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AN EMPIRICAL ANALYSIS OF PESTICIDE MARKETING IN PAKISTAN

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Abstract. This paper investigates empirical analysis of pesticide import trend, marketing margins and incentives of various intermediaries, price index of common insecticides and total outlay of farmers on purchase of pesticides. Estimates of the quadratic regression model revealed steeper growth trend as compared to that of simple linear regression model. Local companies offered high profit margins (up to 30%) and incentive schemes to dealers to get maximum market share as compared to multinationals (up to 15%). Multinational imparted effective training programs for the capacity building of farmers and dealers. The total outlay of farmers on the purchase of pesticide in Pakistan was estimated at Rs. 19.612 billion against import bill of Rs. 8.138 billion for 2003.

I. INTRODUCTION

Government's import and sale policies can be divided into two periods. Pre-February 1980 period; when all pesticide imports were in the public sector and pesticides distributed to the farmers either through the Agriculture Ministry's channels or through the private sector at subsidized rates. Post-February 1980 period; when the new agricultural policy was implemented. Subsidies on pesticides for ground spraying were withdrawn and simultaneously the responsibility for importation and sale of pesticides was transferred to the private sector (Farid-u-ddin, 1985).

During the post February 1980 period, pesticide consumption increased from 906 metric tons in 1980 to 5519 metric tons in 1992. Tariq (2002) reported that during last two decades, there was substantial increase in the use of pesticides not only in volume, but also in value. Its use increased by about 70 times (of which about 80% was used on the cotton crop), while

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cotton yield increased only two-folds. The pesticide value exceeded Rs. 12-14 billions, which added to the cost of production.

Most pesticides used in Pakistan were insecticides (74%), followed by herbicides (14%), fungicides (9%), acaricides (2%), and fumigants (1%) (Khan, 1998). Synthetic pyrethroids were introduced in Pakistan in 1980 when permethrin, deltamethrin, fenvalerate were commercially launched. In five years (1980 to 1985), more than a dozen brands of pyrethroids were made available to farmers. It was estimated that more than 70 percent of the total pesticides market was of synthetic pyrethroids (Malik, 1986). The pyrethroids constituted about 45 percent in terms of value. The phoshphatic group captured 39 percent of the market and share of chlorinated hydrocarbon was 9 percent while carbonate pesticide accounted for 4 percent during 1984 (Memon, 1986).

Rough estimates given by multinational companies showed that almost 80-90 percent of pesticides were used on cotton crop while remaining 10-20 percent consumed on paddy, sugarcane, fruits, and vegetables (Eavy *et al*., 1995). The most serious pest on cotton in Pakistan is whitefly, which is the vector of cotton leaf curl virus. During 1993, cotton leaf curl virus was responsible for an estimated loss of 3 million bales of cotton, equivalent to almost 25 percent of total production. Large amounts of pesticides were, therefore, used to eliminate this insect (Khan, 1998). Province-wise share of pesticide market was 90 percent for the Punjab, 8 percent for Sindh and 2 percent for NWFP and Balochistan (Khan, 2000).

Objectives

The specific objectives of the present study are given hereunder:

1. To develop regression model on the import of pesticides.
2. To analyze the marketing pattern of pesticides by various intermediaries vis-à-vis market share of insecticides, price index, and incentive packages.
3. To estimate total outlay of farmers on the purchase of pesticides in Pakistan.

II. DATA COLLECTION AND ANALYSIS

SECONDARY DATA ANALYSIS

Secondary data collected from Department of Plant Protection, Ministry of Agriculture and Livestock, Karachi were analyzed for meaningful results.

Linear regression model was applied to study growth trend of pesticide consumption during 1980-2003. Linear regression is a method of modeling the conditional expected value of one variable given the values of some other variable(s). The simple linear regression model is typically stated in the form:

$$y = \beta_0 + \beta_1 x + \varepsilon$$

The right hand side may take more general forms, but generally comprises a linear combination of the parameters, here denoted by β_0 and β_1. The term ε represents the unpredicted or unexplained variation in the response variable; it is conventionally called the "error" whether it is really a measurement error or not, and is assumed to be independent of x. The error term is conventionally assumed to have expected value equal to zero. Linear regression can be extended to a quadratic function, which is a polynomial function of the form:

