Indian Journal of Fundamental and Applied Life Sciences ISSN: 2231– 6345 (Online)
An Open Access, Online International Journal Available at www.cibtech.org/sp.ed/jls/2014/03/jls.htm
2014 Vol. 4 (S3), pp. 1755-1762/ Noorivandi and Ommani
Research Article

THE EFFECT OF FERTILIZERS AND PESTICIDES RUNOFF ON AQUATIC ECOSYSTEM OF KARUN RIVER IN KHOUZESTAN PROVINCE (CASE STUDY: ECOLOGICAL BEHAVIOUR OF WHEAT FARMERS IN AHWAZ TOWNSHIP)

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ABSTRACT
The purpose of research was identifying the effect of fertilizers and pesticides runoff on aquatic ecosystem of Karun River by analyzing ecological behavior of wheat farmers in Ahwaz Township, Khuzestan province, Iran. The method of research was a descriptive-correlative. The sample size was wheat farmers Karun River margin in Ahwaz township (n=115). A five-point Likert-type scale was used as the instrument to gather data in order to measure the ecological behavior of farmers. Data were analyzed using the Statistical Package for the Social Sciences (SPSS). Questionnaire reliability was estimated by calculating Cronbach's alpha and it was appropriate for this study (Cranach's alpha 0.91). Based on CV, different items of ecological behavior of farmers have been ranked. As can be seen the highest rank related to "*the only method that I used to combat pests was chemical pesticides.*" and it shows that the wheat farmers ecological behavior about usage of fertilizers is high dangerous. The second rank related to "*the only way that I used to eliminate weeds was chemical toxins*". Thus situation of ecological behavior has not suitable situation. Majority of farmers had not well-performance of the ecological behavior. Approximately, 51% of farmers had high and very high dangerous level. Based on the results, the correlation between favorability of ecological behavior and participation in extension activities and educational level at the level of 0.01 was significant. Liner regression was used to predict changes in favorability of ecological behavior. Participation in extension activities and educational level may well explain for 37.6% changes ($R^2 = 0.376$) in ecological behavior of farmers.

Keywords: *Fertilizers, Pesticides, Aquatic Ecosystem, Karun River, Ecological Behavior*

INTRODUCTION
Pollution by nutrients from agricultural activities causes many problems in the environment.

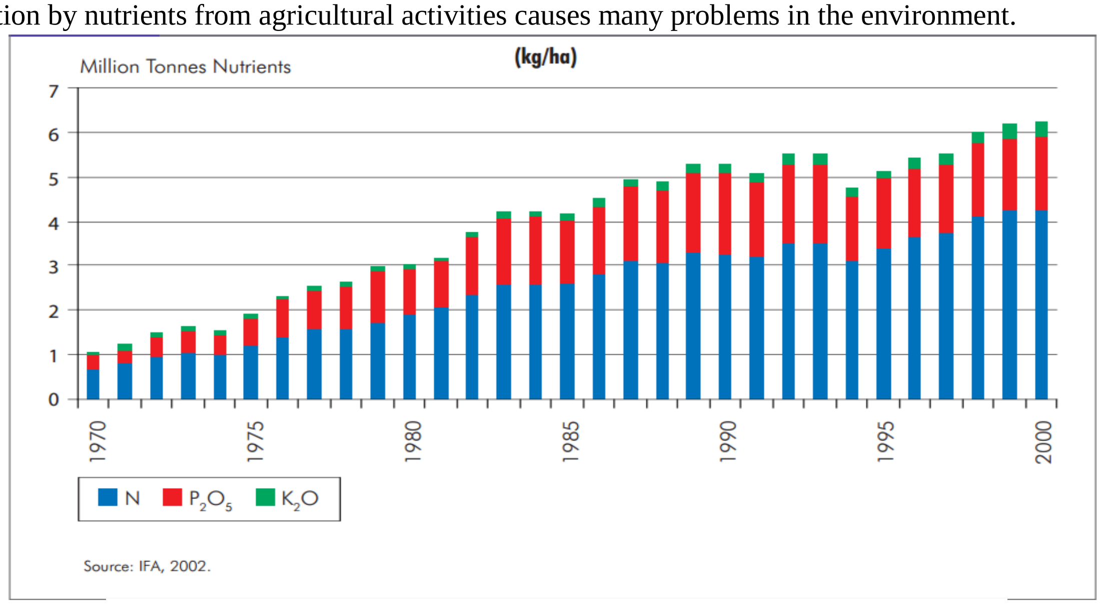

Figure 1: Fertilizer Consumption in the Middle East Region (IFA, 2002)

