

**Ranking effective factors of training in basis of sustainable agriculture promotion using TOPSIS method**Ali Dadaras Moghadam<sup>1</sup>, Nona Ghanaat<sup>2</sup>, Adel Ranji\*<sup>3</sup>, Babak Mohammadi Sharafshade<sup>4</sup><sup>1</sup> Department of Extension and education agricultural, Birjand Branch, Islamic Azad University, Birjand, Iran<sup>2</sup> Department of Mechanics of Agricultural machinery, Science and Research Branch, Islamic Azad University, Zahedan, IRAN<sup>3</sup> Young researchers club, Takestan Branch, Islamic Azad University, Takestan, Iran<sup>4</sup> Irrigation Engineering Shahrood University of Technology Student[planing.researcher@yahoo.com](mailto:planing.researcher@yahoo.com)

**Abstract:** This paper presents how the TOPSIS method is used in ranking the training methods that are used for sustainable agriculture. Sustainable agriculture is the adoption of eco friendly methods of agriculture that will aid in preserving the environment for future generations. This research is looking into how effective the factors of training for sustainable agriculture are in promoting it. The objective of this research is to find out which method is factor is more effective when it comes to the driving factor of the training on sustainable agriculture. Since this is a problem with multi decisions for the solution, the TOPSIS method is the best to use as it supports the evaluation of multi decision criteria. The TOPSIS method will be used side by side with the AHP method, this is because the weights of criteria will be gotten using the AHP method. The research will give both the qualitative and quantitative aspects of the research. The most important part of the assessment is to understand the TOPSIS method and criteria in order to analyze the effectiveness of the training that sustainable agriculture uses. The finding of the research was that the most effective factor that influences the training of sustainable agriculture is increase in crop yield. This is because the increase in crop yield will automatically lead to the other factors; for example, increase in crop yield will lead to improved economic status of the region and its people. The conclusion of the research is based on the most effective factor and the benefits it gives to the regions that decide to adopt sustainable agriculture.

[Ali Dadaras Moghadam, Nona Ghanaat, Adel Ranji, Babak Mohammadi Sharafshade. **Ranking effective factors of training in basis of sustainable agriculture promotion using TOPSIS method.** *Life Sci J* 2012;9(4):886-890] (ISSN:1097-8135). <http://www.lifesciencesite.com>. 137

**Keywords:** TOPSIS, AHP, effective factors on training, sustainable agriculture

**1. Introduction**

Sustainable agriculture is an integrated system of plant and animal production practices that depend on the principles of ecology that is the study of organisms and the environment around them (Miguel, 2006). This type of agriculture is a form of environmental awareness. Some of the farming methods used has long-term negative effects on the environment, thus the need to promote sustainable agriculture (Hodgson, 2011). For example, tillage will eventually cause soil erosion while irrigation without having proper drainage will damage the soil. Farmers who venture into sustainable agriculture have to be trained on how to use this method of farming. Lack of awareness at both the ground level and at the higher level translates that there is need for training for both the farmers and the people.

The statement of the problem here is how effective the training basis of sustainable agriculture is. Is it effective enough to influence a farmer to decide to practice sustainable agriculture? The assessment of this question will be done using the TOPSIS method to analyze the effectiveness of the training factors. Using the TOPSIS and AHP methods, the result was that an increase in crop yield was the most effective factor in the training basis of sustainable agriculture promotion.

The main challenge that was faced is the discovery that TOPSIS has to be used hand in hand with the AHP method. In other words, TOPSIS method is interdependent to the AHP method. In conclusion, the research proved that the superior factor was increased crop yield as this will automatically lead to the other benefiting factors that are a result of sustainable agriculture.