$$y = \beta_0 + \beta_1 x + \beta_2 x^2 + \varepsilon$$

Quadratic function is sometimes referred as a degree 2 polynomial or a 2^{nd} degree polynomial. The values of the parameters β_0, β_1, and β_2 are estimated by the method of least squares, that minimizes the sum of squares of the residuals (Cohen *et al.*, 2003). Quadratic regression model is one of linear regression models even though it does not represent a straight line. Simple and quadratic models of linear regression are widely used in biological, behavioral and social sciences to describe relationships between variables (Wikipedia, 2007). In the present study, variations of pesticide import in function of time was studied and the above linear regression models were applied for their suitability to define the growth trend during 1980-2003.

Significance of the quadratic model over simple linear model was determined using Fisher's test (Neter *et al.*, 1996). F^*-value was calculated using the following equation:

$$F^* = \frac{SSE_{\text{Reduced Model (Linear)}} - SSE_{\text{Full Model (Quadratic)}}}{df_{\text{Reduced Model}} - df_{\text{Full Model}}} \div \frac{SSE_{\text{Full Model}}}{df_{\text{Full Model}}}$$

The degrees of freedom are those associated with the sum of squares of error (*SSE*) of reduced and full models. Large value of F^* leads to large difference between *SSE (Reduced model)* and *SSE (Full model)* and suggests that due to induction of quadratic term in the simple linear regression model, *SSE* has significantly reduced. The following decision rule was applied for testing the significance of F^*:

If $F^* \leq F\,(1-\alpha, df_R - df_F, df_F)$, drop quadratic term

If $F^* > F\,(1-\alpha, df_R - df_F, df_F)$, retain quadratic term

1. Trend Analysis of Pesticide Import

Table 1 presents the pesticide import during 1981 to 2003. The table shows that only 665 metric tons were imported in 1980, which increased to 17,443 metric tons in 1990, and 61,299 metric tons in 2000 while 78,132 metric tons were imported in 2003. Imported pesticides are both in finished and raw forms. Active ingredients are imported and the same are locally formulated. Proportion of locally formulated pesticides has substantially increased since 1982, when for the first time pesticides were formulated in Pakistan. The share of locally formulated pesticides was recorded to be 29 percent for 1982 and 69 percent for 2003. The proposed quadratic regression model is given as under:

$$Pesticide\ (import) = 5965 - 273.98\ (year) + 124.93\ (year)^2$$

TABLE 1

Pesticide Import during 1980-2003

Year	Imported in finished form (MT)	Local formulated (MT)	Total import (MT)	Value (Million Rs.)	Percentage of local formulation by weight
1980	N/A	N/A	665	39	N/A
1981	N/A	N/A	7,105	225	N/A
1982	3,552	1,448	5,000	320	29
1983	4,875	1,713	6,588	627	26
1984	6,081	3,132	9,213	2,256	34
1985	8,270	4,260	12,530	2,249	34
1986	8,834	5,665	14,499	2,978	39
1987	8,019	6,829	14,848	3,259	46
1988	6,256	6,816	13,072	2,334	52
1989	6,869	7,738	14,607	3,642	53
1990	7,502	9,941	17,443	4,581	57
1991	6,157	14,056	20,213	5,536	62
1992	6,691	16,748	23,439	6,554	71
1993	6,128	14,151	20,279	5,384	70
1994	10,693	14,175	24,868	5,808	57
1995	20,136	23,239	43,375	7,274	54
1996	24,151	19,068	43,219	9,987	44

1997	24,168	13,836	38,004	9,904	36
1998	22,765	18,811	41,576	6,960	45
1999	27,210	18,470	45,680	7,324	40
2000	19,764	41,535	61,299	4,971	68
2001	20,678	26,914	47,592	7,741	56
2002	26,010	42,794	69,897	6,620	62
2003	24,028	54,105	78,133	8,138	69