Fertilization is considered as one of the main sources of pollution of water bodies caused by agriculture (Kremser and Schnug, 2002). The consumption of NPK (N+ P2O5 + K2O) fertilizers in the Middle East region increased from 1.5 million tons in 1970 to more than 6 million tons in 2002 (Figure 1). The major share of elements goes to nitrogen; phosphatic fertilizers are used at a smaller rate and then potassium is used in very low quantities (IFA, 2002). In past decades in Iran like other developing countries, tendency to usage of fertilizer has been increased. Figures 2 and 3 show trends in fertilizer consumption during the past four decades (FAO, 2005).

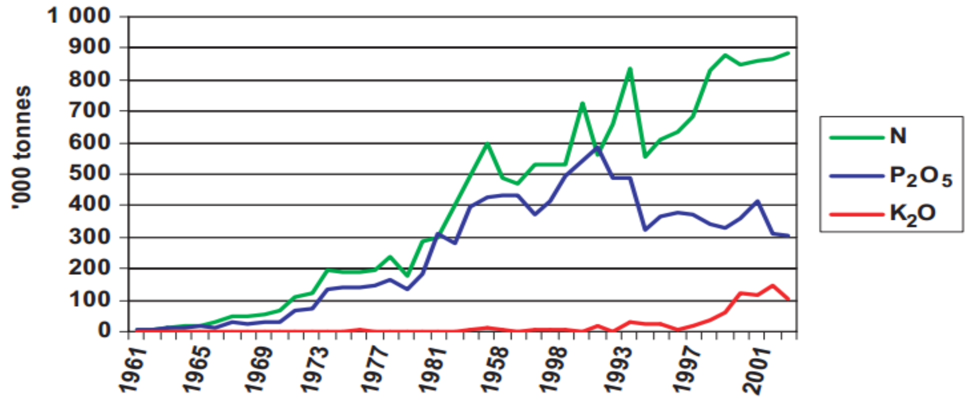

Figure 2: Trends in fertilizer consumption changes in Iran during the past four decades (FAO, 2005)

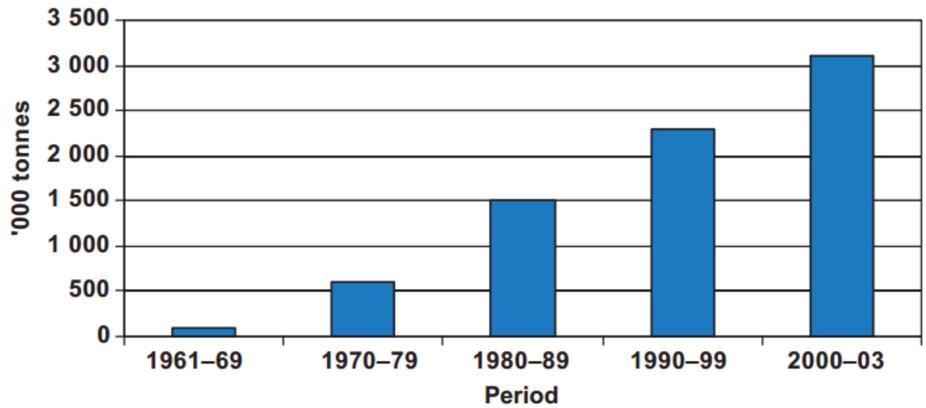

Figure 3: Increasing fertilizer use in Iran since 1961(FAO, 2005)

Water pollution occurs when a body of water is adversely affected due to the addition of large amounts of materials to the water. The sources of water pollution are categorized as being a point source or a non-source point of pollution. Point sources of pollution occur when the polluting substance is emitted directly into the waterway. A pipe spewing toxic chemicals directly into a river is an example. A non-point source occurs when there is runoff of pollutants into a waterway, for instance when fertilizer from a field is carried into a stream by surface runoff.

