The Impact Of Subsidy Policies On Controlling Nitrate Pollution At Farm Land In Zabol County Sistan Province, IRAN

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ABSTRACT

Since, various agricultural policies cannot be studied in vitro, the potential impact of policies before, during or after the policy implementation, must be analyzed using mathematical programming models (MP). In this regard, the consequences of the increase in the price of fertilizers and policies affecting that at farmland in Iran, Sistan province, Zabol County Using the Positive Mathematical Programming Model (PMP) were studied. Data were collected through questionnaires. Environmental indicators were also calculated and the environmental impacts of the removal of fertilizer subsidies on agricultural subsectors within several scenarios were analyzed. The results show that if with the increase in prices of fertilizers, direct payment policy will be also applied, further reduce in the use of chemical fertilizers Can be held. Based on the results of these study the farmers in the area. According to income level and the size of their farm Exhibited different responses to policies. By removing subsidies and increasing prices to competitive prices, from one side it can take a heavy financial burden off the shoulders of government and in the other side to prevent environmental damage due to inefficiency caused by public sector intervention in the market system.

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INTRODUCTION

One of the problems that in the current era as a global issue has been considered by many experts, is the environmental problems, so the environment as the common heritage of civilizations has become a controversial challenge. One of the sectors in which plays a large role in polluting the environment is agriculture sector. Since the agricultural sector compared to other sectors of the economy, have more and more complex communications with environment, many experts believe that the basic infrastructure of agriculture activities is the environment. Besides providing the basic inputs needed for agricultural production, such as soil and water, environment is receptive of adverse effects of agriculture production activities (attracted a lot of waste from production processes) and, especially, water and soil pollution due to indiscriminate use of chemical inputs of fertilizers and pesticides [11].

During the long years indiscriminate use of chemical fertilizers, causes serious damage to the soil and thus to farming activity in the country. Especially nitrogen and phosphate fertilizers, and failure to comply with the basic principles of agricultural science, which make the maintaining of the nutrient balance in the soil necessary. While the need for different types of fertilizers in the country is not more than the current consumption, unfortunately, excessive use of Nitrate and phosphate fertilizers and the lack of consideration of other nutrient in fertilizer formulas exacerbate shortages and decline in soil fertility. Currently, despite the use of chemical fertilizers in Iran is higher than the world average consumption(110 kg per hectare) and is equal to the average fertilizer use in developed countries (116 kg ha), But yield per unit area, mainly due to lack of farmers' knowledge, lack of awareness of Exact needs of crops to fertilizer, lack of balance between macro and micro elements, is much lower than from developed countries [17].

Reasonable reduction of pesticides and fertilizers is one of the the issues that need special attention in order to achieve sustainable development in agriculture sector. For this purpose, in recent years the Supreme Council policy has been formed to reduce the use of pesticides and fertilizers in agriculture [5]. To achieve this goal, several strategies have been considered that a set of these policies, including policies that are supportive. The
present study was designed to examine the policy of increase in the fertilizer prices and the policy of direct payments per hectare. The current policy of subsidizing fertilizer has been replaced with this policies. Subsidies for chemical inputs led to the indiscriminate use of these inputs and subsequent adverse environmental effects caused by the consumption is high. Policy framework for direct payments is direct payments per hectare of crop, which farmer’s strategically important products are covered. In this research four scenarios have been considered for policy implementation so that coincided with the reduction and elimination of subsidies of fertilizer, equivalent to increase in the cost of the optimal amount of fertilizer used per hectare of strategic product, wheat, direct payments will be paid to farmers. This policy has been operating in some European countries, and its various aspects have been analyzed extensively in many studies. In this regard the studies of Kim [10], Sinabell and Hofreither [15], Allanson [1] and Schader [14] can be cited. Changes in cropping patterns and farming systems (organic and non-organic farming), reduced use of chemical inputs, changes in the rental value of the land and income redistribution in favor of small farmers are the results that in these studies have been mentioned.

To assess the effects of different policies on the environment, environmental indicators should be used. These indicators provide useful information to policy makers that can be used to assess the effectiveness of policies.

MATERIALS AND METHODS

Since agricultural policies cannot be studied in vitro, the potential impact of policies, before, during or after the policy implementation must be analyzed using mathematical programming models [16].

Policy analysis based on prescriptive models do not provide acceptable results, because there are often significant differences between the model results and the level of the observed activities [13].