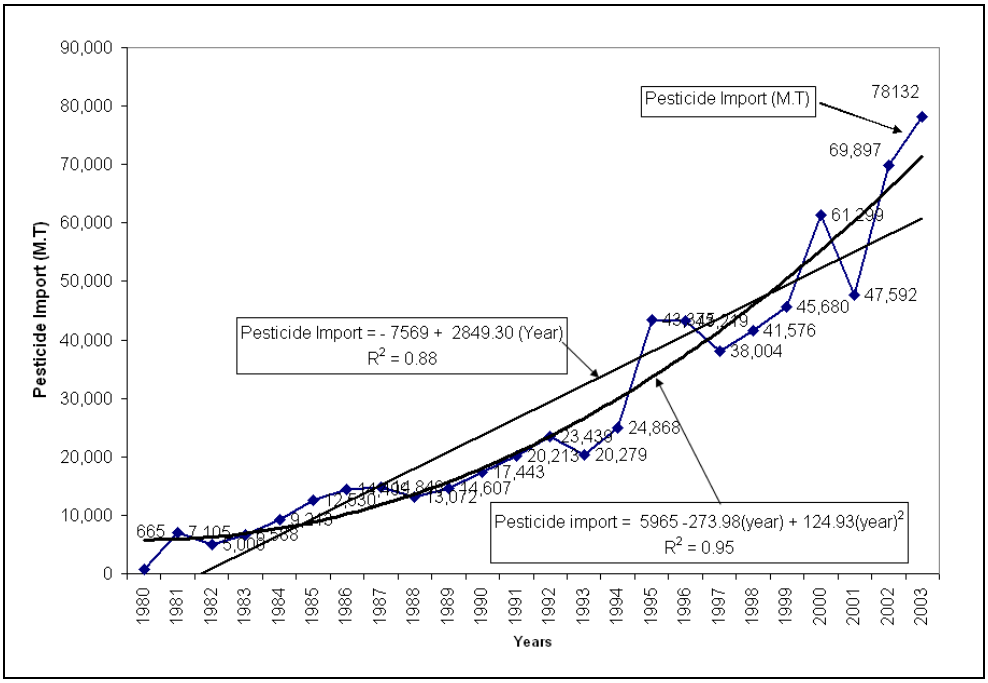
N/A = Not available

Source: Department of Plant Protection, MINFAL, Karachi.

Figure 1 shows the pesticide import trends. Quadratic regression model looks fit well to data because of curvilinear import growth trend. Simple linear regression model represented by a straight line overestimated the import from 1988 to 1994 and underestimated after 2001. Widening gap between estimated values obtained by using simple linear regression model and actual import after 2001 revealed that the linear model may not be proposed for the prediction of pesticide import.

FIGURE 1

Regression Model for Pesticide Import during 1980-2003



SPSS output for linear and quadratic regression models is presented in Box 1 and 2, respectively. Sum of squares of error (SSE) of linear and quadratic models as well as their corresponding degrees of freedom were used to estimate F^* as discussed earlier. F^*-value was estimated at 24.41, which was highly significant ($p < 0.01$); since the tabulated value of F (8.02) against 1 ($df_{Full} - df_{Reduced}$) and 21 (df_{Full}) degrees of freedom at 0.01 level of significance was less than calculated F^* value. From this, it was concluded that quadratic regression model explained significantly more proportion of variance of pesticide import in comparison of ordinary linear regression model.

$$F^* = \frac{1{,}273{,}321{,}650 - 588{,}850{,}452}{22-21} \div \frac{588{,}850{,}452}{21} = \frac{684{,}471{,}198}{28{,}040{,}498} = 24.41$$

BOX 1

SPSS Output of Linear Regression Model for Pesticides Import during 1980-2003

```
Dependent variable.. IMPORT           Method.. LINEAR
Listwise Deletion of Missing Data
Multiple R           .93807
R Square             .87998
Adjusted R Square    .87453
Standard Error   7607.77608

            Analysis of Variance:

               DF   Sum of Squares      Mean Square

Regression      1     9336281364.9     9336281364.9
Residuals      22     1273321650.4       57878256.8

F =     161.30896       Signif F =  .0000

-------------------- Variables in the Equation --------------------

Variable                B     SE B        Beta        T          Sig-T
(Constant)        -7568.57    3205.54                 -2.361      .0275
YEARS              2849.30     224.341    .938075     12.701      .0000
```

Based upon the better visual impression, significant F^*-value ($p < 0.00$) due to induction of quadratic term in the simple linear model and higher R-square (0.95) value, quadratic linear regression model was proposed for pesticide import in Pakistan. The specified model fitted well to the given data

and depicted that import of pesticide did not follow a simple linear regression model; rather, it followed quadratic type relationship in Pakistan.

