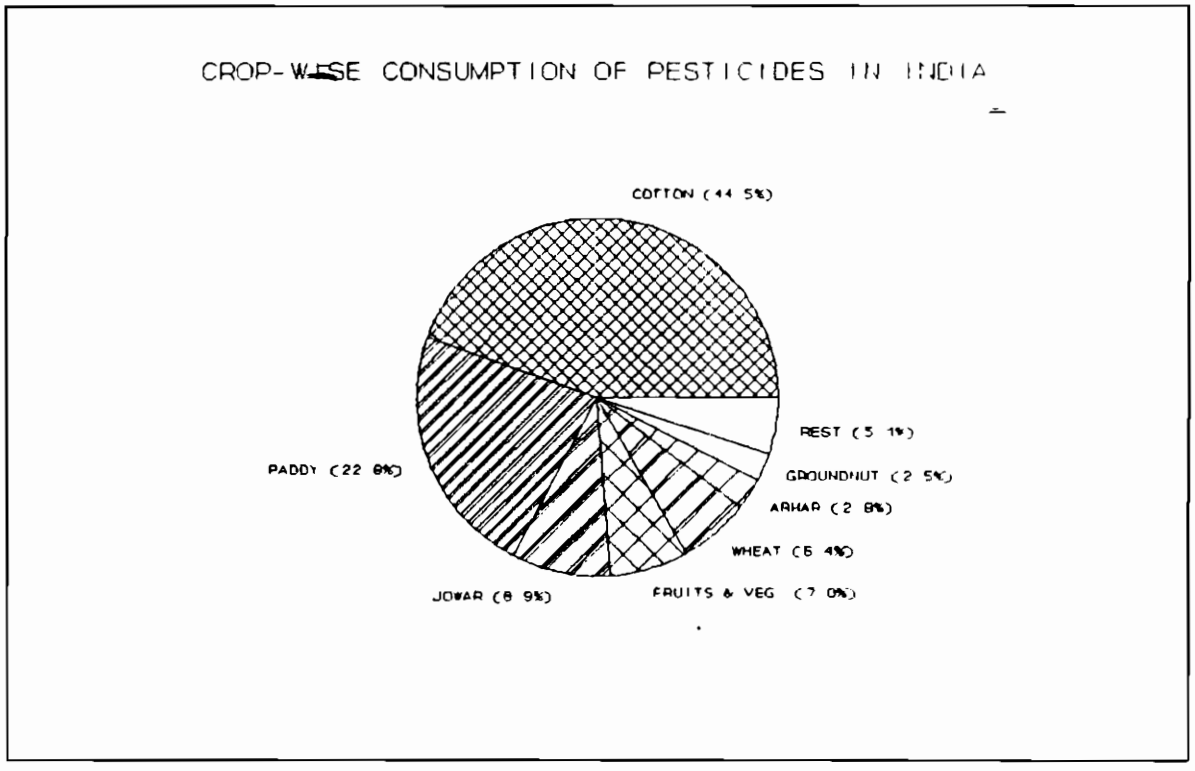


Figure - 4

of the gross cropped area is under cotton. Paddy is the next with a share of 22.8 percent and has a nearly equal (23 percent) share in the gross cropped area. These are followed by jowar with 8.9 percent share and wheat with 6.4 percent share. Six crops account for almost 90 percent of the pesticide use. These are: cotton, rice, jowar, wheat, ground-nut, and tur. This high crop-wise concentration reflects the nature of the agro-economic potential, but is also indicative of very limited efforts in converting potential to effective demand.

Geographic concentration of pesticide use is also very great. Figure 5 indicate that the Andhra Pradesh leads in pesticide consumption with a 16.1 percent share. This is followed by Uttar Pradesh with a 13.6 percent share. 5 (of the 16) states account for nearly 60 percent of the pesticide consumption. Studies indicate that if the identification is done by districts, the