Howitt [7] presented positive mathematical programming (PMP) technique that has no flaws of normative mathematical programming models and is capable of calibrating mathematical programming models correctly. This technique even before its official presentation in 1995, as one of the dominant approaches to agricultural policy analysis in mathematical programming models have been used [3,4,6,12].

Policy analysis in agriculture is typically based on mathematical programming models. Howitt [7] presented positive mathematical programming which has no disadvantages of normative mathematical programming models, and has the capability of calibrating mathematical programming correctly. This method, even before its official introduction in 1995, has been used as a dominant method of mathematical modeling for analysis of agricultural policies.

In this technique, the first step is using a linear programming model to obtain optimized answer of model. The second step is to use the dual values from previous step to make a nonlinear objective function.

The result obtained from this model in base year is exactly the observed values in that year. Finally the nonlinear model can be used to simulate the policies by changing the intended parameters.

In this study, in the objective function a quadratic function is used for each product.

By defining the index k as a substitute for the index i, the production function for product i is defined as follows:

$$y_j = \sum_{i=1}^{n} a_{ij} - 0.5 \sum_{i=1}^{n} \sum_{k=1}^{n} q_{ikj} x_{ij} x_{kj}$$

(1)

In fact, the optimization model based on the production function of equation (1) with inputs i for product j is defined as follows:

$$\pi = \sum_{j=1}^{n} \left( p_j \left[ \sum_{i=1}^{n} a_{ij} x_{ij} - 0.5 \sum_{i=1}^{n} \sum_{k=1}^{n} q_{ikj} x_{ij} x_{kj} \right] - \sum_{i=1}^{n} w_i x_{ij} \right)$$

(2)

$$\text{St}: \sum_{j=1}^{m} x_{ij} \leq b_i$$

$$x_{ij} \geq 0$$

Where $$\pi$$ is the Profit of representative Farm, $$y_j$$ is the yield of activity j in kilogram, $$p_j$$ is the price of one unit of product j, $$x_{ij}$$ is the amount of input i used for crop j, $$w_j$$ is the price of each unit of inputs. $$b_i$$ is the resource available. $$a$$ and $$q$$ are the coefficients of quadratic and constant component of the production function. For estimating this production function, the numbers of parameters that must be estimated are more than data available, it causes the degree of freedom of estimation to be negative and make the estimation of parameters impossible. Paris and howitt [12] proposed a maximum entropy approach for solving this problem. Using this method, the problem of negative degrees of freedom of the model has been solved and it could be estimated all.
the parameters of the quadratic production function without considering additional assumptions. Several studies have used this method to analyze policies, such as [3] and [13].

To estimate the production function using a maximum entropy approach it is necessary to determine support points. It should be noted that in maximum entropy approach, determine the values of this support points is optional, but as howitt (2005) states there is two important points that must be noted when determining the support numbers:

1. These points should be neutral, except that an individual may request specific information from entering the points into model.

2. In order to determine the support points the first order condition is used. The first order condition for this model is:

\[
\frac{\partial \pi}{\partial x_{ij}} = p_{ij} \left[ a_{ij} - \sum_{k=1}^{n} q_{ij,k} x_{kj} \right] - w_t - \lambda_l = 0
\]

(3)

The first order constraint for the production function model can be described as equality of physical marginal product of each input in each product to Ratio of the marginal cost of each unit of input (input cost plus opportunity cost) to product price:

\[
\frac{w_t + \lambda_l}{P_j} = a_{ij} - \sum_{k=1}^{n} q_{ij,k} x_{kj}
\]

(4)

As is clear Equations 3 and 4 satisfy the conditions that equal the value of the marginal product of each input Used in all products with marginal cost of that input. Assuming that the data about yields of products is a source data that each farmer is able to correctly recall, Howitt [8] suggests that the use of this information, in order to ensure more accurate calibration of the production function. So the total production constraint can be estimated with the constraints of the first order As follows:

\[
yield_{j,x_{j,land}} = \sum_{i=1}^{n} a_{ij} x_{ij} - 0.5 \sum_{i=1}^{n} \sum_{k=1}^{n} q_{ikj} x_{ij} x_{kj}
\]

(5)

To ensure that achieved optimization model meet the second-order conditions for a unique optimal, the matrix of the quadratic function should be in a way that is symmetric and positive semi-definite. Therefore, the approach Cholesky decomposition is used. In this approach, the matrix \((Q)\) in the quadratic production function, becomes the product of a lower triangular matrix \((L)\) and its transpose \((L')\).It can be shown as follows:

\[
Q = LL^t
\]

(6)