BOX 2

SPSS Output of Quadratic Regression Model for Pesticide Import during 1980-2003

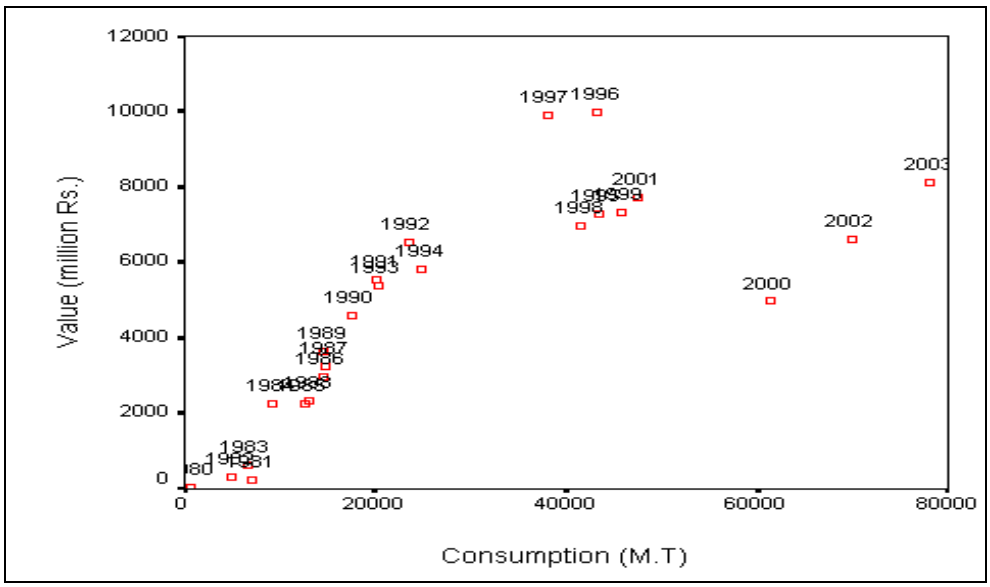
```
Dependent variable.. IMPORT          Method.. QUADRATIC
Listwise Deletion of Missing Data
Multiple R           .97185
R Square             .94450
Adjusted R Square    .93921
Standard Error   5295.32791

           Analysis of Variance:

              DF   Sum of Squares      Mean Square
Regression     2    10020752563.3     5010376281.6
Residuals     21      588850452.1       28040497.7

F =     178.68357       Signif F =  .0000

------------------- Variables in the Equation --------------------

Variable                 B         SE B       Beta        T     Sig-T
Constant)              5965.00     3533.05                 1.689 .1061
YEARS                  -273.98      651.16     -.09        -.421 .6782
YEARS**2                124.93       25.29     1.06        4.941 .0001
```

2. Quantity and Value of Pesticides Import during 1980 to 2003

Figure 2 shows the pesticide import and its corresponding value during 1980 to 2003. The figure shows that there is linear relationship between total pesticide import and its value from 1980 to 1997. After 1997, the quantity of imported pesticide has increased, however, its value has dramatically decreased especially during 2000. The main reasons for this decline were a reduction in prices in global market (Shahid, 2003) and increased share of active ingredients for local formulation in comparison of pesticides import in finished form. Declining price trend of pesticides indicated that pesticide demand was globally decreasing. Ghani (2002) reported that total market of pesticide was about $ 30 billion during 1999-2000, which declined to about $ 24 billion dollars during 2001-02.

FIGURE 2

Quantity and Value of Pesticides Import during 1980-2002



PRIMARY DATA COLLECTION

Multistage cluster sampling was applied to select representative samples of respondents. Cluster sampling has two important advantages over Simple Random Sampling and Stratified Sampling. Firstly, it is economical and secondly it is suitable for selecting a sample when the sampling frame of individual elements is not available. Cluster Sampling only needs a list of elements in the clusters sampled (Anderson *et al.,* 1993).

The target area of present study was limited to three cotton producing districts of Sindh, namely Sanghar, Nawabshah, and Naushahro Feroze. Sanghar district is the top most cotton producing district of Sindh. In 2003-04, Sanghar district produced 637,772 bales out of Sindh province total production of 2,129,553 bales-almost 30 percent (Aziz, 2005).

