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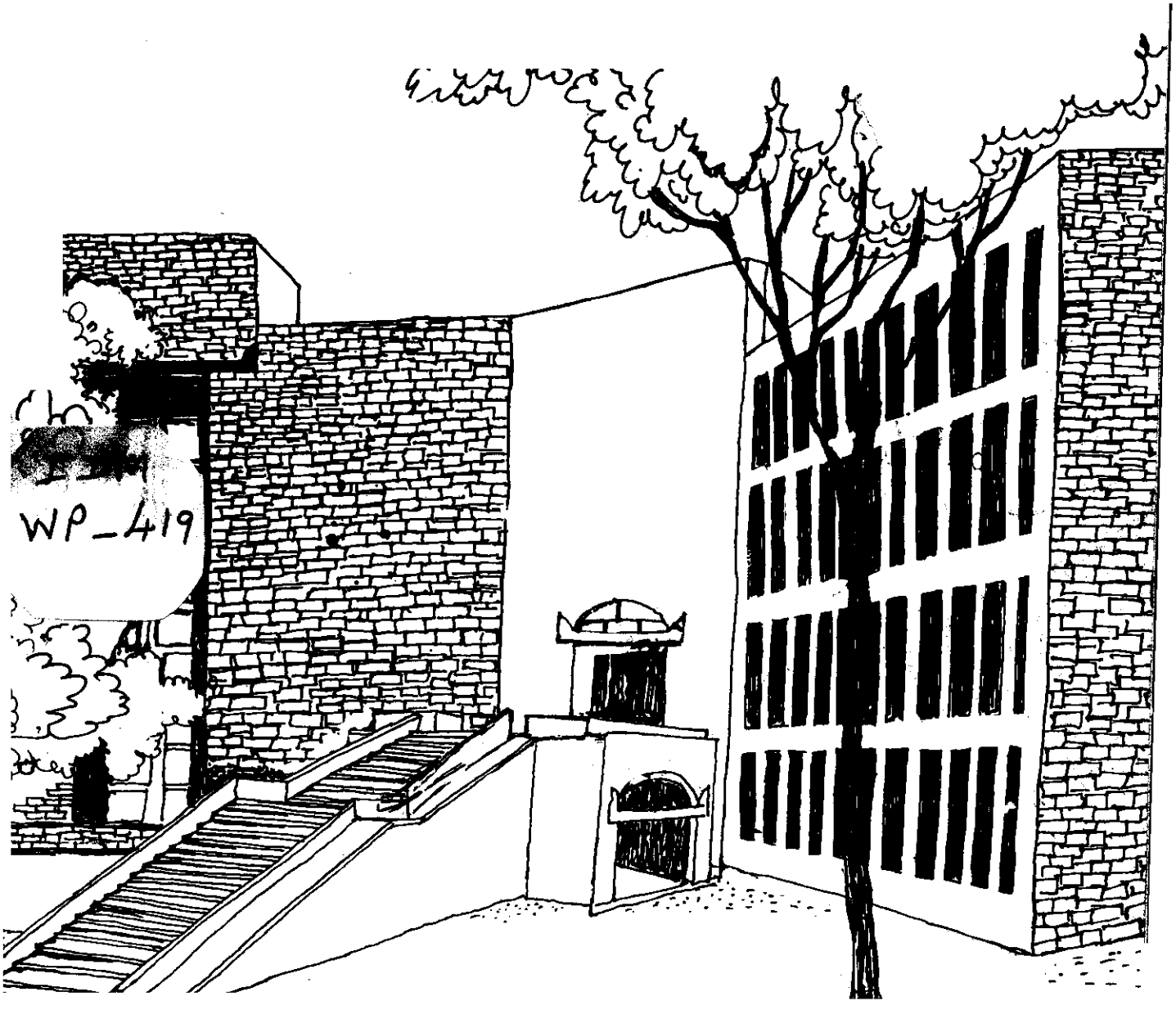

PESTICIDES INDUSTRY: AN ANALYSIS OF IMPORTS, PRODUCTION AND CONSUMPTION

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PESTICIDES INDUSTRY: AN ANALYSIS OF IMPORTS, PRODUCTION AND CONSUMPTION

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It is generally known that the present policy of government is to encourage production of pesticides in the country and reduce reliance on imports. The pesticides industry is in the core sector of industrial development. The industry's performance can be ascertained by different yard sticks. Some of the commonest ones used are the extent to which dependency on imports has declined, increases in indegenous production capacity and its utilization. Though considerable import substitution has taken place comprehensive statistical studies on trends of imports, production and consumption are not available.

"Pesticides" include widely different chemicals both in their manufacture and use. Traditionally, for market analysis and policy formulation for production and subsidy, they are grouped together. The principal groups which constitute "Pesticides" are i) insecticides, ii) fungicides (including bactericides) for control of diseases caused by fungi and bacteria, iii) fumigants for destruction of storage pests, iv) acaricides used to control certain arthropods, v) nematocides

used to control a group of worms unrelated to arthropods, vi) weedicides, vii) growth regulating hormones and viii) raticides. Registration is required for all those in the schedule of the "Insecticides" Act 1968, or those so notified. In regard to these chemicals, there has been technological development, as a result of which the new chemicals are more potent and are required in smaller quantities.

In this study we have statistically examined, the growth rates of imports and production. An important issue in considering the pesticides is the quality of imports and production. An attempt has been, therefore, made to evaluate this aspect by assessing growth rates of fungicides and insecticides separately and area protectable by the insecticides. A review of literature precedes the analysis of imports and production of pesticides.

METHODOLOGY AND DATA

In a statistical analysis of imports, production and consumption, the methodology to be adopted is important. The approach generally used is that of growth rates as per different regression equation models. For determining growth rates, one can adopt the following four regression models.[1]

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[1] Reddy VN, "Growth Rates" Economic and Political Weekly 13(19) pp 806-811, May 13, 1978.

A : $Y_t = a + bt$

B : Exponential $\log Y_t = a + bt$

C : $\log Y_t = a + bt + ct^2$

D : $Y_t = a + bt^2$

where Y = dependent variable (production, imports and consumption as the case may be)

t = time period measured in year (t_1 = 1965-66)

The available sources of data of consumption of pesticides are as published by earlier workers, and, those compiled by reporting agencies in the various states for the zonal meetings convened by the Ministry of Agriculture each year. The methodology of compiling the latter varies with states and, therefore, data have not been considered comparable. Further it has not been possible to compile time series data based thereon.