**1.1 Theoretical framework**

Sustainable agriculture can be used to enhance the economic status of a region and at the same time preserve the ecosystem as well as the environment. Most farmers see sustainable agriculture as a way to improve crop yield, increase their income and increase the diversity in the crops they grow (Cauwenbergh, 2007). For the promotion of sustainable agriculture, there has to be training for both individuals and groups on methods that they can use to successfully adapt to sustainable agriculture. Sustainable agriculture should improve the quality of life; this is environmentally and in the approach of farming as the old methods that farmers are used to have long-term damage to the soil (Rosing, 2005). This way, the resources can be maintained for future generations to use. Training for

both the farmers and concerned government departments is important in the promotion of sustainable farming as this is what will determine whether to practice sustainable agriculture or not as they would have all the knowledge they need to make the decision.

There are factors that drive the decision to train trainees on particular things concerning sustainable agriculture. It is important for the government, especially the agricultural department, and farmers to have the required training for sustainable agriculture. It is important to train as this will give people the knowledge, skill, attitude and understanding required for sustainable agriculture. Environmental impact assessment and planning are the most important things that they should be trained about as this would help them to manage the natural resources. The driving factor that creates the need for training is the fact that there are no skilled people to implement environmental legislation and economic instruments that are appropriate enough to ensure sustainable development and protection of the natural resources.

The other form of training is done through field trips. This is done for the trainees to see the actual impact of sustainable agriculture as well as the practical part of the training. Through the field trips, the trainees are taught ways and what to use in the farms. For example, if the trainees are taken to a farm, they can see how pesticides and chemicals are used. Here, they can learn how to use the chemicals and pesticides in the right quantity to avoid damages to the environment. Through the field trips, most trainees would understand what they did not understand verbally.

## 2. Material and Methods

The methods that will be used in this research are the TOPSIS method and the AHP method. The AHP method has to be used as the TOPSIS cannot be used on its own unless the weight of criteria has been provided for the research. The TOPSIS method is usually used when one has multi-decisions to make from many or different alternatives to consider before reaching the final decision. The TOPSIS method considers three criteria to the decision (Lichtfouse, 2009). These include qualitative benefits criteria; cost attributes criteria and the quantitative benefits criteria. This method also considers two estimated alternatives when coming up with the ideal solution; the ideal alternative, which is the option that has the best of all the benefits considered and the negative ideal alternative which has the worst attributes values of the decision (Zhang, 2010). The final solution that will be decided upon when using the TOPSIS method should lie in between the ideal alternative and the negative ideal alternative.

The AHP is an effective tool in the modeling and structuring of a multi-criteria problem. The method develops priorities for goals in order to get the different alternatives that are available (Kahraman, 2007). This value is achieved using pairwise comparison as it gives quantitative information that will be considered in the decision making stage. The pairwise comparison also offers the best basis for making an analysis on the present and the anticipated situation expansively (Grovera, 2005). The pairwise comparison uses all the alternatives available and compares them on the positive and negative attributes they have. The strategy selection is based on the qualitative criteria of each strategy. The numerical qualitative strategy has to be altered to numerical values to come up with the right decision or alternative options. There are steps that have to be followed to implement AHP successfully. Firstly, one has to identify the problem. In this step, one defines what the problem is and comes up with a goal to solve it. The second step is creating a hierarchy model for the problem at hand. The model should have the goals that one has set as well as the alternative goals and criteria. The criteria goals should always relate to the alternative goals (Bernroider, 2008). The AHP method should always have a hierarchy diagram that resembles a family tree. At the very top of the tree arrangement is the overall goal. It is then followed by criteria in the middle and finally the alternative goals at the bottom (Nguyen, 2005).

The third step is to create a pairwise comparison matrix for each of the lower levels ( $n \times n$ ) using a relative scale of measurements. The pairwise comparison scale should range between 1-9 scale (Gafsi, 2006). It is done in terms of which element dictates the other. The final step of the AHP method is a summary of all the steps above, that is the pairwise comparison and having determined the consistency, one comes up with the equation that will help calculate the weights of criteria as well as develop a matrix judgment

$$CI = (\lambda \max - n) \div (n - 1)$$

$$CR = CI \div RI \text{ (Taskin, 2007).}$$

### 2.1 Input to TOPSIS method

The method usually considers that there are (m) alternatives and (n) attributes each having a score with respect to the relevant criteria of both (m) and (n). When the option is (i) and criterion is (j), the score of option in respect to the criterion is  $x_{ij}$ ; then we have a matrix  $x = (x_{ij})$   $m \times n$  matrix, considering that j is the better set of attributes and j' is the less adequate set of attributes (Kulak, 2005).