Multistage cluster sampling was applied to select sample respondents from three districts. In the first stage, one *tehsil* from each district was randomly selected as per plan depicted in Table 2. According to information provided by District Offices (Agriculture), there were 16 pesticide dealers in Nawabshah city, 16 in Shahdadpur, and 3 in Bhiria City; thus, in all, there were 35 pesticide dealers in three *tehsil* headquarters. The following equation, suggested by Tryfos (1996), was used to determine the representative sample size:

$$n = \frac{N\pi(1-\pi)}{(N-1)\left(\frac{C}{Z_{a/2}}\right)^2 + \pi(1-\pi)}$$

Where n is recommended sample size, N is population size, π is characteristic of interest, C is ± error rate, and $Z_{a/2}$ is tabulated value for confidence interval. Using the above equation, a sample of 23 pesticide dealers was suggested for proportion of 0.5, which gives the maximum variance of 0.25 $[0.5 \times (1 - 0.5) = 0.25]$, error rate of ±10%, and 90% confidence interval. The suggested sample of pesticide dealers was divided into three *tehsil* headquarters disproportional to their population sizes because the number of pesticide dealers in Bhiria City was quite small as compared to other two *tehsils*. The sampling plan is depicted in Table 2. A sample of 10 pesticide dealers from Shahdadpur, 10 from Nawabshah, and 3 from Bhiria were selected for the study.

TABLE 2

Cluster Sampling Plan for Selection of Dealers

District	Tehsil	Selected Tehsil Headquarter	Pesticide Dealers	
			Population	Sample
Sanghar	Sanghar Jam Nawaz Ali Khipro Shahdadpur Sinjhoro Tando Adam	Shahdadpur	16	10
Nawabshah	Daulat Pur Safan Nawabshah Sakrand	Nawabshah	16	10
Naushahro Feroze	Bhiria Kandiaro Moro N. Feroze	Bhiria	3	3
Total		3 Tehsils	35	23

There were 87 pesticide firms/companies registered with the Directorate General, Agriculture Extension, Hyderabad, Sindh in 2003-04. On the basis

of key informant input, it was ascertained that there were about 30 pesticide companies in the study area selling pesticides through their active sales network. Using the above equation for the population size of 30, proportion of 0.5, error rate of ±10%, and confidence interval of 90%, a representative sample size of 19 was determined. Nineteen companies were randomly selected. From each selected company one sales executive was purposively selected; randomization was not possible because of mobile nature of job of sales executives.

PRIMARY DATA ANALYSIS

Primary data regarding marketing of pesticides in the study area are presented as under:

1. Market Share of Insecticides

Sale in terms of quantity (metric tons) and in terms of value (million Rs.) sold during 2003 is presented in Table 3. The table shows that during 2003, the total sale by weight was 970.75 metric tons. Shares of companies by status indicated that 23.4 percent of total sale was hoarded by multinational companies while the shares of national and generic companies were estimated at about 32.1 and 44.5 percent, respectively.

TABLE 3

Company Status-wise Sale of Insecticides

Status of the companies		Sale of pesticides by weight (MT)	%age	Sale of pesticides in million Rs.	%age
Multinational		227.14	23.4	152.18	32.2
Local	National	311.50	32.1	124.35	26.4
	Generic	432.11	44.5	195.20	41.4
Total		970.75	100.0	471.73	100.0

Pesticide market of the study area (in terms of value) was estimated to be Rs. 471.73 million. Calculated shares of the multinational, national, and generic companies were 32.2, 26.4 and 41.4 percent, respectively. Difference between the shares of multinational companies in terms of weight and value was due to higher prices of their products as compared to prices offered by local companies. The combined share of local companies (national and generic) was 68 percent. This estimated share of local companies was in

general agreement with that of Novartis (2000) report that the share of local companies was 60 percent in Pakistan. This showed that during three years, the share of local companies increased from 60 percent in 2000 to 67.8 percent in 2003 (when data were collected for the present study) due to induction of new local companies in the pesticide market.