Official import statistics[2] have been used by us. As regards, production, the annual reports of the Director General Technical Development, New Delhi are the standard sources. Based on these, Table 1 provides imports and production. Due to a total absence of data on carry over stocks of pesticides each year, the availability is equated with the total of production and imports. In this compilation, sulfur, which has varied

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[2] Monthly Statistics of Foreign Trade Vol. II, Imports

used outside the area of plant protection, was excluded. The exports which form a small part, were also not accounted for. Pesticides consumption for public health programmes has a significant share. In the past, only one attempt has been made in compiling annual consumption for this purpose.[3] These (Table 1) have been used by us without any attempt at verification.

In the first part of the paper, growth rates of imports are examined as also of the diaggregates, followed in the second part, by a similar study of production in the country. The third part provides a similar statistical view of the consumption of the pesticides.

REVIEW OF LITERATURE

Several factual papers have been published giving the quantum of imports. Vijayagopalan[4] reported the pesticides imports of 12654 tonnes in 1972-73, 16583 tonnes in 1974-75, 15318 tonnes in 1975-76. (These are different from the compilation we have reported). The imports were lower (6106 tonnes) in 1976-77 but rose to 11745 tonnes in 1977-78.[5] In reviewing the performance of indegenous industry Chadha[6] estimated the import

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[3] Vijayagopalan S (1978), Pesticides Industry in India: An Economist Appraisal, Pesticides Annual Number 1978, pp 5-6.

[4] Ibid, pg 8.

[5] S S Chadha S. 1978, "Production of Pesticides in India", Pesticides Annual Number 1978, pg 11.

[6] Ibid, pg 14-15.

figure at about 25 per cent of total availability in the country. According to him 34 chemicals were imported in 1977-78, inclusive of most of the newer and sophisticated pesticides.

The consumption pattern in India is significantly different from the world pattern. In 1974, herbicides was the largest groups, constituting 42.7 per cent of total pesticides consumed in the world, followed by insecticides (35.7 per cent), fungicides (18.8 per cent), soil fumigants (1.4 per cent), growth regulators (0.9 per cent) and defoliants (0.5 per cent).[7]

In India, in 1967-68, insecticides constituted 72.0 per cent, fungicides 24.0 per cent, rodenticides 2.0 per cent, weedicides 2.0 per cent, rest 0.1 per cent[8] of total pesticides. The share of insecticides declined to 63.5 per cent in late seventies. Fungicides then constituted 32.7 per cent, herbicides 2.1 per cent, rodenticides 0.8 per cent, fumigants 0.6 per cent, and acaricides 0.3 per cent.[9]

The licenced capacity of pesticide production was 82,135 tonnes and an additional letters of intent had been issued for 25040 tonnes. The installed capacity (1978-79) was then 67474

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7 Farm Chemicals Sept. 1977, pp 38-43.

8 Fourth Five Year Plan (1969-70 to 1973-74) Proposals for Pesticides and Plant Protection (1968), Pesticides Association of India, New Delhi.

9 Pesticides - A Feature Commerce, April 1978, pg 499.

tonnes. The current production level is about 50,000 tonnes, valued at Rs.60 crores.[10] The annual growth rate of indegenous production between 1966 to 1977 is reported to have been 9.9 per cent.[11]

The relatively comprehensive publications applying the available statistical methods for estimation are the Pesticides Market Studies.[12] Recognizing the skewed distribution of consumption across states, the focus of the study was on selected district. The diversity of use pattern in states on different crops and rates of uses reflected in the findings. The multiple regression model based on cross sectional data of farmers of selected districts was used in estimating demand for each of the district. Further, factors affecting changes in pesticides consumption for these districts were also ascertained. For all these a detailed survey of farmers was specifically undertaken. These studies were not intended to provide a macro level national estimate , however, they were most comprehensive for the districts surveyed and possibly the region they represented.

One other publication using conceptually an altogether different methodology, was that of National Council of Applied

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10 Sharma K.D. 1979, Production and Supply of Pesticides, Pesticides Information 4(4), Jan.-March 1979, pp 96-97.

11 Pesticides Annual Number 1978, pg 7.

12 Pesticides Market Studies, Vol.I to X (New Delhi Pesticides Association of India, 1971-72).

Economic Research.[13] Besides studying the farmers' awareness to pest infestation, their problems and attitudes, the study attempted to estimate the potential need of pesticides in the country on the basis of the pest occurrence needing protection as perceived by the farmers themselves. The report also provided a basis for reporting extent of infestation.

Possibly due to the prevailing environment of limited studies on methodology, the working group appointed by the Ministry of Agriculture[14] suggested a desirable level of pesticides consumption on the basis of six per cent growth rate for agriculture.

CHARACTERISTICS OF IMPORTS AND EXPORTS

The aspect of import substitution in pesticide industry can be examined by different indicators. The simplest is the number of products solely imported, solely produced or both produced and imported. Further, one can determine the rate at which the imports and indigenous production have varied in quantity and value and the per tonne cost of these chemicals. The percentage shares of imports in total availability of pesticides and its

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13 Pesticides in Indian Agriculture (New Delhi 1967, National Council of Applied Economic Research).

14 Report of the Working Group on Pesticides Industry for the Plan (1978-79 to 1983-84) (New Delhi, Ministry of Petroleum, Chemicals and Fertilizers, Government of India).

value can be the other criteria. In view of the possibility of varied potency of pesticides affecting availability in the market, the rate at which area protectable by insecticides has varied can also be an indicator of import dependency, or product substitution.

In 1966, as many as 19 pesticides were being imported which are now reduced to twelve. There has also been a rapid decline in number of fungicides imported. Currently, identified fungicides imported now are almost nil. The number of fungicides imported has been always less than insecticides. In contrast to fungicides, the number of imported insecticides (identified) has not decreased significantly. In 1966, ten insecticides are identified from the import list, but their number did not change even upto 1978. As the imported chemicals are not always clearly stated, this analysis may not be final. However, it does give a picture of decline in items of imported pesticides but not of insecticides.