So if \(t\) support values would be considered and the probability of support point \(z_{zi}\) happens would be \(p_{zi}\) and the probability of support point \(z_{ij}\) happens would be \(p_{ij}\), then the estimated value of parameters of vector \(a\) and matrix \(Q\) will be calculated as follows:

\[
E(a_i) = \sum_{p=1}^{p} z_{pi} p_{pi}
\]

\[
E(q_{kj}) = \sum_{p=1}^{p} \sum_{l=1}^{l} z_{pl} p_{pl} \ln p_{pl} - \sum_{j=1}^{m} \sum_{i=1}^{n} \sum_{k=1}^{k} \sum_{l=1}^{l} p_{kl} \ln p_{kl}
\]

(7)

Then the maximum entropy function to calculate parameters \(a\) and \(Q\) would be:

\[
\text{Max } H(p) = -\sum_{j=1}^{m} \sum_{i=1}^{n} p_{ij} \ln p_{ij} - \sum_{j=1}^{m} \sum_{i=1}^{n} \sum_{k=1}^{k} \sum_{l=1}^{l} p_{kl} \ln p_{kl}
\]

\[
\frac{w_t + \lambda_l}{P_j} = E(a_k) - \sum_{k=1}^{n} E(q_{kj}) x_{kj}
\]

(8)

\[
yield_{j,x_{j,land}} = \sum_{i=1}^{n} E(a_{ij}) x_{ij} - 0.5 \sum_{i=1}^{n} \sum_{k=1}^{n} E(q_{ikj}) x_{ij} x_{kj}
\]

\[
E(a_{ij}) = \sum_{p=1}^{p} z_{pi} p_{pi}
\]

\[
E(p_{ij}) = 1
\]
\[
\sum_{p=1}^{t} p^{l}_{m_{pq}} = 1
\]
\[
\frac{p_{a_{pq}}}{p_{a_{pq}}} \geq 0 \quad \frac{p_{a_{pq}}}{p_{a_{pq}}} \geq 0
\]

In the above equations, \( H(p) \) is the entropy of model that must be maximized. Two last equations show that the sum of probabilities should be equal 1 and the other equations have been defined previously.

In the third step of PMP approach the vector \( \vec{a} \) and matrix \( \vec{Q} \) obtained from previous step will be used to obtain a nonlinear production function. This function and the resource constraints will make a nonlinear programming model as follows:

\[
\text{Max} \quad \sum_{j=1}^{m} \left( p_{j} \left| \sum_{i=1}^{n} a_{ij} x_{ij} - 0.5 \sum_{i=1}^{n} \sum_{k=1}^{n} Q_{ij} x_{ij} x_{ik} \right| \right) - \sum_{j=1}^{m} \sum_{i=1}^{n} w_{i} x_{ij}
\]

s.t: \[
\sum_{j=1}^{m} x_{ij} \leq b_{i}
\]
\[
x_{ij} \geq 0
\]

The smaller mentioned index, the less environmental pollution and higher sustainability in agriculture. These index for various crops and for Nitrate and phosphate fertilizers, in each scenario was estimated and their changes compared to the base year is calculated.

**Fertilizer sustainability index:**

Different concepts are included in the Agricultural sustainability topics and this issue covers various aspects. Sustainable agriculture involves a positive role for agricultural production in the economic growth, reduce poverty, conserve natural resources and protect the environment. Generally, there are two fundamental goals for sustainable agriculture, sustainable agricultural production and reduce the damaging environmental effects of agricultural activities [9].

The Sustainability in agriculture could be assessed using the amount of fertilizer consumption per unit area. As the proportion of fertilizer or pesticide applied per unit area in a period of time declines, caused by a specific policy, the farmer moves toward greater sustainability [11]. Accordingly, the mentioned index is defined as follows:

\[
\text{Fertilizer sustainability index} = \frac{\text{The amount of fertilizer consumption (kg)}}{\text{Cultivated area (ha)}}
\]

In the next section, the method of calculation of the environmental indices is described.