## 2.2 The steps of TOPSIS

There are steps that one has to follow in order to come up with the best decision. The steps are as follows (Kulak, 2005): The first step of the TOPSIS methods is to come up with a normalized decision matrix. This step transforms the various attributes dimensions to non-dimensional attributes which will allow comparison across the criteria (Wang, 2005). The normalized data is:

$$R_{ij} = x_{ij} / (3 \times 2^{ij}) \quad i=1, \dots, m; \quad j=1, \dots, n$$

The second step is to come up with a weighted normalized decision matrix. Assume that we have a set of weights for each criterion,  $w_j$  for  $j=1, \dots, n$ . Multiply each column of the normalized decision matrix with its associated weight and the new matrix will be  $v_{ij} = w_j r_{ij}$ .

The third step of the TOPSIS method is to determine the ideal and the negative ideal solutions. The ideal solution is:  $A^* = \{V_1^*, \dots, V_n^*\}$ , where  $V_j^* = \{\max(v_{ij}) \text{ if } j \in J; \min(v_{ij}) \text{ if } j \in J'\}$

The negative ideal solution is:

$$A' = \{v_1', \dots, v_n'\}, \text{ where} \\ V' = \{\min(v_{ij}) \text{ if } j \in J; \max(v_{ij}) \text{ if } j \in J'\}$$

The fourth step of the TOPSIS is to calculate the separation measures for each of the alternatives. The separation from the ideal alternative is (Fish, 2008):

$$S_i^* = [\sum_j (V_j^* - V_{ij})^2]^{1/2} \quad i=1, \dots, m$$

The separation from the negative ideal alternative is:

$$S_i' = [\sum_j (V_j' - V_{ij})^2]^{1/2} \quad i=1, \dots, m$$

The fifth step is to calculate the closeness to the ideal solution,  $C_i^*$

$C_i^* = S_i' / (S_i^* + S_i')$ ,  $0 < C_i^* < 1$  then select the option of  $C_i^*$  that is closest to 1.

### Case Study

The TOPSIS method is applied to the problem at hand. The effective factors of training in the basis of sustainable agriculture promotion as well as factors that determine the training for the promotion of sustainable agriculture is what we will consider for the case study. There are three main factors that influence a nation to consider sustainable agriculture. These factors are improving the general economic status of the region; this is both the nation or state and the farmer's economic status, to preserve the ecosystem for the future generations to use and finally to increase the region's crop yield and diversity of the crops they

produce (Shavali, 2005). The main objective is to rank the factor that is most effective for a nation to decide to train on sustainable farming. The second objective is deciding which method and criteria for the decision-making criteria would give the best ranked factor. This factor has to consider negative effects, positive effects and the cost.

In most cases, the determinant factor is usually the cost of training that would influence the decision of whether to train for sustainable agriculture as a way of promoting it or not (Iskander, 2007). The other crucial factor that has to be considered is the positive and negative effects of sustainable agriculture. In this case, both short-term and long-term effects of the decision made have to be considered when making the decision.

In this instance, the two other remaining factors were considered for the TOPSIS method; preserving the ecosystem and increasing the crop yield. This is because when a nation decides to settle on the economic factor alone, they would most likely settle to use it as the topmost factor for training in the basis of promoting sustainable agriculture. This would not be right as there are other crucial factors that have to be considered as well.

### 3. Applying the TOPSIS method

The three factors were considered in the TOPSIS method since they were used as the options that were considered when coming up with the decision of the most ranked factor. The economic factor (A), ecosystem factor (C) and the crop yield factor (B) were considered in the decision making process.

