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# Effect of Sewage Water on Spinach Yield

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## ABSTRACT

The study has been conducted to evaluate the effect of sewage water on spinach yield. A total of 70 spinach growers were interviewed from Rahim Yar Khan District, Pakistan. Cobb Douglas production function was employed to find out the possible effect-positive or negative on spinach yield. Dummy variable was used for this purpose and it was found that application of the sewage water to spinach vegetable has a substantial positive effect on its yield. However, different studies indicate that continuous use of such type of water depletes soil fertility and productivity in the long run. Therefore, treatment plants are needed to clean the sewage water and this is the way in which we can benefit from this type of water in terms of nutritional and monetary aspects. On the other hand, treated sewage water would reduce degradation of land resources.

**Key Words:** Spinach; Sewage water; Yield; Cobb Douglas; Dummy variable

## INTRODUCTION

Water pollution in some ways is more complex than air pollution because almost anything can be spilled or dumped into water including kitchen sink (Anderson, 2004). Sewage is the best example in Pakistan. Sewerage water contains a large variety of wastes ranging from domestic to industrial; therefore, quality of such water is not suitable to irrigate any crop because of presence of many toxic chemicals (Furedy *et al.,* 1999; Zarsky & Hunter, 1999; Murtaza *et al*., 2003; Ghafoor *et al.*, 2004).

The city effluent is mainly used for raising vegetables in the vicinity of the cities (Hernandez *et al.,* 1991; Qadir *et al.,* 1997; Qadir *et al.,* 1999). Leafy vegetables like cauliflower, cabbage, spinach, etc. grow quite well in the presence of sewage water (Murtaza *et al*., 2003) whereas vegetables such as radish are sensitive to sewage water (Bakhsh *et al*., 2005). Vegetables grown by the use of sewage water contain many heavy metals causing serious health hazards to the community and animals as well (Qadir *et al.,* 1999; Murtaza *et al.,* 2003). This concern is of special importance, where un-treated sewage is applied for longer periods to grow vegetables in urban lands.

Another problem faced by the farmers is the management of soil productivity. The productivity of soil is simply its power to produce crops in useful quantities and is related to the physical and chemical characteristics of the soil itself together with the hydrological and meteorological systems in which is situated. Loss of soil productivity has been a continuing concern around the world (Field, 2001). As far as the use of sewerage water is concerned, its application increases production of leafy vegetables in the short run, however, continuous use badly impacts soil productivity.

The present study has been designed to see what could happen to the spinach yield in the presence of sewage water in the short run.

## METHODOLOGY

**The data.** For the purpose of this study, a primary data set was collected using personal interview schedule in district Rahim Yar Khan since spinach cultivation is concentrated in this district. A comprehensive questionnaire was used to collect information from spinach growers operating in various villages of the selected district during 2003 - 04. The purpose sampling technique was adopted to select the villages and the spinach-growing farmers. The reason for using purposive sampling technique is that cultivation of spinach is limited to the specific farms in the district. A total of 70 farmers were interviewed, out of these, 30 farmers were using sewage water for irrigating their spinach crop.

**Analytical framework.** Root crops such as radish, carrot, turnip, etc. are sensitive to sewage (Bakhsh & Hassan, 2005, 2005a) and poor quality of ground water (Bakhsh *et al.,* 2005) because the application of sewage and poor quality of ground water deteriorates quality of such vegetables and it also affects the growth of vegetables badly. To see the impact of sewage water on spinach cultivation, the regression analysis model was used to investigate whether or not sufficient evidence was available from farmers' fields that the use of sewage water is affecting spinach yield positively or negatively. Our objective was that whether the intercept and the slope parameters in regression equation are affected by the use of sewage water. The dummy variable approach was adopted. Cobb Douglas type production function was used to determine the impact of various independent variables on spinach yield and due to the ease in computation and interpretation. Important factors affecting yield were incorporated in the analysis, many variables such as varieties, farmyard manure, time of sowing, type of soil, etc. were still left out since our major emphasis was to determine the effect of sewage on spinach yield and on the other hand, these variables were not incorporated in production function due to non-availability of sufficient information on these variables.

Consider the following Cobb-Douglas production function in general form:

$$y_i = \prod_{i=1}^{m} \chi_{ij}^{\;b_i} e^{u_i}$$

Where,

i = 1, 2, m are inputs; j = 1, 2, n are farms, $y_i$ is output of the j-th farm; $\chi_{ij}$ is the level of i-th input on th j-th farm, $b_i$ is parameters including intercept to be estimated, $u_i$ is error term and e is the natural exponent (Ali & Chaudhry, 1990). We can write the above production function in log linear form as:

$$\ln y = A + \sum_{i=1}^{m} b_i \ln \chi_{ij} + \mu$$

Where,

A = lna and all other notations are as previously defined. Description statistics about the independent variables included in the model are given in Table I, while brief description is explained below:

LnLP = Natural logarithm of land preparation in tractor hours.

LnSEED = Natural logarithm of seed rate per acre in kg.

LnFER = Natural logarithm of fertilizer nutrients applied per acre in kg.