The variations in tonnage of imported pesticides has been large (Table 1). The minimum was in 1969-70 (2081 tonnes) and the maximum in 1974-75 (16592 tonnes). Its share in total availability of pesticides is shown in Graph I. This also has varied greatly. Viewing the share of imports on the basis of 3 years' moving averages, its highest share (35.2 per cent) was in triennium ending 1967-68 which declined to 18.2 per cent in

1971-72. It, however, rose to 30.4 per cent in the triennium ending 1974-75 but has been slowly declining since then.

Imports: Growth Rates

The growth rate of quantity of imports has been low and statistically not significant (3.0 to 5.8 per cent, Serial Number 1, Table 2). It is important to note, however, that the total value of imports has been rising at a much faster rate (11.9 to 22.3 per cent, Serial Number 3, Table 2), due to the value per tonne of imported pesticides rising more rapidly (8.9 to 17.3 per cent, Serial Number 4, Table 2) than the increases in quantity imported. The growth rates for total value are also statistically significant.

Area Protectable by Imported Insecticides

The analysis of growth rates based on tonnage or value provide a working picture of availability of imported pesticides. It, however, does not clearly indicate how the field needs are satisfied. The growth rates of imported identified insecticides in term of tonnage has been 7.4 to 12.8 per cent (Serial Number 7, Table 2). It is, however, necessary to know how the rates of increase of imported insecticides are in relation to area coverable by them. While, the tonnage of imported identified insecticides has been increasing, the growth rates of area coverable by imported insecticides are actually negative

(Serial Number 9, Table 2). (For this analysis only insecticides identified in the import list could be included. It is, therefore, likely that import of more potent insecticides have remained unidentified, thus perhaps deflating the growth rate of area coverable). Even though, these rates are not statistically significant it is indicative of a situation in which the country is continuing to import chemicals of decreasing potency.

From the policy considerations, it is important to note, not only the increasingly higher import bill, but also its unit cost. As pointed out earlier, the growth rates of both these are higher than that of quantity. Added to this is the unhappy situation of continued import of chemicals with low potency. (This is subject to acceptance of fact that the source relied upon for import statistics includes all pesticides). On examining the list of imports, one observes a high share of chlorinated hydrocarbons in the imports. It is well known that many of these chemicals are on the way out and at least three insecticides were imported even though produced in the country. This situation must cause concern, specially because quite a few of these are on the banned list in developed countries. Some of them are being produced in these countries not for local use but only for export. This relationship of developed countries with less developed countries has been recently highlighted in a

publication from the developed world.[15] On these considerations, the import policy of pesticides does need a review.

Exports

The published export statistics indicate wide variability, probably, principally arising out of definition used for pesticides. One estimate was for Rs.4.8 million (m) in 1969-70, Rs.3.15 m in 1970-71. Rs.0.95 m in 1971-72, and Rs. 1.98 m in 1972-73.[16] Later data reveal an export of 1010 tonnes in 1973-74, 485 tonnes in 1974-75, 1620 tonnes in 1975-76 (excluding sulphur). Their value approximated Rs.2 to 3 m.[17] However, a later publication had put a very high value of export at Rs.12.1 m in 1974-75, Rs.13.9 m in 1975-76, Rs.21.2 m in 1976-77 and Rs.16.3 m in 1977-78.[18] A scrutiny of the list of exports, however, revealed inclusion of nicotine salts and its other derivatives (in addition to nicotine sulphate) of high value. The principle chemical in export lime light, in this period, was aluminium phosphide exported to both developed and developing countries. BHC, aldrin (not manufactured in India) and lindane and nicotine sulphate were the other insecticides exported. The export list

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15 David Weir and Mark Schapire, "Circle of Poison" (San Francisco Institute for Food and Development Policy, 1981).

16 R.V. Raghavan, "Problems of Pesticides Industry", Commerce, July 10, 1976, pp 83-87.

17 Technical Pesticides Industry in India, A Status Report, Industrial Extension Bureau, Govt. of Gujarat, Ahmedabad 380009.

18 Anonymous 1978, Exports of Pesticides, Pesticides Information 4(3), Oct.-Dec. 1978, pg 30. (Based on Basu Chemicals Pharmaceuticals and Cosmetic Export Promotion Council, Bombay).

also included weedicides, fungicides, and fumigants. The countries importing these were, U.K., Belgium, GDR, Switzerland, Spain, France, U.S.A., Japan, Canada and Australia as also many developing countries.[19] A large number of countries imported aluminium phosphide manufactured in India.

PRODUCTION

Currently 49942 tonnes (1977-78) of pesticides numbering 29 are produced in the country, out of which 14 are insecticides, six are fungicides including antibiotics, four are weedicides, two are raticides and three are fumigants. Quantitywise also insecticide is the largest group accounting for 91.4 per cent of the total pesticides production. Fungicides production is 6.3 per cent, weedicides 1.4 per cent, fumigants 0.6 per cent and raticides 0.3 per cent of the total output. Amongst pesticides, BHC has the largest share (63.9 per cent); this along with DDT, Malathion, Parathion, and Carbaryl account for 85.5 per cent of the total pesticides produced in the country.

Production: Growth Rates

The trends of production of pesticides are clear and significant. In 1966, 11 chemicals were being produced and the number has now increased to 29. The growth rate of indigenous pesticides in terms of tonnage of production is

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19 Ibid

8.9 to 16.0 per cent (Serial Number 2, Table 2), which is almost double that of imports. This reflects the creditable performance of the industry towards self sufficiency. At the same time, it is important to note that the rate of increase in total value or per unit cost is much higher than growth rate of tonnage produced (16.8 to 40.4 per cent total value, 16.0 to 29.4 per cent unit cost) (Serial Number 5, Table 2). A further indepth study can only reveal whether this increased rate of unit cost is unrelated to the general rise in cost of production and inflation in the country, or whether pesticides industry's performance in this regard is different.

Area Protectable by Indigenously Produced Insecticides

The performance of pesticides industry, in addition to quantity of production, is also distinctly creditable in respect of the quality of insecticides produced. Increasingly, more potent new generation insecticides are being introduced and produced in the country. While the growth rate of tonnage of insecticides production is 8.3 to 14.6 per cent, the growth rate of the potency as indicated by area protectable by these insecticides is much higher (14.8 to 27.4 per cent, Serial Number 10, Table 2). This performance on the production front is in sharp contrast to quality of imports which seems to be degenerating in terms of potency as judged from the growth rate of area protectable when compared to the growth rate of quantity of imports.