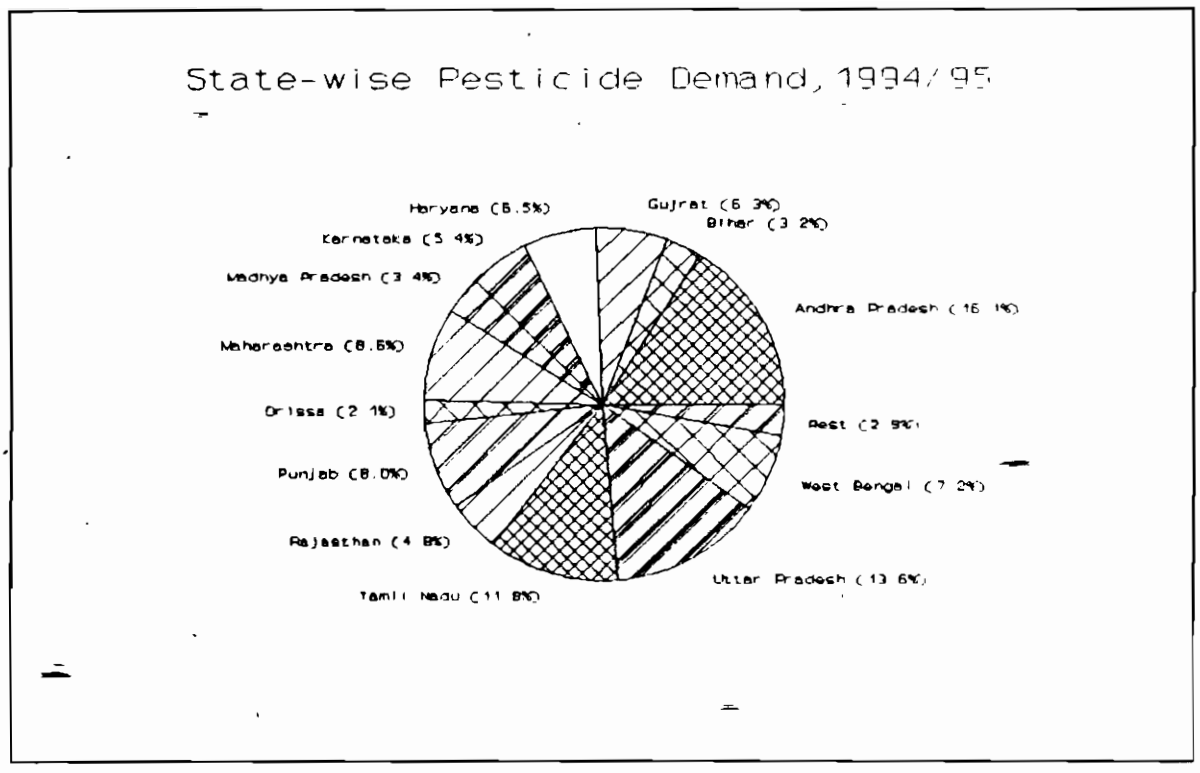


Figure-5

geographic concentration is much higher. This reflects the very limited efforts made by the pesticide companies in developing new markets and spreading the use to new areas and crops. This is constraining the growth rates.

Industry Structure and Distribution

Pesticide production in India is carried out by about 650 firms of which 500 are in the small scale sector (David 1995). Another estimate puts the number of firms at about 850 (Srivastava and Patel 1991). The small scale sector is only engaged in making formulations whereas the large scale sector produces both technical grade material and formulations. Out of 65 firms in large scale sector there are both multinationals and Indian corporates. The bulk of the production of DDT and BHC is in the public sector. Except for malathion, ethion, fenvalerate, cypermethrin and aluminum phosphide, most other products have a marked market concentration in that one company has a predominant market share. The top 10 companies account for 80 percent of the production, and the top 16 companies for 94 percent of the production (David 1995). Thus, there is substantial concentration in this industry. The major reason appears to be the resources and capabilities required, especially the research capabilities and investment required for new molecules, and the power this commands.

The basic industry structure of manufacturing and distribution is depicted in Figure 6. By a scheme introduced by the central government in 1974, manufacturers of certain technical grade pesticides were required to allocate 50 percent of their technical grade pesticide produced to the state governments. This is available to non-associated formulators, the objective being to ensure better availability and prices to the farmers. The scheme applies to 6 important pesticides. However, associated formulators get raw material, credit and other support more easily. In the final picture, the technical grade manufactures have about a 60 percent market share in the

formulations market, the non-associated formulators 20 percent, 15 percent being with the government and the rest with small distributors/ retailers (David 1995). Technical grade manufactures also collect the lion's share (61.4 percent) from the customer rupee (Table 3). However, the presence of "Me-Too" formulators affects quality standards in the market and inhibits the market development initiatives and investments of technical grade manufactures.