Farms often use large amounts of herbicides and pesticides, both of which are toxic pollutants. These substances are particularly dangerous to life in rivers, streams and lakes, where toxic substances can build up over a period of time. Farms also frequently use large amounts of chemical fertilizers that are washed into the waterways and damage the water supply and the life within it. Fertilizers can increase the amounts of nitrates and phosphates in the water, which can lead to the process of eutrophication. Fish and other aquatic biota may be harmed by pesticide-contaminated water. Pesticide surface runoff into rivers and streams can be highly lethal to aquatic life, sometimes killing all the fish in a particular stream (Helfrich *et al*., 1996; Toughill, 1999).

MATERIALS AND METHODS

The purpose of research was identifying the effect of fertilizers and pesticides runoff on aquatic ecosystem of Karun River by analyzing ecological behavior of wheat farmers in Ahwaz Township, Khuzestan province, Iran. The method of research was a descriptive-correlative. The sample size was wheat farmers Karun river margin in Ahwaz township (n=115). A five-point Likert-type scale was used as the instrument to gather data in order to measure the ecological behavior. Data were analyzed using the Statistical Package for the Social Sciences (SPSS). Questionnaire reliability was estimated by calculating Cronbach’s alpha and it was appropriate for this study (Cranach's alpha 0.91).

RESULTS AND DISCUSSION

Demographic Profile

Table 1 shows the demographic profile and the descriptive statistics for some characteristics of wheat farmers. The results of the demographic information and the descriptive statistics of the participant indicated that all of participants were men. The minimum age of participant was 20 years. Their maximum work experience was 25 years old.

Table 1: Demographic profile of wheat farmers Karun river margin (n=115)

Variables	F	P	CP
Age			
20-30	19	16.52	16.52
30-40	28	24.35	40.87
40-50	57	49.57	90.43
50-60	11	9.57	100.00
Educational level (year)			
5>	55	47.83	47.83
6-8	36	31.30	79.13
8-12	13	11.30	90.43
12<	11	9.57	100.00
work experience (Year)			
1-5	34	29.57	29.57
5-10	48	41.74	71.30
10-15	23	20.00	91.30
15<	10	8.70	100.00

F: Frequency, P: Percentage, CP: Cumulative Percentage

Identifying the Effect of Fertilizers and Pesticides Runoff on Aquatic Ecosystem of Karun River in Khuzestan Province

With regard to the assessment the effect of fertilizers and pesticides runoff on aquatic ecosystem of Karun River in Khuzestan province, was used ecological behavior model that present by KAISER et al (1999). The results in Table 2 showed the performance of wheat farmers on the ecological behavior. Based on the number of items (n = 6), minimum and maximum acquisition score (min = 1, max = 5), range scores between 6 and 30 was vary. This range was divided into 5 categories. People who had 6 to 11 score was located in very low dangerous behavior group, who had score 11 to 16 was located in the low dangerous behavior group, people who 16 to 21 were in the unsure group, who had a score of 21 to 26 in the high dangerous behavior group, and those who had score 26 to 30 were located in the very high dangerous group.

A: Very Low Dangerous Behavior Group: 6< A<11
B: Low Dangerous Behavior Group: 11< B<16
C: Unsure Behavior Group: 16< C<21
D: High Dangerous Behavior Group: 21< D<26

E: Very High Dangerous Behavior Group: 26< E<30

As can be seen the highest rank related to "*the only method that I used to combat pests was chemical pesticides.*" and it shows that the wheat farmers ecological behavior are high dangerous about usage of fertilizers. As can be seen from Table 2, the second rank related to "*the only way that I used to eliminate weeds was chemical toxins*". Thus situation of ecological behavior has not suitable situation. Table 3 categorizes farmers in five groups. Majority of farmers had not well-performance of the ecological behavior. Approximately, 51% of farmers had high and very high dangerous level.