For the application of the models, an expert team was formed. The experts determined the criteria that could be used. They used pairwise comparison matrices to calculate the criteria weights using the AHP method. At this stage, the AHP method had to be introduced as we could not assume or guess the weights of criteria. The weight of criteria had to be calculated at the evaluation stage of the research. They have to be based on the basis of objectives and the sub-weights of criteria on their related criterion which will then be calculated using the AHP method so as to come up with the results of the weights of criteria and weight of sub-criteria (Luo, 2012). In this case, there were no sub-criteria weights. Using the weights of criteria that had been calculated using the AHP method, the experts followed the TOPSIS method steps to rank the effectiveness of the factors. The team of experts was considering the three major factors including economic, ecosystem and increase in crop yield. The factors had both positive and negative effects of settling on them. The weight of criteria that was used was derived using the AHP method. The tables below show the results of both methods starting with the AHP

then the TOPSIS method. The analysis in table 2 was arrived at using the TOPSIS steps.

Table 1: Alternative weights obtained using the AHP method.

| Positive effects of the factors | Weights |
|---------------------------------|---------|
| A                               | 174     |
| B                               | 751     |
| C                               | 74      |

Table 2: Results obtained using the TOPSIS method.

| Alternative factors | $S_i^*$ | $S_i'$ | $C_i^*$ |
|---------------------|---------|--------|---------|
| A                   | 41.4    | 22     | 5       |
| B                   | 83      | 40.5   | 83      |
| C                   | 24.8    | 33.8   | 57.7    |

#### 4. Results

According to this information, the best alternative was the crop yield since the positive effects that it has will drive forth all other factors. If the crop yield increases, the economic status of both the region and the farmers will definitely increase. This is because when the crop yield increases, depending on what type of farming the farmers are practicing (for example if the crop yield of a horticulture farmer increases), this means that they have a lot of produce to sell thus increasing personal income and the nation's as well (Min, 2009). If the farmer does not produce horticultural produce, the surplus crops they get can be sold within the region thus increasing personal income. Increase in crop yield would be ranked as the most effective factor of training in the basis of sustainable agriculture. There was a weakness involved however while using the TOPSIS method. One of the major challenges faced was that other methods like AHP method had to be incorporated to generate the weight of the criteria as it could not be randomly assumed. That was the only challenge faced during the research period.

#### 5. Conclusion

Sustainable agriculture is positive and has a lot of benefits for those implementing it. The major benefit that a region would get is economic growth for both the region and the farmers due to increased crop yield. The other benefit that will be experienced is the preservation of the ecosystem for future generations. Through the research findings, increased crop yield has been ranked the most effective factor that should be used in the promotion of sustainable agriculture. This factor is what should drive a nation to adopt and train both the required government officials and the farmers to practice sustainable agriculture. Crop yield is ranked the most effective factor as it automatically influences other factors that will aid in the promotion of sustainable farming.

#### Recommendations:

The TOPSIS method cannot be used alone; it has to go hand in hand with the AHP method unless there is a provided weight of criteria that can be used in the TOPSIS method. For one to come up with an extensive qualitative and quantitative result the TOPSIS steps have to be carefully followed or one might risk having results that are not reliable. The use the AHP method should have been noted earlier as this would have made the whole research process easy. All alternative goals should be exhausted; this also includes the sub alternatives too so as to come up with the best solution for the problem. These two methods, TOPSIS and AHP will help one come up with the best and most effective solution to a problem that has alternative solutions.

#### Corresponding Author:

Adel Ranji

Young researchers club, Takestan Branch, Islamic Azad University, Takestan, Iran

E-mail: [planing\\_researcher@yahoo.com](mailto:planing_researcher@yahoo.com)

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#### Appendices

- A.  $\Sigma$  -sum of all
- B.  $\lambda$  -lamda
- C.  $\epsilon$  -equals to

1/26/2012