The figures on total production of pesticides over the years by product groups is given in Table 4. Insecticides clearly dominate, followed after a huge margin by fungicides and then herbicides. The production had increased by 33 percent between 1982/83 and 1992/93. Sales figures of the members of the Association of Basic Manufactures of Pesticides are given in Table 5. Rallis,

Table - 3 : Share of Various Contituents of Pesticides Industry in Consumer's Rupee

	Constituent	Share (%)
1.	Technical Grade Material Manufacturers	61.36
2.	Formulators	12.00
3.	Government	11.68
4.	Retailers	10.01
5.	Distributers	4.95
	Total	**100.00**

Source: Srivastava, U.K. & N.T. Patel (1990)

Table - 4 : Progress of Production of Pesticides in India

Year	Insecticides (Mt. Tonnes)	Fungicides (Mt. Tonnes)	Herbicides (Mt. Tonnes)	Rodenticides (Mt. Tonnes)	Others (Mt. Tonnes)	Total (Mt. Tonnes)
1952.53	200					200
1953.54	154	598	60	104	11	154
1954.55	432	1411	14	269	135	432
1955.56	2303	2191	240	39	15	2303
1960.61	6729	1906	454	188	645	7442
1965.66	10428	3104	417	144	293	12168
1970.71	21722	3216	426	182	778	23501
1975.76	32898	2552	580	200	607	35247
1978.79	45500	2733	1069	260	702	49847
1979.80	46115	2927	981	306	1063	50223
1980.81	39306	2815	1554	340	1202	43262
1981.82	44278	3946	1818	355	1106	48658
1982.83	53922	3828	2151	283	1452	57926
1983.84	53519	4552	2180	429	800	58718
1984.85	51468	4030	3000	460	10	58550
1985.86	47885	7700	2860	70		54922
1986.87	47602	6600		100		56186
1987.88	49370					56920
1988.89	54480					65880
1989.90	56000					66470
1991.92						75000
1992.93						77000
1993.94						

Note: Disaggregate data are not available for several years.
Source: David, B. Vasantharaj (1995)

Table - 5 : Company-wise Sales Values of Pesticides in India (Rs. Crores)				
S.No.	Company	1989	1990	1991
1	Ciba-Geigy	65.27	83.2	117
2	Nocil	70	78.5	98
3	Bayer	69	77.6	115
4	Exel	58	79	85
5	Hoeechst	64.2	68	80
6	Sandoz	67	80.2	58
7	Shaw Wallace	38	44	54
8	ICI	36	40	48
9	Indofil	30	33.6	40
10	Cyanamid	28.1	34.2	43
11	BASF	19.47	30.3	37
12	Searle	28.1	27.1	30
13	Rallis	82	98	140
14	BPM	50	55	45
15	R.D.Agro	20	22	20
16	Monsanto	15	17	15
17	Gharda	48	52.8	77
18	HIL	40	44	44
19	Others	153	177	186
	Total	**981.14**	**1141.5**	**1332**