Table 2: Ecological behavior of Wheat Farmers Karun margin in Ahwaz Township

Items	1		2		3		4		5		Mean	sd	CV	Rank
	F	%	F	%	F	%	F	%	F	%				
The only method that I used to combat pests was chemical pesticides.	11	6.18	10	5.62	33	18.54	35	19.66	26	14.61	3.791	0.826	0.218	1
The only way that I used to eliminate weeds was chemical toxins.	8	4.49	7	3.93	48	26.97	32	17.98	20	11.24	3.426	0.817	0.238	2
I mix fertilizer with irrigation water.	12	6.74	11	6.18	45	25.28	39	21.91	8	4.49	3.174	0.805	0.254	4
I believe that chemical fertilizers have favorable effect on product quality.	15	8.43	10	5.62	34	19.10	43	24.16	13	7.30	3.252	0.899	0.277	6
Additional water of my farm, through drainage entered to the Karun river.	12	6.74	7	3.93	29	16.29	51	28.65	16	8.99	3.452	0.867	0.251	3
The additional water of farms entering the Karun river is without danger to the environment.	13	7.30	14	7.87	31	17.42	42	23.60	15	8.43	3.278	0.903	0.276	5

(1 = Very Low, 5 =Very High),

Table 3: Frequency of farmers based on ecologically dangerous behaviuor levels

Ecologically dangerous behavior level	Frequency	Percent	Cumulative Percent
Very low	11	9.57	9.57
Low	10	8.70	18.26
Moderate	35	30.43	48.70
High	42	36.52	85.22
Very high	17	14.78	100.00
Total	115	100	

Mean=3.383

Correlation Study

Spearman correlation coefficients to test hypotheses was used, the results of this test are as follows (Table 4). The Spearman correlation coefficient is defined as the Pearson correlation coefficient between the ranked variables (Myers and Well, 2003). For a sample of size *n*, the *n* raw scores X_i, Y_i are converted to ranks x_i, y_i, and ρ is computed from:

$$\rho = 1 - \frac{6 \sum d_i^2}{n(n^2 - 1)}.$$

Where $d_i = x_i - y_i$, is the difference between ranks.

The results of table 4 showed, the correlation (r=0.378) between favorability of ecological behavior and participation in extension activities at the level of 0.01 was significant. It means that with 99% of confidence, we can conclude that farmers with high participation in extension activities had high favorable ecological behavior.

Also the results of table 4 showed, the correlation (r=0.474) between favorability of ecological behavior and educational level at the level of 0.01 was significant. It means that with 99% of confidence, we can conclude that farmers with high level of education had high favorable ecological behavior.

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Based on the results of table 4, the correlation between favorability of ecological behavior and income, farm size, social participation, crop yield was not significant.

Table 4: Relationship between favorability of ecological behavior and independent variables

Independent variable	Dependent variable	r	p
Extension activity	Favorability of Ecological Behavior	0.378	0.000
Educational level		0.474	0.000
Income		0.079	0.108
Farm size		0.119	0.083
Social participation		0.098	0.101

Regression Analysis

For analyzing interaction role of independent variable on dependent variable was used multiple regression.

Given a data set $\{y_i,\ x_{i1}, \ldots, x_{ip}\}_{i=1}^{n}$ of *n* statistical units, a linear regression model assumes that the relationship between the dependent variable y_i and the *p*-vector of regressorsx_i is linear. This relationship is modeled through a *disturbance term* or *error variable* ε_i — an unobserved random variable that adds noise to the linear relationship between the dependent variable and regressors. Thus the model takes the form

$$y_i = \beta_1 x_{i1} + \cdots + \beta_p x_{ip} + \varepsilon_i = \mathbf{x}_i^{\mathrm{T}}\boldsymbol\beta + \varepsilon_i, \qquad i = 1, \ldots, n,$$

where $^{\mathrm{T}}$ denotes the transpose, so that $\boldsymbol{x}_i^{\mathrm{T}}\boldsymbol\beta$ is the inner product between vectors $\boldsymbol{x}_i$ and $\boldsymbol\beta$.