Capacity Utilization

In addition to the criteria of tonnage and value of production, it is important to know how the installed capacity has been utilized during the time span. The variation in percentage capacity utilization has been from 90 per cent in 1967-68 to 53 per cent in 1968-69 (Graph II). The high percentage was primarily due to two insecticides, BHC and DDT. Currently, the capacity utilization is nearly 71 per cent, which can be considered quite satisfactory. The performance of pesticides industry in this regard is greatly dependent on the factories manufacturing insecticides which have the largest share in the total production of pesticides.

CONSUMPTION

Growth Rates of Consumption

The growth rates by different regression equations for all (imported + produced), pesticides, insecticides, and fungicides alone, as well as the latter two combined, are shown in Table 3; along with them are also given the growth rates, after reduction for public health uses from pesticides, insecticides and insecticides plus fungicides, so as to indicate rates of increases in consumption for agriculture.

Out of the four regression models, a decision has to be taken as to the one which can best explain the observed trend in the time span under study. For this purpose, one can rely on the R^2 value as an indicator of the best fit. From Table 3 which gives the relevant statistics, the R^2 values for total pesticides are not much different for the first three models. This statistic is, therefore, not so helpful for this purpose. If the t-statistics of the constants a, b and c are examined, generally, they tend to be not significant in case of the equation $y_t = a + bt + ct^2$. The highest t-statistics are usually in the equation $\log y_t = a + bt$, followed by that of $y_t = a + bt^2$, and $y_t = a + bt$. Most of these values are no doubt significant. If, therefore, an opinion has to be framed on the basis of these analyses, the regression model $\log y = a + bt$ would be the proper choice. If this is accepted, then one would have to conclude that pesticides consumption follows a totally linear trend. However, when the pesticides consumption data, is plotted (Graph III), the actual trend appears to be somewhat similar to the graph $y_t = a + bt^2$, if the years with wide variability in consumption are overlooked. We have, therefore, generally referred to the statistics of the equation $y_t = a + bt^2$ in the following discussions and also for deriving conclusions.

The growth rates of total pesticides were worked out for our data as well as those of Vijayagopalan (1978) published earlier (Serial Number 1 and 2, Table 3). As stated earlier, we have thought it advisable to exclude sulphur from compilation due to its varied non-agricultural uses, besides being used as fungicides. Our data showed a relatively slow growth rate of 8.3 per cent per annum as compared to 20.4 per cent per annum based on data of Vijayagopalan. Even if the differences observed are accounted for by omission of sulphur from our data, the difference is such as would cause concern to all investigating the problem. The desirability of standardization of definition of "pesticides" and the sources to be relied upon, thus assume great significance in pesticides studies.

While the quantitywise growth rate of pesticides is 8.3 per cent per annum (Serial Number 1, Table 3), the valuewise growth is remarkably higher. The progress in the pesticide business as experienced in the market is better expressed by 28.6 per cent per annum rate of increase in value of total pesticides marketed in the country (Serial Number 3, Table 3). When the value per tonne of pesticides marketed is examined, the growth rate is 17.8 per cent per annum, which thus is responsible for high growth rate of total value of pesticides.

The problem of sources of data and the effect on calculated growth rate is no doubt serious, but when one attempts to separate the pesticides used for agriculture, the problem is even more so. At present there is only one published source of data on pesticides used for public health (Vijayagopalan, 1978) and we have made use of this. The growth rates for our pesticides data after substracting the use for public health, and that of Vijayagopalan have been also shown in Table 3 (Serial Number 5 and 6). In each case the growth rates for pesticides used for agriculture is substantially higher than corresponding rate for total pesticides (Serial Number 1 and 2). This also means low growth rate of pesticides consumed for public health.

We have attempted to identify insecticides in the import list. After adding the insecticides production in the country to it, - data readily available - the growth rates of insecticides have been worked out separately. Similarly, fungicides data have been examined. This disaggregated data provided some significant insight into the segments of the pesticides market. The growth rate of insecticides (Serial Number 7) is higher than total pesticides (Serial Number 1). It is also so when the growth rates of insecticides for agriculture are examined (Serial Number 8).

On examining the two groups namely insecticides and fungicides, it is evident that the latter has not shown any significant growth in tonnage over the years (Serial Number 9). Even the assumption of linearity in its consumption does not appear valid. The wide difference between the growth rates of insecticides and fungicides points out the need of disaggregated studies on pesticide consumption.

When fungicides have such low growth rates, aggregating these two segments lowers the growth rate indicator. If the latter rate is applied to insecticides, it will create situations wherein supply will not be able to meet the demand of this particular group of pesticides. Conversely, a production policy for fungicides, keeping in view the overall growth rate of pesticides, will lead to their glut. The conclusion is obvious that aggregates of the two widely different types of chemicals is not rational. The current practice of aggregating these for analysis needs to be substituted by analysis of the groups of chemicals separately.

In the aforesaid analysis of the disaggregates, it has not been possible to accurately know all the imported insecticides and fungicides as some quantities of imported pesticides are bulked into general heading like 'others' imports. It has not been possible to disaggregate this. To know if this group would cast any significant shadow on our conclusions for insecticides

and fungicides, these unclassified entries in the import list were bulked and growth rates determined over the time span studied (Serial Number 12, Table 3). These unidentified pesticides import did not show statistically significant trend, and in one equation even linearity assumption was not valid. Even in terms of their value (Serial Number 13), this is more or less so. Therefore, the conclusions that have emerged for insecticides, and fungicides in comparison with the aggregate pesticides are valid.

So far, the two situations examined were concerned with the separation of consumption of pesticides for public health and the study of the disaggregates, insecticides and fungicides out of the conglomerate group of pesticides. These studies have shown the possibility of improving the method of estimation based on growth rates of pesticides demand.

There is yet another direction which if adopted may help the estimation. This concerns the replacement of the present system of estimation on tonnage basis to one in which it will be related to area protectable by them. The pesticides themselves have been shown to be a heterogeneous group, but even the "insecticides" include scores of chemicals. These chemicals vary greatly in the amount of active ingredients to be used per hectare for efficient insect control. Some of these require as high as 2 kg. of active ingredient per hectare, and others

are equally effective even if the active ingredient is half or even one tenth of the above value. In general the chlorinated hydrocarbons are less potent than organo-phosphorous group of pesticides. The latest to enter, the synthetic pyrethroids, are effective at dosages of a few hundred grams or even less per hectare. Therefore, in estimating pesticides demand, if the unit of weight is used, the real picture as to the extent to which the actual field needs will be met will not emerge. The availability of pesticides without reference to potency will not be a satisfactory guide in market studies.