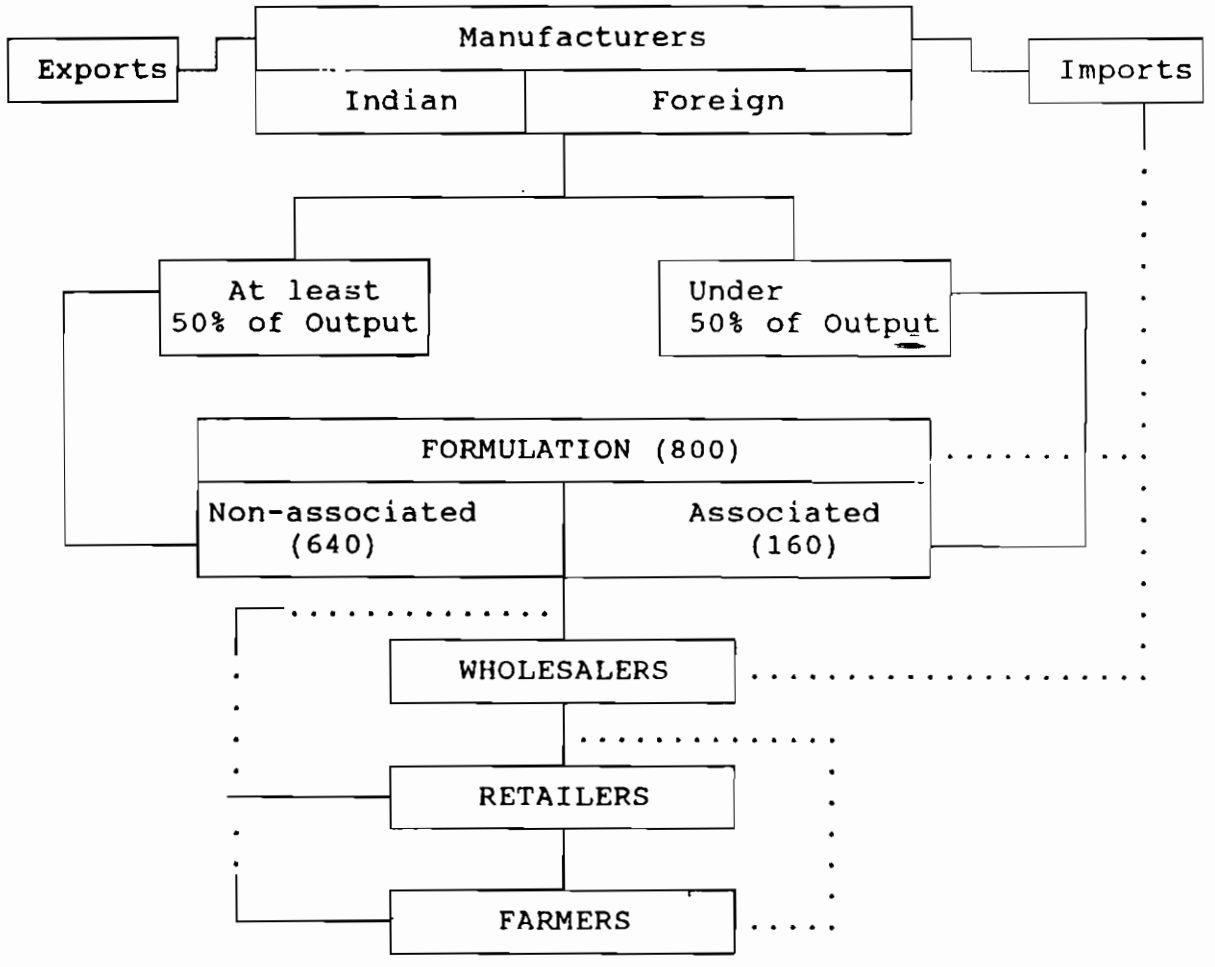
Source : David, B.V. (1995).

Table - 6 : 1992 Global Pesticides Sales Turnover of Top 15 Companies		
Sl. No.	Company	Million US $
1	Ciba-Geigy	2831
2	Du Pont	1995
3	Bayer	1869
4	Rhone-Poulenc	1842
5	Zeneca	1716
6	Monsanto	1647
7	Dow Elanco	1581
8	Hoechst	1333
9	BASF	1142
10	American Cyanamid	1000
11	SAndoz	841
12	Schering	788
13	Shell	725
14	FMC	455
15	Sumitomo	417

Source: Verma, J.S. (1995).

Ciba-Geigy and Bayer are the largest in 1991. Internationally, the companies ranked by their global sales turn over are given in Table 6. Ciba-Geigy, Du Pont and Bayer are the largest.

The Scheme of Manufacture and Distribution is as follows:



Total Sale Points 77080

Primary route
Secondary route

Source: Srivastava, U.K. and N.T. Patel (1991).

Figure - 6

The marketing/distribution of pesticides is done through state departments, cooperatives and private outlets. According to one estimate (Srivastava and Patel 1990) there are over 77000 distribution points/ retail outlets. Of them, most are private, followed by cooperatives and state department. The highest number of outlets are in Andhra Pradesh, followed by Tamil Nadu and then Gujarat.

EMPIRICAL EVIDENCE

Multiple regression analysis using available official time-series data from early-1950's to late 1980's-early 1990's (between about 30 to 40 observations) indicates (see Table 7) that some of the major (statistically significant) determinants of pesticide consumption levels over time are as follows. High yielding varieties area has a consistent positive association indicating the importance of agronomic potential in the market environment. Crop output prices have a positive association (90 percent level), and pesticide prices have a strong negative association - indicating the importance of agro-economic potential in the market environment. Besides, wage rates have a positive association again indicating the importance of agro-economics.