**Nitrogen balance index:**

This indicator shows the physical difference between the total amount of nitrogen entering the soil and the total amount of nitrogen drawn out from the soil based on the nitrogen cycle in a system of farming per hectare. The total amount of annual nitrogen entrance to the soil surface in order to calculate nitrogen balance index, includes:

A - Inorganic or chemical fertilizers that this component is measured as follows:

\[
\text{The total amount of nitrogen entering through chemical fertilizer application (tons)} = \frac{\text{The total amount of nitrogen fertilizers applied in farming unit (tons)}}{\text{applied in farming unit (tons)}}
\]

B- Livestock manure nitrogen production that this component is measured as follows:
The estimated amount of nitrogen fertilizer available in manure (kg N / tons) = The total amount of manure used in farming unit (tons) * Conversion factor (12)

C- Biological nitrogen fixation

There are two ways of fixing nitrogen in the soil: First, the activity of the symbiotic bacteria that lives in root tubers of legume crops (beans, clove and alfalfa). The second way is nitrogen fixation by soil living organisms. The amount of nitrogen-fixing in the soil by Symbiotic bacteria, is directly related to the level of the legume crops cultivated and is calculated as follows:

\[
\text{Nitrogen-fixing in the soil by Symbiotic bacteria (kg N)} = \frac{\text{The level of legume crops}}{\text{cultivated (ha)}} * \frac{\text{Nitrogen fixation coefficient}}{\text{for the crop (kg / ha)}}
\]

The amount of nitrogen fixed by free-living organisms in soil is directly related to cultivated area of all products and is calculated as follows:

\[
\text{Nitrogen fixation by living organisms in the soil (kg N)} = \frac{\text{cultivated area of all products (ha)}}{\text{nitrogen-fixing coefficient of living organisms in the soil (kg / ha)}}
\]

D- Atmospheric deposition of nitrogen, this component is calculated as follows:

\[
\text{Atmospheric Adsorption (deposition)} = \frac{\text{The total area cultivated (ha)}}{\text{Absorption (deposition) rate of N (kg N / ha)}}
\]

Also, to calculate the total annual amount of nitrogen drawn out from the soil, the amount of harvested product and harvested grass is multiplied by the absorption coefficient of nitrogen per kilogram of crop respectively:

\[
\text{The amount of N drawn out by harvested crop (kg)} = \frac{\text{The amount of product produced (tons)}}{\text{Absorption coefficient of Nitrogen for harvested crop (kg N / tons)}}
\]

According to the subjects mentioned above, it can be stated:

\[
\text{The N entered to soil} = \text{Animal manures} + \text{Fertilizers} + \text{Atmospheric Adsorption} + \text{Biological nitrogen fixation}
\]

\[
\text{Drawn out N from soil (t N)} = \frac{\text{The total amount of harvested grass and crop (tons)}}{\text{Nitrogen balance (surplus / deficit)}}
\]

\[
\text{Nitrogen balance index per Ha (kg / N)} = \frac{\text{Nitrogen drawn out from the soil}}{\text{Nitrogen entered to the soil}}
\]

\[
\text{Nitrogen Efficiency index} = \frac{\text{The total amount of nitrogen drawn out from soil}}{\text{the total amount of nitrogen entered to soil}} * 100
\]

It should be noted that in this study the factors listed above in equations are taken from OECD calculations.
RESULTS AND DISCUSSION

Considering that in Sistan province, Zabol County is known as a leading city in producing many crops, in this study, the farmers of this city constitute the statistical population of the study. Difficulty of accessing and meeting people because of their dispersion in the study area resulted in obtaining a list of the community group, and using the random cluster sampling the questionnaires were filled. The required information was obtained through interviews and completing 120 questionnaires.

In order to avoid biases caused by the different attributes and various decision behavior of farmers in a model of decision making, the farmers were classified into three homogeneous groups, with similar attributes and decision behavior using cluster analysis, and for each group a model was considered. The results of the application of these methods and some characteristics of the farms in each group (cluster) in Table (1) are presented.

Table 1: Characteristics of homogeneous groups of farmers in the study area

<table>
<thead>
<tr>
<th>Variable</th>
<th>Group I</th>
<th>Group II</th>
<th>Group III</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of farmers = 48</td>
<td>4.3</td>
<td>9.8</td>
<td>16.9</td>
</tr>
<tr>
<td>Average total return (10 RLS)</td>
<td>3434403</td>
<td>9231619</td>
<td>15213599</td>
</tr>
<tr>
<td>The average weight of chemical fertilizers used (kilograms per hectare)</td>
<td>Nitrogen fertilizer (N)</td>
<td>196</td>
<td>224</td>
</tr>
<tr>
<td>Phosphate fertilizer (P)</td>
<td>154</td>
<td>176</td>
<td>198</td>
</tr>
<tr>
<td>Cropping pattern</td>
<td>Wheat, Cucurbitaceae, vegetables</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: calculations and findings.

To evaluate the effects of the policy of subsidy removal of chemical fertilizers and direct payment policy four scenarios described in Table (2) have been studied.