Often these *n* equations are stacked together and written in vector form as

$$\mathbf{y} = \mathbf{X}\boldsymbol\beta + \boldsymbol\varepsilon,$$

where

$$\mathbf{y} = \begin{pmatrix} y_1 \\ y_2 \\ \vdots \\ y_n \end{pmatrix}, \quad \mathbf{X} = \begin{pmatrix} \mathbf{x}_1^{\mathrm{T}} \\ \mathbf{x}_2^{\mathrm{T}} \\ \vdots \\ \mathbf{x}_n^{\mathrm{T}} \end{pmatrix} = \begin{pmatrix} x_{11} & \cdots & x_{1p} \\ x_{21} & \cdots & x_{2p} \\ \vdots & \ddots & \vdots \\ x_{n1} & \cdots & x_{np} \end{pmatrix}, \quad \boldsymbol\beta = \begin{pmatrix} \beta_1 \\ \beta_2 \\ \vdots \\ \beta_p \end{pmatrix}, \quad \boldsymbol\varepsilon = \begin{pmatrix} \varepsilon_1 \\ \varepsilon_2 \\ \vdots \\ \varepsilon_n \end{pmatrix}.$$

Some remarks on terminology and general use:

y_i is called the *regress* or *dependent variable*. The decision as to which variable in a data set is modeled as the dependent variable and which are modeled as the independent variables may be based on a presumption that the value of one of the variables is caused by, or directly influenced by the other variables. Alternatively, there may be an operational reason to model one of the variables in terms of the others, in which case there need be no presumption of causality.

$x_{i1}, x_{i2}, \ldots, x_{ip}$ are called *regressors* or or *independent variables*. The matrix $\mathbf{X}$ is sometimes called the design matrix.

Usually a constant is included as one of the regressors. For example we can take $x_{i1} = 1$ for $i = 1, ..., n$. The corresponding element of $\boldsymbol\beta$ is called the *intercept*. Many statistical inference procedures for linear models require an intercept to be present, so it is often included even if theoretical considerations suggest that its value should be zero.

Sometimes one of the regressors can be a non-linear function of another regressor or of the data, as in polynomial regression and segmented regression. The model remains linear as long as it is linear in the parameter vector $\boldsymbol\beta$.

The regressors x_{ij} may be viewed either as random variables, which we simply observe, or they can be considered as predetermined fixed values which we can choose. Both interpretations may be appropriate in different cases, and they generally lead to the same estimation procedures; however different approaches to asymptotic analysis are used in these two situations.

$\boldsymbol\beta$ is a *p*-dimensional *parameter vector*. Its elements are also called *effects*, or *regression coefficients*. Statistical estimation and inference in linear regression focuses on $\boldsymbol\beta$. The elements of this parameter

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vector are interpreted as the partial derivatives of the dependent variable with respect to the various independent variables.
ε_i is called the *error term, disturbance term*, or *noise*. This variable captures all other factors which influence the dependent variable y_i other than the regressors$\boldsymbol{x}_i$. The relationship between the error term and the regressors, for example whether they are correlated, is a crucial step in formulating a linear regression model, as it will determine the method to use for estimation.

$$x'x = \begin{bmatrix} \sum y^2 & \sum x_1 y & \sum x_2 y \\ \sum x_1 y & \sum x_1{}^2 & \sum x_1 x_2 \\ \sum x_2 y & \sum x_1 x_2 & \sum x_2{}^2 \end{bmatrix}$$

$$CF = \begin{bmatrix} \left(\sum y_i\right)^2 / n & \left(\sum x_{i1}\right)\left(\sum y_i\right) / n & \left(\sum x_{i2}\right)\left(\sum y_i\right) / n \\ \left(\sum x_{i1}\right)\left(\sum y_i\right) / n & \left(\sum x_{i1}\right)^2 / n & \left(\sum x_{i1}\right)\left(\sum x_{i2}\right) / n \\ \left(\sum x_{i2}\right)\left(\sum y_i\right) / n & \left(\sum x_{i1}\right)\left(\sum x_{i2}\right) / n & \left(\sum x_{i2}\right)^2 / n \end{bmatrix}$$