Gross cropped area is not found to be a statistically significant determinant. Area growth has not been an important factor in production growth in India for several decades now. Irrigation by raising the agronomic and agro-economic potential through yields, and also escalating some pest problems, should lead to greater pesticide use. However, this association is found to be positive but not consistently robust in India, possibly because of the dominant use on cotton which is largely unirrigated.

Table - 7 : Results of Linear Model Estimates: Factors Affecting Pesticides Consumption in Agriculture

Model No.	Constant	Regression Coefficients						R-SQ
		Price Crop Output	Price Pesticide	Wage Rate	Area Gross Sown	Area Gross Irrig	Area Under HYV	
1.	-5134.52	218.833 (1.859)	-338.829 (2.977)			576.176 (0.618)	952.162 (2.539)	0.95
2.	33110.52	222.588 (1.869)	-352.957 (3.019)		-278.174 (0.675)	759.211 (0.775)	996.671 (2.592)	0.95
3.	-24243.5					1204.788 (2.416)	387.824 (1.504)	0.94
4.	2147.47	62.231 (0.352)	-371.569 (3.193)	98.785 (1.180)		441.748 (0.474)	1096.556 (2.798)	0.95
5.	577.238		-356.854 (3.341)	120.892 (2.221)		530.954 (0.602)	1081.041 (2.822)	0.95

Note: Figures in parentheses are the t-statistics of the coefficients.

In other evidence, studies of cost of cultivation in major green revolution areas such as the Punjab (Gandhi 1996) have shown that the expenditure on pesticides has increased very rapidly, far more rapidly than that on any other input. However, its contribution to increase in the total cost of production has been very little. This is because the share of pesticides in the total cost of production is very small. This also indicates that the farmer sensitivity to pesticide prices in such areas may not be very high. The study also indicates that labour has a very large share in the cost of production. Thus, even small increases in the wages would lead to a profit squeeze and a shift towards adoption of labour saving technology - particularly herbicides. This trend is observed substantially in the labour intensive crop of rice in Punjab.

The rise in the wages would be related to the opportunities for employment in the agriculture and non-agriculture sector (both organized and unorganized sector employment), slowing down of the population growth, urbanization, and more labour intensive opportunities in the agriculture sector eg. livestock and vegetable crops. All these factors are showing movement with

development in the recent years and these would lead to wage increases and rapid expansion in potential for herbicides. Herbicide use in rice is found to be lower in traditional rice areas but in non-traditional irrigated rice areas such as Punjab and Haryana, substantial expansion in herbicide use has taken place (Naylor 1994). This is related to the labour intensity of rice and the shortage of labour/ high wages in these areas. Herbicide is making rice cultivation possible (and profitable) in some of these areas. However, environmental costs are there.

Weeds reduce yields by upto 33 percent (Gautam and Misra 1995). Relative to tractors, weedicides have a stronger labour substitution effect (Narayan 1992) but weedicides help to substantially reduce the cost of production.

For cotton in Andhra Pradesh, the expenditure on pesticide is found to be the highest on large farms (Pandurangadu and Raju 1990). 93 percent of the pesticide expenditure is on insecticides - 56 on conventional and 37 on Synthetic Pyrethroids. The elasticities for pesticides from Cobb-Douglas production function estimation come out to be non-significant for all categories of farms, showing zero marginal product. This suggests excessive/ indiscriminate use. Many more sprays were reported than recommended. Cost of cultivation of cotton was reported to be rising due to such pesticide use, and use of expensive pesticides.

Apart from complementarily, there is also competition between yield saving (eg. pesticides) and yield increasing inputs (eg. fertilizers) (Seeta Prabhu 1985). It is found that when faced with yield uncertainty, the farmers who are risk-averse tend to use higher than optimal levels of yield saving inputs and lower then optimal level of other inputs. The marginal value product of pesticides is often found to be lower then its price. The major motivation of pesticide application becomes the provision of some insurance against damage. As a result more pesticide is used than is economically optimal (in direct terms). Besides, large farmers use more pesticide due to their financial capacity. Aggregate production function coefficient of pesticides is not significant (Upender 1995). But integrated pest management significantly reduces the pesticide use (Burrows 1983). Pesticide consumption in India is significantly affected by the price of pesticides, and area under high yielding varieties (Gopal and Gopal 1995).