Table 2: Studied scenarios and the crop covered by direct payment policy

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Type of Policy</th>
<th>Crop covered by direct payment policy</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td>Reduction in fertilizer subsidy by 50%</td>
<td>-</td>
</tr>
<tr>
<td>(2)</td>
<td>Reduction in fertilizer subsidy by 100%</td>
<td>-</td>
</tr>
<tr>
<td>(3)</td>
<td>Reduction in fertilizer subsidy by 50% + Direct payments per hectare</td>
<td>wheat</td>
</tr>
<tr>
<td>(4)</td>
<td>Reduction in fertilizer subsidy by 100% + Direct payments per hectare</td>
<td>wheat</td>
</tr>
</tbody>
</table>

Source: calculations and findings.

The suggested product to cover by direct payments policy in the area is wheat. In this study it is assumed that the amount of direct payments per hectare for products covered by this policy is equivalent to the increased costs of Optimum dosage of fertilizer applied per hectare due to the subsidy removal of fertilizer. The Mentioned amount for the product is obtained by multiplying the optimal amount of fertilizer consumption per hectare by the amount increased of fertilizer prices. The Suggested direct payments per hectare in Table (3) is presented.

Table 3: Suggested amount of direct payments per hectare of crop: 10 RLS

<table>
<thead>
<tr>
<th>Crop scenario</th>
<th>wheat</th>
</tr>
</thead>
<tbody>
<tr>
<td>(3)</td>
<td>211210</td>
</tr>
<tr>
<td>(4)</td>
<td>420000</td>
</tr>
</tbody>
</table>

Source: calculations and findings.

The results for each scenario have been calculated in form of changes in environmental indicators compared to base year (2012-2013). Data Tables (4), (5) and (6) shows the decrease in sustainability index for both nitrogen and phosphate fertilizer compared to the base year in the three groups of farmers of zabol city in various scenarios. Mentioned tables show the amount of applying of fertilizers in all scenarios for all crops following removal of subsidies and thus increase the price of chemical fertilizers. Also Reduction in crops which have used relatively more of fertilizer is more than other crops. It should be noted that due to the resource constraints that farmers have always faced in real world, they perform the best choice to allocate limited resources to the various activities, this fact forms the basis of PMP; The belief that the farmer makes always the best choice for optimal allocation of resources in dealing with different conditions [8]. When the price of fertilizer increased _ as shown in Table (4) _ the representative farmer of this group changed his Cropping pattern. When farmer observes the increase in the price of fertilizers, Using these input in his sight will be limited, thus will try to allocate this input to be able to make higher profit.
Table 4: Changes in sustainability index of chemical fertilizers in the first group of farmers in Zabol

<table>
<thead>
<tr>
<th>scenario</th>
<th>crops</th>
<th>fertilizer</th>
<th>wheat</th>
<th>Cucurbitaceae</th>
<th>vegetables</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>P</td>
<td>-21.945</td>
<td>-10.97</td>
<td></td>
<td>-10.97</td>
</tr>
<tr>
<td>(2)</td>
<td>N</td>
<td>-59.78</td>
<td>-29.89</td>
<td></td>
<td>-29.89</td>
</tr>
<tr>
<td></td>
<td>P</td>
<td>-45.045</td>
<td>-22.52</td>
<td></td>
<td>-22.52</td>
</tr>
<tr>
<td>(3)</td>
<td>N</td>
<td>-47.432</td>
<td>-21.56</td>
<td></td>
<td>-21.56</td>
</tr>
<tr>
<td></td>
<td>P</td>
<td>-29.645</td>
<td>-13.47</td>
<td></td>
<td>-13.47</td>
</tr>
<tr>
<td>(4)</td>
<td>N</td>
<td>-83.417</td>
<td>-37.24</td>
<td></td>
<td>-37.24</td>
</tr>
<tr>
<td></td>
<td>P</td>
<td>-58.643</td>
<td>-26.18</td>
<td></td>
<td>26.18</td>
</tr>
</tbody>
</table>

Source: calculations and findings.

Data in Table (5) that shows the changes in the sustainability index of the fertilizer for representative farmer’s crops of the second group, reflects the fact that the largest changes in mentioned index in case of both fertilizers in all scenarios occur in wheat.