As these chemicals vary greatly in their potency, our hypothesis is that aggregating such products of diverse potencies on tonnage basis and estimating the growth rate leads to an under-estimation of demand or the need of insecticides for agriculture.

For analysing this hypothesis, the active ingredients needed per hectare for effectively controlling crop pests were derived from printed literature of chemical manufacturing companies, recommendations of departments of agriculture and other published sources as also consultation with entomologists. Data of various sources were averaged for each technical grade insecticide. But there was a snag in the process. Many compounds are formulated into dusting powders, wettable powders and emulsions. The

active ingredient of the same chemical compound when recommended as dusts was higher than for wettable powder. The dosage was the least for emulsions. In order to arrive at an average, proportions of active ingredients marketed through these three formulations were to be ascertained. The exact data as to the quantities of technical material marketed and used in these three formulations, which would be very useful for market studies, were not available and the knowledge of persons in the marketing of pesticides was, therefore, depended upon. A weighted average of active ingredient per hectare needed for insect pest control in the field was then calculated.

After compiling the data on the availability of insecticides in tonnes, the area that could be protected per tonne was calculated. Yearwise data of this type showed high increases in area coverage by the insecticides that were available. The growth rate of area protectable by insecticides (Serial Number 14, Table 3) has been generally higher (10 to 20 per cent) than growth rate of the insecticides on tonnage basis (7.8 to 10.7 per cent). This difference is an indicator of the increased share of more potent chemicals with the passage of time. It was not possible to calculate this separately for insecticides used in agriculture, as the insecticidewise uses in public health could not be had. However, the public health programme consume only low potency chemicals like DDT, BHC and Malathion. If, therefore, these are accounted, the growth rate of area protectable by available insecticides will be higher.

It is possible that the stagnation in pesticides market (in tonnage) reported in the last few years, may not be so in terms of area protected as more potent chemicals may have substituted the traditional ones. This can be examined after chemical-wise data for these years become available.

SUMMARY

The statistical analysis of import of pesticides in terms of quantity revealed a slow growth rate. However, the growth rates of their value were high due to increased per unit cost of the imported quantity. The imported insecticides had higher growth rates than total pesticides imported, suggesting the need of disaggregated studies. In contrast to imports, the rate of increase in production of pesticides in the country has been much higher, and its value has been growing even faster. When the analysis of growth rates is extended to quality, the picture which emerges needs a close scrutiny. The quality of insecticides imported (as judged from the area protectable) indicated increased rate of imports of low potency chemicals. However, in respect of insecticides produced in the country the rate of growth of area protectable was higher than the rate of growth in tonnage terms.

As in case of imports and production, the growth rates of value of total pesticides was higher than growth rates of quality available. The growth rates of pesticides used for agriculture were higher than the total, suggesting the need of separate analysis for the two sectors, agriculture and public health. The study also revealed that the rate of increase in availability of insecticides was higher than total pesticides, indicating the need for disaggregated studies of insecticides and fungicides which have been shown to have widely different growth rates. As in case of insecticides produced in the country the growth rate of area protectable by all the insecticides have been higher than their increases in tonnage. The study thus has pointed out the need of disaggregated studies of pesticides, which is a conglomerate group of chemicals with widely different production processes and uses.

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Table 1: Annual Imports and Production of Pesticides (All) and Use for Public Health

(Tonnes)

Year	Imports*	Production@	Total	Consumption for Public Health $
1965-66	12122	13928	26050	7976
1966-67	8237	15342	23579	9695
1967-68	7354	23077	30431	9695
1968-69	14380	18635	33015	14102
1969-70	2081	24006	26087	14156
1970-71	5608	24555	30163	14156
1971-72	11111	28597	39708	9600
1972-73	-	-	-	10084
1973-74	12664	32422	45086	13137
1974-75	16592	35025	51617	12341
1975-76	15343	34251	49594	15400
1976-77	6133	40825	46958	15205
1977-78	12350	49942	62292	29100

Source: * As per Monthly Statistics of Foreign Trade Vol.II, Imports; excluding sulphur, and including DDT preparations.

Annual Reports of DGTD

Vijayagopalan S (1978) Pesticides Industry in India: An Economic Appraisal Pesticides Annual Number 1978, pp 5-8.

For analysis averages of 1971-72 and 1973-74 were used.

Table : Growth Rates of Imports and Production of Pesticides (1965-66 to 1976-77)

S.No.	Commodity	Statistic	A	B	C	D
1.	Total Imported Pesticide Tonnes	GR%	3.0	3.2	12.9	5.8
		R^2	0.06	0.38	0.68	0.74
		a	8268.1	8.91	9.19	8944.2
		(t)	(3.01)	(24.05)	(14.23)	(4.52)
		b	311.48	0.032	-0.087	24.895
		(t)	(0.83)ns	(0.63)ns	(0.38)ns	(0.89)ns
		c			-0.009	
		(t)			(0.53)ns	
2.	Pesticides Production in India Tonnes	GR%	8.9	9.3	5.6	16.0
		R^2	0.93	0.94	0.94	0.93
		a	10849.1	9.55	9.48	17458.7
		(t)	(6.40)	(163.73)	(96.46)	(14.49)
		b	2528.3	0.093	0.12	176.01
		(t)	(11.84)	(12.60)	(3.69)	(12.11)
		c			0.0019	
		(t)			(0.85)ns	
3.	Value of Imported Pesticides Rs. Lakhs	GR%	11.9	11.6	22.5	22.3
		R^2	0.48	0.54	0.58	0.52
		a	222.1	5.99	6.29	489.42
		(t)	(0.78)ns	(23.96)	(14.87)	(2.48)ns
		b	117.4	0.116	-0.016	9.152
		(t)	(3.05)	(3.42)	(0.11)ns	(3.30)
		c	-	-	0.010	
		(t)			(0.91)ns	
	Value of Imported Pesticides Rs./Tonne	GR%	8.9	8.4	9.4	17.3
		R^2	0.32	0.35	0.35	0.37
		a	4415.8	8.59	8.62	6424.4
		(t)	(1.38)ns	(12.32)	(18.33)	(2.88)
		b	940.0	0.084	0.071	75.72
		(t)	(2.17)ns	(2.33)ns	(0.42)ns	(2.42)ns
		c	-	-	0.001	
		(t)			(0.09)ns	
	Value of Pesticides Production Rs. Lakhs	GR%	16.8	26.4	9.6	40.4
		R^2	0.64	0.90	0.91	0.68
		a	-1464.9	5.57	5.70	63.34
		(t)	(1.34)ns	(27.013)	(16.00)	(0.85)ns
		b	613.56	0.26	0.21	43.92
		(t)	(4.46)	(10.16)	(1.81)ns	(4.86)
		c	-	-	0.003	
		(t)			(0.45)ns	

... Contd.