Between 1971/72 and 1988/89 pesticide expenditure in Rs./ha in India show negative growth rates in the Eastern (-2.0) and Western (-8.7) regions, a very high positive growth rate in the Northern region (32.4) and a high positive growth rate in the southern region (8.8) (Kumar and Rosegrant 1994). Between 1971-75 and 1986-88, the share of pesticides in the cost structure rose from 0.3 to 1.2 percent.

Pesticides fall into the category of extended problem solving type of decision-making in the buying behaviour of farmers (Venugopal 1994). Impulsive buying is rare. New pesticides first have to enter into the consideration set of the buyer. Then they have to win or find a niche within this set. Thus, in a competitive market place, new entrants would not find it easy to enter. Brand equity and brand loyalty are very important.

EMERGING ECONOMIC ENVIRONMENT FOR PESTICIDES MARKET

As is evident from the frame-work, the agro-chemical industry has substantial micro-macro linkages with many different aspects of the economic environment. Besides, the macro-environment has changed substantially in India since the announcement of the new economic policy in mid-1991 leading to increasing liberalization of the economy.

The liberalization has set the direction for increasing fiscal discipline. The achievements on this front have been somewhat slow to come but the direction has been clear. The popular belief of

unlimited government funds has been broken. Clear signals have been sent to every front that the Central Government does not have unlimited funds to subsidize and bale-out every activity and therefore the activities must be either self-reliant or be discontinued. Since the fiscal deficits are still high (Dholakia, 1995), this fiscal pressure is likely to continue into the future.

The implications for agriculture are that pressures to reduce subsidies to agriculture will continue - major subsidies are in irrigation, fertilizers and electricity. However, minimum support prices which take into account the cost of cultivation are also likely to be raised, as happened in 1993, and as a result profitability of agriculture will be protected (Acharya, 1995). This is also because prices of most agricultural commodities in India are lower than world prices, and subsidy levels are lower than in developed countries (Gulati and Sharma, 1991). Besides, the reforms are especially careful with agriculture since it is considered a sensitive sector (India, Ministry of Finance, 1993, Bhagwati and Srinivasan 1993).

Liberalization has also ushered in a policy of phased opening out of the economy to international trade. It also opened out the economy to foreign investment. GATT and the WTO has added another major dimension to this: a time-table for phased opening out/reduction in barriers and subsidies not only for India but all around the world has been set.

It is believed that this will have a large net positive effect for the agriculture sector of India (Oza 1995, Nachane 1995, Gulati 1995, Gulati and Sharma 1995). Even though the agriculture sector receives many subsidies, but when output side price distortions are taken into account, agriculture is found to be net taxed in India (Gulati and Sharma, 1991). As a result, trade liberalization in the wake of GATT should bring new opportunities to the agriculture sector in India and enhance its profitability rather than other-wise.

It has been established that cotton, which is the largest pesticide using crop in India, has substantial international competitive advantage (Gulati and Sharma 1991). As a result, trade liberalization will result in enhanced prospects for this crop and therefore a positive effect on pesticide use. Even for foodgrains this year, there has been a substantial rise in exports which will help enhance the profitability and have a positive effect on pesticide use.

The improvement in the protection of intellectual property rights (IPR) in the wake of GATT and WTO will result in a better environment for the growth of the agricultural input industry, particularly, the pesticide and seed industry, where substantial investment in research and development is involved. With better IPR protection, more firms will be encouraged to undertake R & D efforts and will be encouraged to introduce new products. In a competitive environment, this will help to expand the market.

Even though the rate of population growth in India is declining, India's population will continue to grow substantially well into the next century, crossing 1 billion soon after the turn of the century. Feeding such a huge population will continue to be a major problem and priority for a long time to come. With reasonable income growth assumptions, the food situation is likely to be one of either near self-sufficiency or of significant deficit in the 2000-2005 time frame (see Table 8, Sarma and Gandhi 1990). As a result, agriculture will continue to receive priority.

Table - 8 : Projected Foodgrain Supply-Demand Balances Under Alternative Scenarios of Production & Consumption Projections in Year 2000

	Consumption Scenario		Total Demand	Production Scenario		
				(1)	(2)	(3)
				219.4	210.7	215.2
						(Million Metric Tons)
1	Consumption of Past Per Capita Income Growth Rate	a) b)	206.4 214.8	13 4.6	4.3 -4.1	8.8 0.4
2	Growth Rates Envisaged in the Perspective Plan	a) b)	219.7 227.3	-0.3 -7.9	-9 -16.6	-4.5 -12.1
3	First Accelerated Growth Rate Scenario	a) b)	226.3 233.3	-6.9 -13.9	-15.6 22.6	-11.1 -18.1
4	Second Accelerated Growth Rate Scenario	a) b)	234.5 240.7	-15.1 -21.3	-23.8 -30	-19.3 -25.5

Source : Sarma, J.S. & Vasant P. Gandhi (1990).