$$x'x - CF$$

b=SP^{-1}.g

$$x'x - CF = \begin{bmatrix} SP_{yy} & SP_{1y} & SP_{2y} \\ SP_{1y} & SP_{11} & SP_{12} \\ SP_{2Y} & SP_{21} & SP_{22} \end{bmatrix} \quad g = \begin{bmatrix} SP_{1y} \\ SP_{2y} \end{bmatrix} \quad g' = \begin{bmatrix} SP_{1y} & SP_{2y} \end{bmatrix} \quad SP = \begin{bmatrix} SP_{11} & SP_{12} \\ SP_{21} & SP_{22} \end{bmatrix}$$

$$SP^{-1} = \frac{N'}{|SP|}$$ b=SP^{-1}.g For testing significant of coefficients (b, b_1, b_2….):

$$F = \frac{MS_{reg}}{MS_{res}} = \frac{SS_{reg}/df_{reg}}{SS_{res}/df_{res}} = \frac{SS_{reg}/k}{SS_{res}/n-k-1} = \frac{SS_{reg}}{SS_{res}} \times \frac{n-k-1}{k}$$

K=number of variables
n=Sample size

$$F = \frac{n-k-1}{k} \times \frac{R^2}{1-R^2}$$

$$SS_{reg} = b'g$$

$$SS_{reg} = [b_1 b_2] \times \begin{bmatrix} g_1 = SP_{1y} \\ g_2 = SP_{2y} \end{bmatrix} = (b_1 \times SP_{1y}) + (b_2 \times SP_{2y})$$

Therefore:

$$SS_{reg} = (b_1 \times SP_{1y}) + (b_2 \times SP_{2y}) \qquad R^2 = \frac{SS_{reg}}{SS_y}$$

$$SS_y = SS_{reg} + SS_{res}$$

$$F = \frac{n-k-1}{k} \times \frac{SS_{reg}}{SS_{res}}$$

$$V = MS_{res} \times SP^{-1}$$

$$MS_{res} = \frac{SS_{res}}{df_{res}}$$

$$t = \frac{b_j}{\sqrt{v_{jj}}}$$

Table 5: Multivariate regression analysis

Independent variable	B	Beta	T	Sig
Extension activity	0.716	0.469	2.927	0.000
Educational level	0.908	0.809	3.928	0.000
Constant	1.909	----	3.674	0.000

R^2=0.376, F=10.12, Sig= 0.000

Table 5 shows the result for regression analysis by stepwise method. Liner regression was used to predict changes in favorability of ecological behavior. Participation in extension activities and educational level may well explain for 37.6% changes (R^2 = 0.376) in ecological behavior of farmers.

$Y=1.909+0.716x_1+0.908x_2$

Conclusion

Based on the results the highest rank of ecological dangerous behavior was related to "*the only method that I used to combat pests was chemical pesticides.*" and it shows that the wheat farmers ecological behavior are high dangerous about usage of fertilizers. Also, the second rank related to "*the only way that I used to eliminate weeds was chemical toxins*". Thus situation of ecological behavior has not suitable situation. Majority of farmers had not well-performance of the ecological behavior. Approximately, 51% of farmers had high and very high dangerous level. The correlation (r=0.378) between favorability of ecological behavior and participation in extension activities at the level of 0.01 was significant. It means that with 99% of confidence, we can conclude that farmers with high participation in extension activities had high favorable ecological behavior. Also the results showed, the correlation (r=0.474) between favorability of ecological behavior and educational level at the level of 0.01 was significant. It means that with 99% of confidence, we can conclude that farmers with high level of education had high favorable ecological behavior. Liner regression was used to predict changes in favorability of ecological behavior. Participation in extension activities and educational level may well explain for 37.6% changes (R^2 = 0.376) in ecological behavior of farmers.

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