Table 2: (Contd.)

S.No.	Commodity	Statistic	A	B	C	D
6.	Value of Pesticides Production Rs./Tonnes	GR%	16.0	17.1	16.0	29.4
		R^2	0.50	0.76	0.77	0.51
		a	-0.01	-3.99	-3.77	0.024
		(t)	(0.33)ns	(17.13)	(9.50)	(1.05)ns
		b	0.013	0.17	0.086	0.0009
		(t)	(3.337)	(5.840)	(0.66)ns	(3.4)
		c	-	-	0.006	
		(t)			(0.67)ns	
7.	Identified Imported Insecticides Tonnes	GR%	7.4	8.0	3.7	12.8
		R^2	0.8	0.78	0.80	0.74
		a	16336.5	9.799	9.68	22483.5
		(t)	(6.13)	(99.84)	(58.30)	(10.04)
		b	2352.0	0.08	0.13	168.76
		(t)	(6.49)	(5.97)	(2.26)ns	(5.36)
		c	-	-	-0.004	
		(t)			(0.93)ns	
8.	Insecticides Production Tonnes	GR%	8.3	8.8		14.6
		R^2	0.92	0.87		0.89
		a	12781. 2	9.574		17742.8
		(t)	(8.82)	(121.07)		(14.56)
		b	2131.6	0.088		170.18
		(t)	(9.98)	(7.61)		(8.42)
9.	Area Protectable Identified Imported Insecticides (*000 ha)	GR%	-2.2	3.0	-5.2	-3.8
		R^2	0.04	0.05	0.52	0.37
		a	7624.0	8.91	8.85	7245.85
		(t)	(4.58)	(29.32)	(16.47)	(6.01)
		b	-146.1	-0.03	-0.004	-10.53
		(t)	(0.65)ns	(0.72)ns	(0.02)ns	(0.62)ns
		c	-	-	-0.002	
		(t)			(0.1)ns	
10.	Area Protectable by Insecticides Produced (*000 ha)	GR%	14.8	14.9		27.4
		R^2	0.64	0.78		0.69
		a	2322.4	8.88		8765.1
		(t)	(0.46)ns	(49.37)		(2.56)ns
		b	3028.13	0.149		254.94
		(t)	(4.02)	(5.63)		(4.49)

... Contd.

Table 2: (Contd.)

S.No.	Commodity	Statistic	A	B	C	D
11.	Identified Insecticides (Imported + Production) Tonnes	GR%	7.8	8.2	7.0	10.7
		R^2	0.62	0.64	0.65	0.40
		a	16751.7	9.844	9.828	24574.8
		(t)	(3.46)	(69.13)	(63.79)	(5.34)
		b	2654.3	0.082	0.094	150.9
		(t)	(4.04)	(4.22)	(2.52)	(2.61)
		c	-	-	-0.001	
		(t)			(0.40)	
12.	Area Protectable by All Insecticides (*000 ha)	GR%	10.5	10.1	17.3	20.0
		R^2	0.70	0.75	0.78	0.78
		a	8034.3	9.40	9.62	13851.7
		(t)	(1.97)ns	(68.70)	(42.99)	(5.56)
		b	2652.3	0.10	0.005	210.88
		(t)	(4.78)	(5.41)	(0.07)ns	(6.02)
		c			0.007	
		(t)			(1.24)ns	

GR: Growth Rate

ns: Not Significant

Equation A : $y_t = a + bt$

" B : $\log y_t = a + bt$

" C : $\log y_t = a + bt + ct^2$

" D : $y_t = a + bt^2$

Table 3: Growth Rates of Pesticides and Other Estimates of Time Series Data (1965-66 to 1976-77) Regression Equations*

S.No.	Product	Statistic	A	B	C	D
1.	Pesticides Tonnes (Excluding Sulphur)	GR%	6.9	7.1	2.9	8.3
		R^2	0.85	0.84	0.90	0.44
		a	20479.2	10.027	9.989	29000.0
		(t)	(8.19)	(140.61)	(165.40)	(7.87)
		b	2557.1	0.071	0.101	128.82
		(t)	(7.55)	(7.28)	(6.86)	(2.78)
		c	-	-	-0.003	-
		(t)			(2.44) ns	
2.	Pesticides (Vijayagopalan 1978)	GR%	11.7	11.7	0.11	20.4
		R^2	0.89	0.92	0.92	0.91
		a	11200.7	9.69	9.70	20148.2
		(t)	(3.60)	(124.11)	(68.99)	(9.58)
		b	3994.57	0.117	0.113	326.52
		(t)	(8.72)	(10.15)	(2.09) ns	(9.36)
		c	-	-	0.0003	-
		(t)			(0.79) ns	
3.	Pesticides Value Rs. Lakhs (Excluding Sulphur)	GR%	20.5	21.3		28.6
		R^2	0.56	0.83		0.38
		a	-1167.0	6.417		883.6
		(t)	(0.80) ns	(28.59)		(0.67) ns
		b	714.7	0.213		41.52
		(t)	(3.60)	(6.97)		(2.50) ns
4.	Pesticides Value Rs./Tonnes	GR%	13.2	12.9	12.1	17.8
		R^2	0.43	0.59	0.59	0.28
		a	1280.9	8.082	8.06	4821.3
		(t)	(0.40) ns	(32.22)	(29.57)	(1.77)
		b	1187.3	0.129	0.145	66.83
		(t)	(2.76)	(3.79)	(2.19) ns	(1.95)
		c	-	-	-0.001	-
		(t)			(0.28) ns	
5.	Pesticides (-Publish Health) for Agriculture Tonnes	GR%	8.5	8.8	1.4	9.0
		R^2	0.68	0.62	0.78	0.27
		a	11204.5	9.485	9.396	19056.0
		(t)	(3.30)	(59.32)	(71.24)	(4.91)
		b	2110.3	0.088	0.158	93.82
		(t)	(4.57)	(4.03)	(4.92)	(1.92) ns
		c	-	-	-0.006	-
		(t)			(2.60) ns	

* Excluding Sulphur

...Contd.