Table 5: Changes in sustainability index of chemical fertilizers in the second group of farmers in Zabol

<table>
<thead>
<tr>
<th>scenario</th>
<th>crops</th>
<th>fertilizer</th>
<th>wheat</th>
<th>Cucurbitaceae</th>
<th>vegetables</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td>N</td>
<td>-32.48</td>
<td>-16.24</td>
<td></td>
<td>-16.24</td>
</tr>
<tr>
<td></td>
<td>P</td>
<td>-26.4</td>
<td>-13.2</td>
<td></td>
<td>-13.2</td>
</tr>
<tr>
<td>(2)</td>
<td>N</td>
<td>-64.96</td>
<td>-32.48</td>
<td></td>
<td>-32.48</td>
</tr>
<tr>
<td></td>
<td>P</td>
<td>-52.8</td>
<td>-26.4</td>
<td></td>
<td>-26.4</td>
</tr>
<tr>
<td>(3)</td>
<td>N</td>
<td>-42.33</td>
<td>-19.6</td>
<td></td>
<td>-19.6</td>
</tr>
<tr>
<td></td>
<td>P</td>
<td>-33.26</td>
<td>-15.4</td>
<td></td>
<td>-15.4</td>
</tr>
<tr>
<td>(4)</td>
<td>N</td>
<td>-52.72</td>
<td>-26.64</td>
<td></td>
<td>-24.64</td>
</tr>
<tr>
<td></td>
<td>P</td>
<td>-42.37</td>
<td>-19.8</td>
<td></td>
<td>-19.8</td>
</tr>
</tbody>
</table>

Source: calculations and findings.

According to Table (6) it is clear that the representative farmer of third group relatively is less affected by suggested policies than the other groups. According to table (6) farmers of this group have 57% decrease in using of nitrate fertilizers on average compared to the base year Table (3) shows that the third group of farmers have higher income levels than the other two groups, so the farmers in this group are also less affected.

Table 6: Changes in sustainability index of chemical fertilizers in the third group of farmers in Zabol

<table>
<thead>
<tr>
<th>scenario</th>
<th>crops</th>
<th>fertilizer</th>
<th>wheat</th>
<th>Cucurbitaceae</th>
<th>vegetables</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>P</td>
<td>-19.8</td>
<td>9.9</td>
<td></td>
<td>9.9</td>
</tr>
<tr>
<td>(2)</td>
<td>N</td>
<td>-50.4</td>
<td>-25.2</td>
<td></td>
<td>-25.2</td>
</tr>
<tr>
<td></td>
<td>P</td>
<td>-35.64</td>
<td>-17.82</td>
<td></td>
<td>-17.82</td>
</tr>
<tr>
<td>(3)</td>
<td>N</td>
<td>-38.55</td>
<td>-18.9</td>
<td></td>
<td>-18.9</td>
</tr>
<tr>
<td></td>
<td>P</td>
<td>-30.29</td>
<td>-14.35</td>
<td></td>
<td>-14.35</td>
</tr>
<tr>
<td>(4)</td>
<td>N</td>
<td>-57.1</td>
<td>-27.72</td>
<td></td>
<td>-27.72</td>
</tr>
<tr>
<td></td>
<td>P</td>
<td>-45.88</td>
<td>-22.27</td>
<td></td>
<td>-22.27</td>
</tr>
</tbody>
</table>

Source: calculations and findings.

Table (7) shows the calculated values of nitrogen balance and nitrogen efficiency indices and their percentage changes compared to the base year in different scenarios, in different groups of Zabol farmers. In the first group of farmers, NB index reduced from 202 kg per hectare to 56 kg per hectare per year in the fourth scenario that means a reduction of 72 percent in this index compared to before of the removal of fertilizer subsidy and implementation of direct payment policy. The decrease in value of this index is greater, the quantity of excess (remained) of fertilizers in soil and water of area is smaller Resulting in less pollution caused by agricultural activities in environment.

Changes in efficiency indicators show that the value of this indicator for all scenarios and for all three groups of farmers is rising. Actually the increase in this index means that the externalities caused by chemical fertilizers application is decreasing and thus further improvement in environmental quality after implementation of the aforementioned scenarios. Actually the increase in this index means that the externalities caused by chemical fertilizers application is decreasing and thus further improvement in environmental quality after implementation of the aforementioned scenarios.
Considered a complex problem so the study tried to examine removal of fertilizer subsidies policy and instead of that suggested direct payment policy on and increase the removal and direct payment policies, will lead to decrease in the environmental pollution due to effects of removal of fertilizer subsidy is accompanied by the policy of.

Response to these policies so the response in farmers clusters are different from each other. Second, if the policy that Farmers firstly according to the effects of various policies.