LnLBR = Natural logarithm of labour hours used in various farming activities excluding harvesting.

D = Dummy variable for sewage use. It was taken as 1 if sewage water was used otherwise zero.

## RESULTS AND DISCUSSION

Production function was estimated by incorporating dummy variable in the function. Results obtained by using the model are depicted in Table II. Value of $R^2$ was 0.38, which was sufficiently high indicating that 38% variation in spinach yield was due to the included variables in the model. Five independent variables were included in the model. Out of these, only one variable i.e. labour was statistically non-significant even at ten % probability level. Three variables were statistically significant at five % probability level and the remaining one at ten %.

Thoroughly prepared soil guarantees high percentage of germination of seed. This becomes more crucial for growing vegetables. Our results indicated that the fields well prepared were at a greater chance to achieve higher yield as depicted by statistically significant coefficient of land preparation. Similarly, the coefficient of fertilizer was also positive and statistically significant indicating an increased yield of spinach with more use of fertilizer. However, the coefficient of seed had a negative sign depicting that an increase in the quantity of seed would decrease spinach yield. This was due to the fact that majority of the farmers were using higher quantities of seed, such use was resulting in thickly populated vegetative growth and ultimately reducing the yield. The recommended rate per acre is 9 kg (Baloch, 1994; Government of Punjab, 1998) whereas the respondents of the spinach growers were using seed in the range of 16.63 to 17.20 kg per acre.

Our main interest was to estimate the impact of sewage water on spinach yield. For this purpose, dummy variable for sewage water was included in the function. As expected, the sign of this dummy variable was positive and significant at five % probability level. The positive coefficient indicates that the spinach growers using sewage water obtain higher yield since sewage water contains a large amount of organic nutrients. However, Ghafoor *et al.* (2004) estimated concentration of heavy metals in the leaves of spinach above the permissible limits of WHO for those vegetable fields, where were irrigated by sewage water. They also concluded that the application of sewage water enhanced leafy vegetables yield tremendously in the short run; however, continuous use of this type of water for irrigation purposes deteriorated soil fertility in the long run. Literature highlights serious health concerns regarding consumption of such vegetables (Carbera *et al.*, 1998; Ahmad, 2005; Tahir *et al.*, 2005) since sewage irrigated

**Table I. Descriptive Statistics of Various Variables**

| Variables | Sewage water users | Water users other than sewage |
|---|---|---|
| Land preparation (tractor hours/ac) | 4.53 (1.04) | 4.58 (1.13) |
| Seed (kg/ac) | 16.63 (3.84) | 17.20 (5.11) |
| Fertilizer (kg/ac) | 101.87 (44.26) | 102.45 (63.64) |
| Labour (hours/ac) | 216.78 (95.19) | 190.70 (90.60) |
| Yield (kg/ac) | 7148 (1739.60) | 6062.28 (2222.99) |

Figures in parenthesis are standard error

**Table II. Results of Production Function**

| Variables | Coefficients | Standard error |
|---|---|---|
| Constant | 8.13* | 0.56 |
| Land preparation | 0.68* | 0.16 |
| Seed | -0.28** | 0.14 |
| Fertilizer | 0.14* | 0.06 |
| Labour | -0.07 | 0.09 |
| Dummy for sewage | 0.23* | 0.08 |
| $R^2$ | | 0.38 |
| Adjusted $R^2$ | | 0.33 |
| F value | | 7.69 |
| No. of observations | | 70 |

Dependent variable = logarithm of yield in kg

* and ** indicate level of significance at five and ten percent respectively

vegetables contain heavy metals (Kiranjit *et al.*, 1998; Mitra & Gupta, 1999; Din 2002; Ali, 2003; Bhatti & Perveen, 2005).

**Suggestions.** In spite of presence of heavy metals, sewage enhances production of vegetables excluding root crops because of having abundance of organic matter. This is also true in case of leafy vegetables like spinach. This vegetable flourishes well when irrigated with sewage water. A one % increase in the use of sewage was accompanied by 23 % increase in spinach yield. This result shows that vegetable growers should use sewage water to increase their production. However, harmful effects on human and animal health and soil productivity as reported by other studies point out that such water should be treated to protect human and animal lives. Such use of water will increase crop yields and reduce cost of production because vegetables irrigated by sewage water need less inorganic nutrients.

Sewage water is polluted mainly by dumping of domestic and industrial wastes into the nallah or sewage. One way of controlling such practice is to impose tax/penalty on those, who are throwing un-treated water in the main sewage. This collected tax/penalty should be used to build water treatment plants and to spend on the welfare of the local communities.

This is the era of free trade and consumers are now becoming much more health conscious, while selecting the consumption of vegetables and other goods. The sewage irrigated vegetables and other products would face a difficult time in the consumer markets if the present practice of using sewage water continues. Therefore, it is the need of the time to focus on such issues. If these issues are solved, then, Pakistan could earn huge amounts of earnings by exporting surplus production of vegetables. Increased production of vegetables would increase employment opportunities in the rural and sub-urban areas, thus improving living standards of the resource poor farming and landless communities.

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