Top ten insecticides sold in the study area in terms of weight during 2003 were summarized in Table 4. The table revealed that highest selling pesticide in the study area was methamidophos, fetched 28.6 percent of all the insecticides followed by endosulfan (12.2%), cypermetherin (9.4%), imidacloprid, (7.6%), fenpropthrin (6.6%), chlorpyrifos (4.6%), bifenthrin (4.3%), profenophos (3.8%), fenvalerate (2.8%), and monocrotophos (2.3%). These pesticides belong to organophosphate, organochlorine and pyrethroid groups, respectively. The estimates can be supported by survey findings of a study conducted by Saleem and Arshad (2005) who reported that most of the pesticides applied in Pakistan were class one as classified by the WHO like monocrotophos, methamidophos, endosulfan and carbufuran. These hazardous pesticides played havoc with biodiversity, environment, and public health standards.

TABLE 4

Top Ten Insecticides in Terms of Weight

Insecticide	Sale of pesticides in weight (MT)	%age
Methamidophos	277.4	28.6
Endosulfan	117.98	12.2
Cypermetherin	90.92	9.4
Imidacloprid	73.5	7.6
Fenpropthrin	63.98	6.6
Chlorpyrifos	44.93	4.6
Bifenthrin	41.7	4.3
Profenophos	36.7	3.8
Fenvalerate	27.6	2.8
Monocrotophos	22.3	2.3
Others	173.74	17.9
Total	970.75	100.0

Organophosphates can slowly poison by attacking an essential body enzyme called “cholinesterase”. The chronic exposure to organophosphate

pesticides can be measured by monitoring changes in blood cholinesterase levels. In humans, decreased blood cholinesterase levels are a sure sign that exposure to these types of pesticides should be avoided until the level is measured as being normal again (PMEP, 2004). Tahir *et al.* (2001) conducted a study in Multan and Bahawalpur divisions to assess the level of poisoning among cotton pickers. The results of blood analysis showed that the post spray season ChE activity in blood sample of only 10 percent female pickers was found to be in the normal range of 88-100 percent whereas this level was hazardous (00-50 percent) among 42 percent of the pickers.

Besides health hazards, the available literature indicated that insects have developed resistance to common insecticides. Whitefly has developed resistance against methamidophos and it should not be used more than once in the season (CCRI, 2004). Further, it was reported that pesticides of pyrethroid group help in resurgence of whitefly.

2. Price Index of Some Common Pesticides

Table 5 revealed the ratios of prices of farmers' price (maximum retail price) and importers' price. The average ratio for local companies was about 2.32, which indicated that a pesticide was imported for Re. 1 and was sold to farmers for Rs. 2.32 while for multinational companies the average ratio was 2.50. This ratio varied from 1.84 for profenophos 40 EC to 4.17 for cypermetherin 10 EC. The weighted average ratio was 2.38.

The weighted average ratio was calculated on the basis of 68 percent of total pesticides sold by local companies and 32 percent by multinational companies (Table 3). Using these estimates, the total outlay of farmers on the purchase of pesticide in Pakistan was calculated by multiplying import bill with 2.41. The estimated outlay was calculated to be Rs. 15,754 million for 2002 and 19612 million for 2003. Chaudhry (2004) reported that total volume of the pesticide market in Pakistan presently stood at US $ 250 million (Rs. 15 billion) during 2002, being a significant market in regional perspective. From this, it may be concluded that the pesticide market has increased from Rs. 12-14 billion as reported by Tariq (2002) for 2000 to about Rs. 15 billion for 2002 (Chaudry, 2004) and 19.6 billion for 2003, estimated by this study.

Marketing margins of channels of local companies were 36 percent for importers, 35 percent for distributors, and 26 percent for dealers. Multinational companies did not sale their products to distributors, but they had their own marketing arrangements. Marketing margins of multinational and their dealers were estimated at 126 and 11 percent, respectively.