Patterns for agriculture in Iran Has always been co-present study investigated the effects of removal of fertilizer subsidies. The present study investigated the efficiency of chemical inputs aimed to reduce the negative externalities of chemical fertilizers application, The direct payments In order to reduce the negative externalities of chemical fertilizers application.

Conclusions

Source: calculations and findings.

Table 7: Changes in nitrogen balance index (NB) and Nitrogen Efficiency Index (NE)

<table>
<thead>
<tr>
<th>Farmers group</th>
<th>scenario</th>
<th>NB index (kg per ha)</th>
<th>Percent change compared to base year</th>
<th>NE index (kg per ha)</th>
<th>Percent change compared to base year</th>
</tr>
</thead>
<tbody>
<tr>
<td>First</td>
<td>Base year</td>
<td>202</td>
<td>-</td>
<td>45.56</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>(1)</td>
<td>89</td>
<td>-55.9</td>
<td>51.56</td>
<td>-13.4</td>
</tr>
<tr>
<td></td>
<td>(2)</td>
<td>75</td>
<td>-62.8</td>
<td>63.9</td>
<td>-40.8</td>
</tr>
<tr>
<td></td>
<td>(3)</td>
<td>66</td>
<td>-67.3</td>
<td>52.74</td>
<td>-15.5</td>
</tr>
<tr>
<td></td>
<td>(4)</td>
<td>56</td>
<td>-72.2</td>
<td>66.7</td>
<td>46.4</td>
</tr>
<tr>
<td>second</td>
<td>Base year</td>
<td>243</td>
<td>-</td>
<td>53.51</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>(1)</td>
<td>101</td>
<td>-58.4</td>
<td>56.5</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>(2)</td>
<td>76</td>
<td>-68.7</td>
<td>64.4</td>
<td>20.7</td>
</tr>
<tr>
<td></td>
<td>(3)</td>
<td>87</td>
<td>-64.1</td>
<td>52.3</td>
<td>-1</td>
</tr>
<tr>
<td></td>
<td>(4)</td>
<td>97</td>
<td>-60.0</td>
<td>70.5</td>
<td>31.8</td>
</tr>
<tr>
<td>third</td>
<td>Base year</td>
<td>235</td>
<td>-</td>
<td>65.57</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>(1)</td>
<td>123</td>
<td>-47.6</td>
<td>66.4</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>(2)</td>
<td>134</td>
<td>-42.9</td>
<td>68.8</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>(3)</td>
<td>149</td>
<td>-36.5</td>
<td>98.45</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>(4)</td>
<td>187</td>
<td>-20</td>
<td>99.36</td>
<td>16</td>
</tr>
</tbody>
</table>

Source: calculations and findings.

Another important chemical fertilizers used in crop production in the area is phosphate fertilizer. So like nitrogen fertilizer, changes in the balance and efficiency indicators for phosphate fertilizer, compared to the base year have been calculated. The data in third and fourth columns of table (8) shows the changes in phosphorus balance index and percentage changes compared to the base year in the study area respectively. The value of this index in the base year in the three groups of farmers Zabol County respectively 45, 50 and 60 kilograms per hectare, which in the fourth scenario the most decrease will happen. The decrease in the index compared to the base year in the fourth scenario for the three groups of farmers respectively is 29.4, for the second group of farmers is 35.5 and for the third group is 32.78. The efficiency index in the base year in the four scenarios for the three groups of farmers of the county is respectively 34, 36.1 and 67.1 that the fourth scenario is confronted with the greatest increase. The increase in the index in this scenario means that the increase in the index in this scenario means that subsidy removal and direct payment policies, will lead to decrease in the environmental pollution due to applying phosphate fertilizers.

Table 8: Changes in phosphorus balance index (PB) and Phosphate Efficiency Index (PE)