Table 3: (Contd.)

S.No.	Product	Statistic	A	B	C	D
6.	Pesticides for Agriculture (Vijayagopalan 1978) Tonnes	GR%	16.1	17.5	0.17	28.9
		R^2	0.88	0.89	0.89	0.89
		a	820.67	8.82	8.81	8984.8
		(t)	(0.27)ns	(62.49)	(34.65)	(4.30)
		b	3640.15	0.175	0.180	297.32
		(t)	(8.12)	(8.40)	(1.85)ns	(8.59)
		c	-	-	-0.0005	-
		(t)			(-0.57)ns	
7.	Total Pesticides (Imports + Production) Tonnes	GR%	7.8	8.2	7.0	10.7
		R^2	0.62	0.64	0.65	0.40
		a	16751.7	9.844	9.828	24574.8
		(t)	(3.46)	(69.13)	(63.79)	(5.34)
		b	2654.3	0.082	0.094	150.9
		(t)	(4.04)	(4.22)	(2.52)	(2.61)
		c	-	-	-0.001	-
		(t)			(0.40)	
8.	Total Identified Insecticides (-Public Health) for Agriculture	GR%	10.1	11.1	6.1	12.7
		R^2	0.36	0.53	0.58	0.31
		a	7526.9	9.147	9.089	14632.8
		(t)	(1.64)ns	(38.16)	(36.26)	(3.37)
		b	2207.5	0.111	0.157	115.9
		(t)	(3.55)	(3.41)	(2.58)	(2.11)ns
		c	-	-	-0.004	-
		(t)			(0.89)	
9.	Identified Fungicides Tonnes	GR%	1.4	Linearity	0.82	2.3
		R^2	0.21(ns)	Not Valid	0.11(ns)	0.17(ns)
		a	1697.5		7.332	1771.29
		(t)	(4.03)		(15.16)	(5.81)
		b	26.417		0.035	1.808
		(t)	(0.46)ns		(0.20)ns	(0.42)ns
		c	-		0.002	
		(t)			(-0.14)ns	
10.	Identified Insecticides + Fungicides	GR%	1.8	Linearity	-9.0	0.34
		R^2	0.03	Not Valid	0.79	Linearit
		a	27615.4		10.234	Not Vali
		(t)	(3.58)		(27.0)	
		b	565.4		0.055	
		(t)	(0.54)ns		(0.59)ns	
		c	-		-0.006	
		(t)			(0.85)ns	

S.No.	Product	Statistic	A	B	C	D
11.	Identified Insecticides + Fungicides (-Public Health) for Agriculture	GR%	9.41	10.0	5.0	11.7
		R^2	0.57	0.55	0.60	0.31
		a	9224.1	9.374	9.266	16500.0
		(t)	(2.03) ns	(44.52)	(42.87)	(3.78)
		b	2234.0	0.100	0.146	115.91
		(t)	(3.62)	(3.51)	(2.78) ns	(2.11) ns
		c	-	-	-0.004	
		(t)			(1.03) ns	
12.	Imported Unidentified Pesticides (All Others) Tonnes	GR%	-15.9	Linearity		-22.3
		R^2	0.09(ns)	Not valid		0.58
		a	13192.3			9600.87
		(t)	(1.81)			(1.78) ns
		b	-993.61			-63650.0
		(t)	(1.08) ns			(0.82) ns
13.	Value of Imported Unidentified Pesticides (All Others)	GR%	17.5	19.8	22.4	33.0
		R^2	0.65(ns)	0.725	0.73(ns)	0.70(ns)
		a	-117.39	4.50	4.80	103.93
		(t)	(0.74) ns	(15.16)	(9.52)	(0.98) ns
		b	90.37	0.198	0.078	6.53
		(t)	(4.54)	(5.30)	(0.47) ns	(5.12)
		c	-	-	0.0086	
		(t)			(0.74) ns	
14.	Area Protectable by Insecticides	GR%	10.5	10.1	17.3	20.0
		R^2	0.70	0.75	0.78	0.78
		a	8034.27	9.40	9.62	13051.7
		(t)	(1.97)	(68.70)	(43.0)	(5.56)
		b	2652.30	0.100	0.005	210.88
		(t)	(4.78)	(5.42)	(0.07) ns	(6.02)
		c	-	-	8.007	
		(t)			(1.24) ns	