TABLE 5

Price Index of Some Common Pesticides

Pesticide	Local Companies				
	Importer	Distri-butor	Dealer	Farmer	$\text{Price} = \frac{\text{Farmer's Price}}{\text{Importer's Price}}$
Abamactin 1.8 EC	250	310	410	525	2.10
Accetamaprid 20 SP	300	360	500	700	2.33
Bifenthrin 10 EC	400	600	850	1000	2.50
Cypermetherin 10 EC	60	150	180	250	4.17
Fenproptherin 20 EC	175	235	350	425	2.43
Imidocloprid 25 WP	285	340	450	600	2.11
Profenofos 40 EC	190	240	300	350	1.84
Methamidophos 60 SL	90	145	180	210	2.33
Total	1750	2380	3220	4060	
Price index	100	136	184	232	
Marketing Margin	36	35	26		
Multinational companies					
	Importer	Dealers	Farmer	$\text{Price} = \frac{\text{Farmer's Price}}{\text{Importer's Price}}$	
Curacran 50EC	180	385	428	2.38	
Politerin C 440EC	240	589	670	2.79	
Karate 2.5EC	180	404	460	2.56	
Deltafos 360EC	250	719	750	3.00	
Thiodan 35EC	120	305	350	2.92	
Confidor 200 SL	600	1000	1100	1.83	
Buctral 60 EC	200	410	550	2.75	
Larin 20 EC	550	1422	1500	2.73	
Total	2320	4734	5808		
Price index	100	226	250		
Marketing Margin	126	11			

3. Incentive Schemes for Pesticide Dealers

Each pesticide company has its own incentive scheme for the dealers. Usually companies collect money in advance from dealers in December and January for the pesticides supplied in May and June (start of insect pest season). This scheme is known as “booking” while during the remaining period dealers purchase the pesticide on cash basis – the cash scheme. Local companies offer very lucrative incentives as a part of booking scheme,

including foreign tours of Bangkok, Dubai and Malaysia. Area Manager of a national company informed that their booking scheme offered Dubai tour with a price tag of Rs. 0.2 million to the dealers. In another package, 30 percent of sale through booking scheme was given in cash known as "cash incentive". Besides, during tour, lottery schemes for dealers ranged from Rs. 0.02 to 5.00 million only were offered. It was estimated by the researcher that the booking scheme offered almost 40 percent in profits and incentives to the dealers. In cash schemes, the local companies offer 15 to 20 percent of purchase to the Dealer.

Data gathered to know the incentive schemes of pesticides companies for dealers revealed that generic and national companies offered more incentives through different schemes (cash prizes and foreign tours) to the dealers to get maximum market share. The same findings are more visible in the survey report of NFDC (2002) stating that pesticide companies have gone over broad offering incentive schemes like "Bhangra scheme" whereby various prices and lottery tickets are used to promote sales. In certain cases this led to over use of pesticides and at times poor grade and discarded pesticides are dumped in the market with major losses to the farming community.

Multinational companies apparently do not offer such incentives of tour and lottery to the dealers. Sales executives of multinational companies did not share specific information with the researcher regarding incentive schemes for dealers. Direct margins offered to dealers were reported to be as low as 2 percent. The researcher, however, collected information from the dealers and determined that on the booking scheme 15 percent was offered while on cash scheme, 8 percent was offered. Because of higher sale of multinational products, dealers were found satisfied with the lower margins since the absolute level of profits was higher.

Bargaining over pesticides of local companies is a common phenomenon in the pesticide market while prices of pesticides of multinational companies are fixed. Sales executives of the multinational companies stated that majority of farmers purchase pesticides from dealers on credit; and that the dealers do choose often substandard pesticides which are available at their shops and make substantial profits in the process.