<table>
<thead>
<tr>
<th>Farmers group</th>
<th>scenario</th>
<th>PB index (kg per ha)</th>
<th>Percent change compared to base year</th>
<th>PE index (kg per ha)</th>
<th>Percent change compared to base year</th>
</tr>
</thead>
<tbody>
<tr>
<td>First</td>
<td>Base year</td>
<td>45.6</td>
<td>-</td>
<td>34</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>(1)</td>
<td>35.76</td>
<td>12.12</td>
<td>37.7</td>
<td>-1.1</td>
</tr>
<tr>
<td></td>
<td>(2)</td>
<td>32.9</td>
<td>13.86</td>
<td>42.3</td>
<td>12.4</td>
</tr>
<tr>
<td></td>
<td>(3)</td>
<td>32.7</td>
<td>13.94</td>
<td>44.7</td>
<td>13.1</td>
</tr>
<tr>
<td></td>
<td>(4)</td>
<td>29.4</td>
<td>13.51</td>
<td>52.3</td>
<td>15.3</td>
</tr>
<tr>
<td>second</td>
<td>Base year</td>
<td>50.6</td>
<td>-</td>
<td>36.1</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>(1)</td>
<td>45.7</td>
<td>11.07</td>
<td>38.7</td>
<td>-1.07</td>
</tr>
<tr>
<td></td>
<td>(2)</td>
<td>43.6</td>
<td>13</td>
<td>42.1</td>
<td>-1.66</td>
</tr>
<tr>
<td></td>
<td>(3)</td>
<td>41.5</td>
<td>13.14</td>
<td>43.3</td>
<td>-1.99</td>
</tr>
<tr>
<td></td>
<td>(4)</td>
<td>35.5</td>
<td>14.2</td>
<td>56.4</td>
<td>-15.6</td>
</tr>
<tr>
<td>third</td>
<td>Base year</td>
<td>60</td>
<td>-</td>
<td>67.1</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>(1)</td>
<td>50.43</td>
<td>12</td>
<td>72.3</td>
<td>-10.7</td>
</tr>
<tr>
<td></td>
<td>(2)</td>
<td>43.45</td>
<td>13.9</td>
<td>84.1</td>
<td>-12.5</td>
</tr>
<tr>
<td></td>
<td>(3)</td>
<td>41.65</td>
<td>14.6</td>
<td>83.2</td>
<td>-12.3</td>
</tr>
<tr>
<td></td>
<td>(4)</td>
<td>32.78</td>
<td>18.75</td>
<td>87.4</td>
<td>-13</td>
</tr>
</tbody>
</table>

Source: calculations and findings.

Conclusions:

Following the recent government policies on removal of fertilizer subsidy and replace it with a policy of direct payments In order to reduce the negative externalities of chemical fertilizers application and increase the efficiency of chemical inputs aimed to reduce the negative externalities of chemical fertilizers application, The present study investigated the effects of removal of fertilizer subsidies. The present study investigated the effects of removal of fertilizer subsidies policy and instead of that suggested direct payment policy on environment through calculate several environmental indices. Also, given that the selection of suitable cropping patterns for agriculture in Iran Has always been considered a complex problem so the study tried to examine changes of cropping pattern due to various policies.

The results of the simulation of removal of fertilizer subsidies and implement direct payment policy show that Farmers firstly according to the effect of policy on their relative income show different behavior patterns in response to these policies so the response in farmers clusters are different from each other. Second, if the policy of removal of fertilizer subsidy is accompanied by the policy of direct payments, while the efficiency of
fertilizer input increases, has more effect on the application of chemical fertilizers. This will lead farmers to distribute cash subsidies between all inputs and reduce the intensity of the indiscriminate use of fertilizers.

The results show environmental indices relating to fertilizers application in investigated scenarios decreases in all crops but pistachio. In most groups, the decrease in the index for crops like vegetables and Cucurbitaceae, which use chemical inputs more than other crop, was higher than other products. In pistachio it was observed that farmers use more fertilizers after policies implementation. Actually the farmer faced with the new prices of chemical inputs would prefer shifted their cropping pattern towards the crop that is more advantageous. The results show that the policy of direct payment like the policy of removal of subsidies, lead to reduce side effects associated with the application of chemical fertilizers.

According to research findings, the following Recommendations are being proposed:

1. According to research findings that emphasize the quantity use of fertilizers is more than needed in the area and also the application is not optimized. In order to increase the efficiency of application of fertilizer input and reduce environmental pollution caused by unbalanced consumption in agricultural production Replacement the policy of subsidized fertilizer with other appropriate supportive policies such as direct payment policy is a fundamental necessity. By removing subsidies and increasing prices to competitive prices, from one side it can take a heavy financial burden off the shoulders of government and in the other side to prevent environmental damage due to inefficiency caused by public sector intervention in the market system.

2. Beneficiaries's answers to questions make it clear that they have used to current pattern of inputs consumption and so for changing their behavior, strong incentives are needed. Actually, it seems that soil decomposition tests in each region and suggest appropriate practical combinations of fertilizers and Educational and Promotional services raising public awareness on this issue is a proper strategy for reducing the use of chemical inputs.

3. Continuous monitoring the environment in order to protect it from harmful effects of pesticides and fertilizers applied in agriculture should be one the main mission of environmental agencies.

REFERENCES