Note: a) Without change in income distribution.
b) With improvement in income distribution.

Nearly 70 percent of the population depends directly or indirectly on agriculture for livelihood, and this has hardly changed in the past decades. Industry as yet does not have the capacity to absorb such a large labour force. Thus, even from the point of view of employment and income, agriculture will continue to be extremely important and receive priority.

Environmental concerns have emerged into the lime-light over the last decade. The environmental costs of growth are being increasingly questioned (Rao 1995, Reddy 1995, Nadkarni 1994). This will have implications for the pesticide industry since pesticides are toxic and are seen as a major risk to the environment.

However, in a country such as India where income levels are very low, unemployment is massive, employment and income growth are still very major priorities. Besides, since agriculture produces a necessity such as food to feed a huge and growing population, a healthy performance of the sector assumes tremendous importance. Agriculture also contributes substantially to export earnings. Thus, growth assumes priority unless any individual environmental issue (such as the Sardar Sarovar dam on Narmada) becomes a major problem centre. Objectives are typically thought of in terms of achieving growth with protection or minimum damage to the environment (Rao and Gulati, 1994). Besides, pesticide use levels in India are among the lowest in the world (Farah, 1994 - World Bank).

Regulations with respect to the introduction of new pesticides, and re-evaluation of existing pesticides is already established through the Insecticide Act and will continue to be important. Besides, the thrust towards integrated pest management, more environment friendly pesticides, as well as grass-roots remedied/innovations will grow (Pastakia 1996).

Fruits of liberalization have been felt by a very large number of people. A significant and widespread change in the mind-set has taken place in the country (Das 1995). Given these, as well as the need for maintaining growth and international competitiveness is likely to make liberalization nearly irreversible.

SOME CONCLUDING OBSERVATIONS

These observations are based on the framework of the market environment, the above analysis and observations on the Indian agriculture sector. Pesticide use is presently highly concentrated by area and crop. Efforts for converting potential to effective demand in the spread to new areas is likely to be particularly important for growth of pesticide use in the future - more than spread to other crops. This is a major challenge to the industry, given the dwindling government investment and development efforts.

Apart form strong output demand, other important basic factors which are likely to drive the potential are: Changes in the cropping pattern - related to domestic and international markets eg. move towards cotton, fruits and vegetables; growing of crops in more adverse conditions eg. early or late, or off-season crops; growing of crops in new areas where conditions are not as conducive as in the principal areas.

Farm level factors which will be important include: Growing of high yielding varieties; growing in the off-season; use of more irrigation water, water-logging, humidity; use of fertilizers; mono-culture including same variety over large areas; multiple cropping - no fallow; market demand based changes - for instance the need to provide quality, good looking, undamaged, disease free products at as low a price as possible; labour shortage - labour substitution; less tillage eg. not doing summer ploughing.

Other demand related factors include: greater awareness about the extent of pest damage and pesticide alternatives for saving it - Company promotion will play a major role here; easier availability of pesticides - more outlets, more responsive outlets, better infrastructure; easier supply and availability of molecules - through greater property right protection; less tolerance for damage/ higher quality standards for the output market - domestic and exports. The serious problem of pest resistance will require the need to continuously develop and introduce new pesticides.

Particularly, the growing demand for agricultural output which is low in price and good in quality will play a major role in creating demand for pesticides. The need for quantity and low price stems from the combination of population pressure, low incomes and a high budget share of food in the expenditure. The need for quality stems from the impact of the media, and the large middle class.

India's Planning Commission projects the total pesticide demand to reach 100,000 MT for agriculture and 44,000 tonnes for public health by the year 2000. At this rate of growth the demand will reach at least 121,500 MT for agriculture by 2005. This is a 43 percent increase over 1994/95. These figures under-emphasis the relevant growth since they include the phasing out of old pesticides - the demand for new pesticides is expected to grow much faster. Besides, recognition of the wider potential and market development efforts by the industry would further accelerate the change.

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