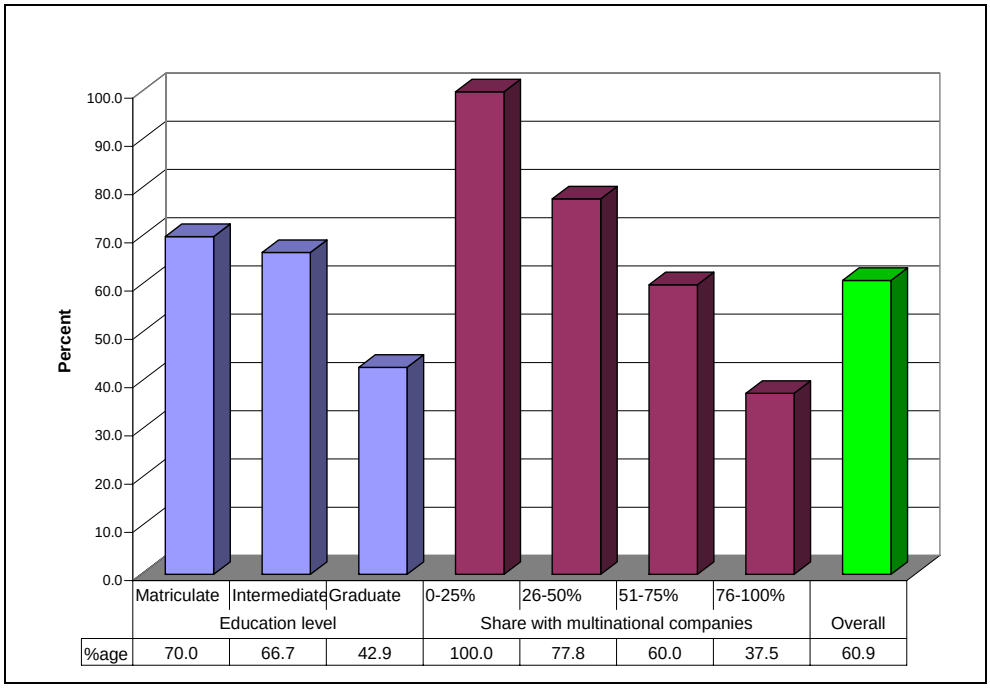
Multinational companies provided incentives against good sale to their dealers in kind rather than cash. They imparted high profile trainings to dealers for their capacity building in various areas of crop protection, record and shop management, sale forecast, and computer packages. Some of the multinational companies provided furniture, computers, and latest computer programs for the identification of diseases and insect pests.

4. Sale of Pesticides on Credit

Figure 3 unveiled that 60.9 percent of the pesticide dealers offered pesticides on credit. The segregated data based upon educational level showed that 70 percent matriculate, 66.7 percent intermediate, and 42.9 percent graduate dealers offered pesticides on credit. This trend shows that more educated dealer preferred sale of pesticide on cash terms.

FIGURE 3

Sale of Pesticides on Credit



Share of multinational companies in total sale of pesticide dealers was divided in four categories, *viz.* I (0 to 25%), II (26 to 50%), III (51 to 75%), and IV (76 to 100%). Strong negative relationship between the share of multinational companies and the sale of pesticides on credit was observed. All the dealers belonging to category I, 77.8 percent from II, 60.0 percent from III, and 37.5 percent from IV were recorded to be offering pesticides on credit. The obvious reason of this trend was that the multinational companies did not offer pesticides on credit to dealers. As a result, less proportion of dealers working with multinational companies offered pesticides on credit to growers. Moreover, the multinational companies offered reasonable profit margins on the sale of pesticides whereas local companies offered very lucrative profit margins through different incentive schemes, as a result the

risk of the unrecoverable amount from unfair growers was met with the hefty profits made on the recoverable amounts. NFDC (2002) reported that pesticide dealers and commission agents provided service of extending credit for the purchase of pesticides.

III. CONCLUSIONS

Consequent upon the institution of liberal policies by the Government of Pakistan in 1980s, aimed at transferring the import and sale of chemical pesticides to the private sector, numerous companies entered the country's pesticide market. Quadratic regression was proposed for the import of pesticides in the country. Estimates of the proposed model revealed steeper growth trend than that of ordinary regression model.

Total outlay of farmers on the purchase of pesticide in Pakistan was estimated at about Rs. 19.6 billion during 2003. Local companies offered high profit margins (up to 30%) and incentive schemes including lotteries and foreign tours to the dealers who, in addition, charged exorbitant interest rate of 30 to 40 percent per annum from the farmers while giving pesticides on loan. Unlike local companies, multinationals offered normal profit margins (up to 15%) to dealers, supplied quality pesticides and imparted training programs for the capacity building of farmers and dealers. Total sale amount of insecticides in Sanghar, Nawabshah, and Naushahro Feroze districts was estimated to be Rs. 471.73 million in 2003-04. Top five insecticides in terms of weight were methamidophos (29%), endosulfan (12%), cypermetherin (9%), imidacloprid, (8%), and fenpropthrin (7%). The above ranking reflected the persistence of old groups of pesticides, *i.e.* organophosphate, organochlorine and synthetic parathyroid in the market; while the recent literature revealed that cotton insect pests had developed resistance to these groups.

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