GR: Growth Rate

ns: Not Significant

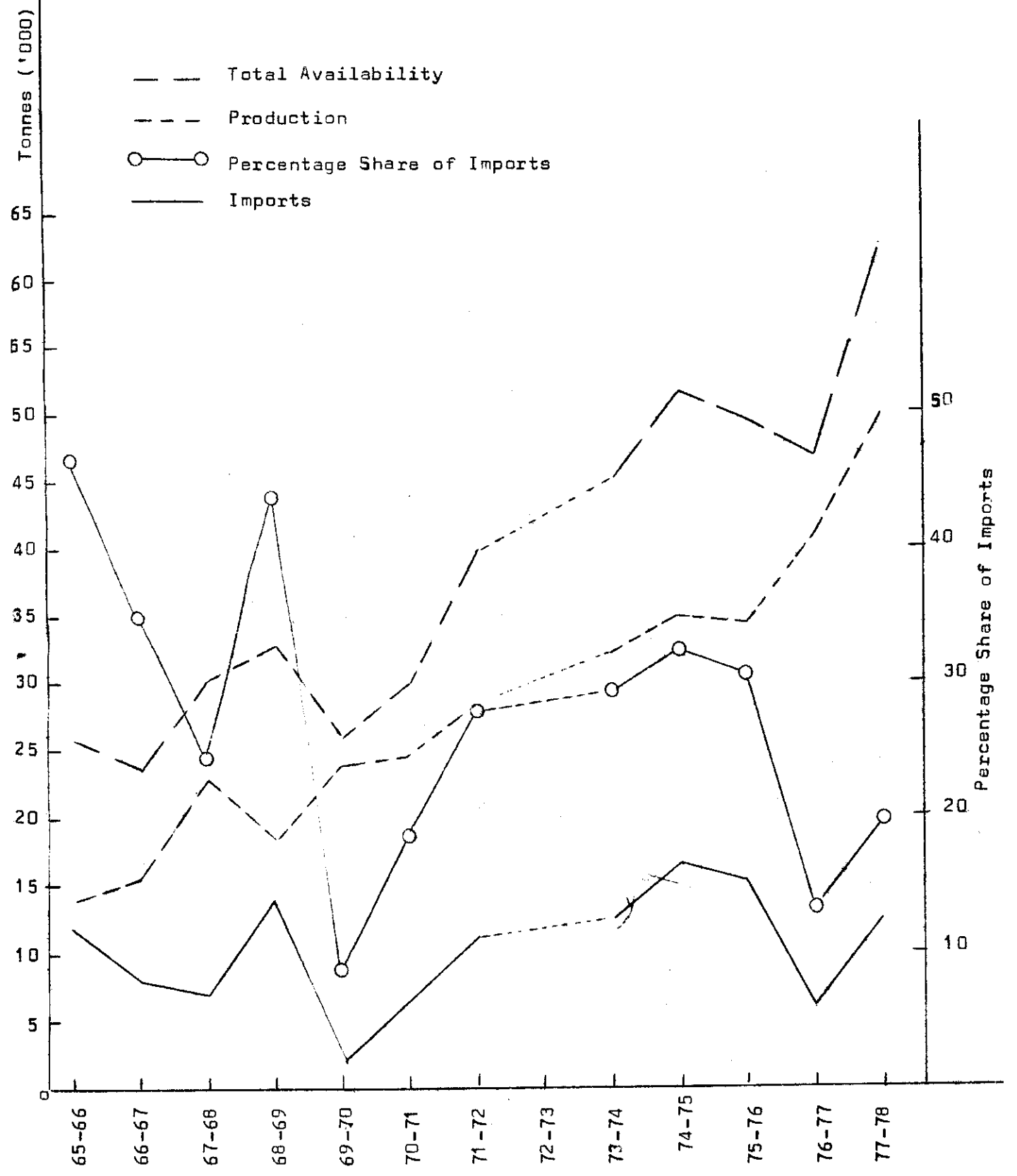
Equation A: $y_t = a + bt$

B: $\log y_t = a + bt$

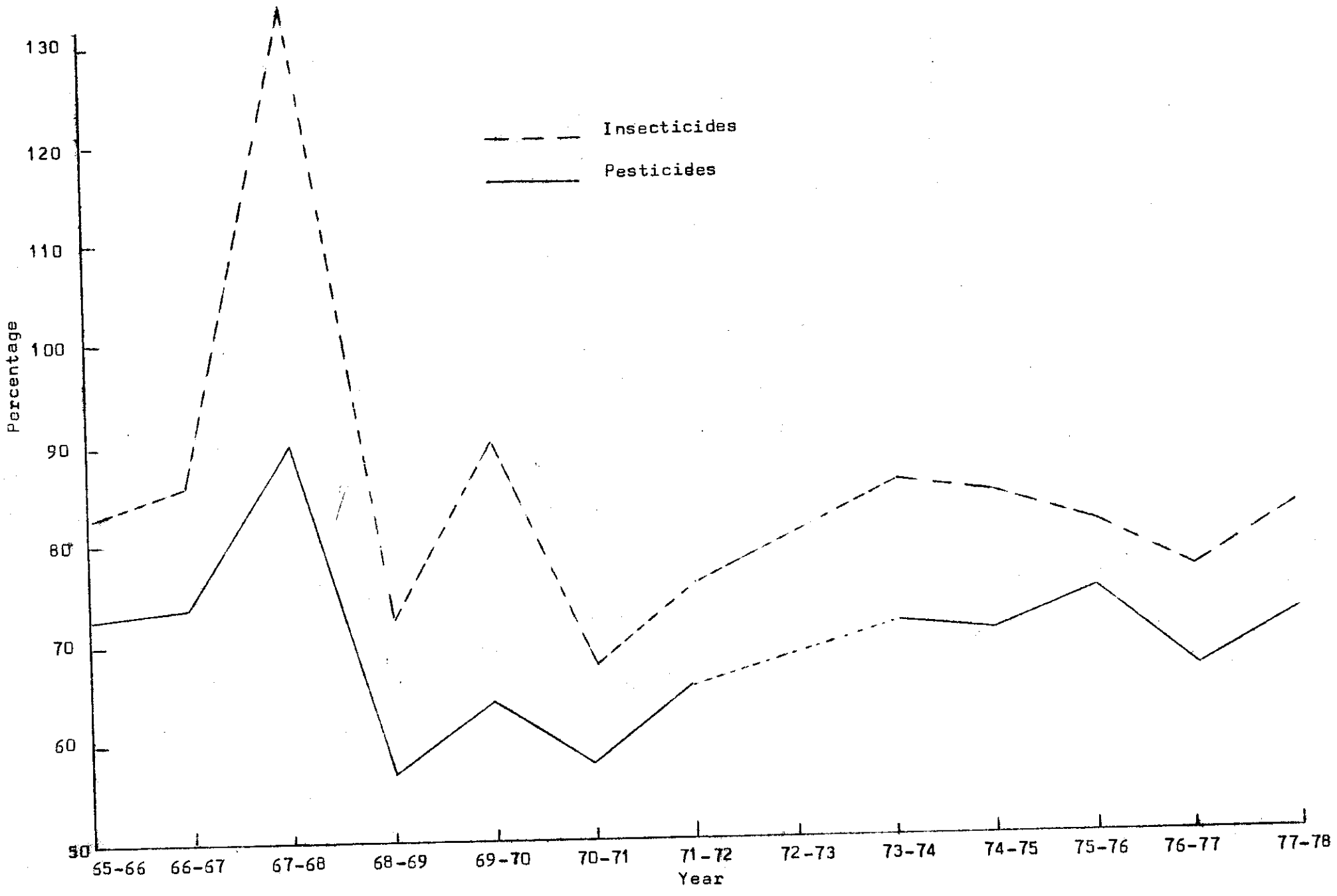
C: $\log y_t = a + bt + ct^2$

D: $y_t = a + bt^2$

Graph I: Imports, Production and Total Availability of Pesticides



Graph II: Percentage Utilization of Installed Pesticides Capacity



Graph III: Pesticides Availability as Represented by Different Regression Equations and Actual