Environmental Energy and Economic Research 2023 7(3): S064
DOI 10.22097/eeer.2023.385178.1281

Research Article

The Economic-Environmental Assessment of the Factors Influencing Input Prices in Sistan and Baluchestan Province: An Emphasis on Agricultural Sustainability Indices

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Received: 25 December 2022 /Accepted: 28 April 2023

Abstract
The agricultural sector is of crucial importance in Iran, especially in the Sistan region due to its role in foreign exchange generation and the regional economy. In this regard, input prices and the underpinning factors can significantly contribute to the sustainability of agricultural indices under various economic and environmental criteria. Sistan-va-Baluchistan province is one of the provinces with a high potential for agricultural production. It is the leading producer of most crops, including horticultural crops. Given the important economic role of this sector in this province, this research aimed to conduct an economic and environmental assessment of the factors influencing input prices with an emphasis on agricultural sustainability indices in Sistan-va-Baluchistan province. Accordingly, the advanced gray technique (GRA) was applied for modeling under multi-attribute decision-making conditions for which 50 questionnaires were administered to farmers and experts separately. The results obtained from the experts showed that alternative 1 (total costs of the production factors) was ranked first with a score of 1 in terms of the gray relational rank. Alternative 2 (crop price fluctuations) was ranked second with a gray relational rank of 0.887. The final scores for gray relational ranks from the farmers' perspective put "guaranteed purchase of crops" in the first rank with a gray relational rank score of 1.
Keywords: Agricultural Sustainability, Economic Assessment, Environmental, Gray, Input Price

Introduction

Input pricing is an important factor influencing the agricultural sector, so any changes in input consumption affect the agricultural sector (Balali et al., 2008; Khairi et al., 2022). Changes in the prices of energy and other inputs influence their consumption significantly because energy consumption is an inverse function of its price (Mirzaei and Ahmadi, 2016). Various features have been proposed by researchers to specify the sustainability of agricultural systems, but only a few of these indicators allow researchers and farmers to measure the sustainability of their agroecological region (Asghari et al., 2012; Beshgh and Tqdusy, 2012; Ghaffari Moghadam et al., 2022; Soltanianzadeh et al., 2023).

In this regard, it can be said that three factors are the sources of attention to the issue of sustainability: (i) the interrelationships of economic activities, (ii) poverty, which is aggravated growingly and even growth patterns have so far been unable to eradicate it, and (iii) pollutant

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emissions and climate change (Aliahmadi et al., 2021). On the other hand, governments try to adopt policies and programs to tackle environmental problems and alleviate human impacts that have had adverse effects on the environment. Presently, most metropolitan cities of the world, including those in Iran, are struggling with the challenge of pollution, which has forced governments to implement long-term and short-term programs (Sardar Shahraki et al., 2018; Qorbani and Firouz Zare, 2008; Mozaffari and Amani., 2023).

Development is a process with diverse dimensions that considers different indicators, e.g., the increase in per capita income, the eradication of absolute poverty, and the alleviation of income injustice in the long run. Development refers to the improvement in the living conditions of all individuals in a country or region.

On the other hand, agricultural development can be an undesirable process. There is extensive evidence that injustice and absolute poverty increase at the early stages of development. In the process of development, undesirable social changes sometimes occur due to changes in the traditional beliefs of communities, which disrupt the existing social principles and increase pressures on political and institutional reforms. There are also concerns about environmental issues in developing countries. There is a relatively global consensus over the environment and development, and sustainable development is defined as "development that meets the needs of the present generation without compromising the potential of production to meet the needs of the future generations." So, the term *development* encompasses not only economic growth but also the distribution of income and facilities for the present and future society.

In the southeast of Iran, the agricultural sector of Sistan-va-Baluchistan province -as a region with very high potential for crop production and the development of the agricultural sector- plays a significant role in the economy of the province and region, so its sustainability is of high importance.

On the other hand, the study of agricultural sustainability indices is a new topic in the agricultural sector and the agricultural economy. This research, therefore, aims to investigate the economic-environmental impacts of the factors influencing input prices with an emphasis on the agricultural sustainability indices in Sistan-va-Baluchistan province using the multi-attribute gray technique (GRA), which has less been used in previous studies. The investigation of sustainability in the agricultural sector is necessary for different generations considering the famous economic-environmental indices given input prices in this sector. So, the research goals are as follows:

- Identifying the economic-environmental factors that influence input prices in the agricultural sector in Sistan-va-Baluchistan province
- Measuring these factors with an emphasis on the sustainability of the agricultural sector in Sistan-va-Baluchistan province

Numerous studies have explored the topic in hand, which are briefly reviewed below. In a study on the effect of the prices of feeding inputs on the chicken price using the ARDL approach, Qahremanzadeh and Pahlevani (2015) stated that chicken meat had lost its place in the food basket of Iranian families for various reasons. The results of the estimation showed that fish powder and corn had the first and second highest impact on the chicken price in the short and long run, respectively. The model's error correction term showed that the short-term imbalance in input prices would be moderated in fewer than two periods, reflecting the fast return of policies in this industry.

Mosavi and Bahmanpouri (2015) used the Target MOTAD model with the positive programming approach to study farmers' response to and income stability under the liberalization of fuel prices in Fars province, Iran in a five-year period. The results showed that all crops except for onions and rainfed barley would decrease with increasing fuel prices. With this increase, rainfed wheat would be eliminated from the cropping pattern. Also, fuel prices will reduce planned returns and risk.

Khodavaisi et al. (2017) studied the effect of subsidy reform on Iran's sugar industry using the GARCH model. The results revealed that the subsidy reform and the increased prices of energy carriers had reduced the mean return of the stock index in the sugar industry and increased its variance.

Mirzaei and Ahmadi (2016) investigated the effect of increasing the prices of energy carriers on inflation in different production sectors, including the agricultural sector using the input-output analysis and pricing models. They concluded that the highest inflation rate (62.89%) would be experienced by the fishery subsector and the subsectors of forestry, animal farming, and agriculture would be in the next ranks.

Ekins P. et al. (2021) studied what is known about the likely economic implications of either current trends or the transformation to a low-carbon and resource-efficient economy in the years to 2050 for which GEO-6 calls. A key conclusion is that no conventional cost–benefit analysis for either scenario is possible. This is because the final cost of meeting various decarburization and resource-management pathways depends on decisions made today in changing behavior and generating innovation. The inadequacies of conventional modelling approaches generally lead to understating the risks from unmitigated climate change and overstating the costs of a low-carbon transition, by missing out the cumulative gains from path-dependent innovation.

In a spatial analysis of the agricultural sustainability gap based on the TOPSIS-GIS, Ebrahimi et al. (2022) conducted a case study on the central district of Kuhdasht and found that the agricultural sustainability level in the ecological, social, and economic dimensions was imbalanced in the villages of this region. This imbalance was observed both at the level of the triple rural districts of this area and given the location of the studied villages.

Yildirim et al. (2022) in their studies assess the sustainability index of hazelnut farms and explore the effects of part-time and full-time farming types on sustainability index in hazelnut production in the Giresun and Ordu Province of Turkey.The research findings showed that overall hazelnut sustainability scores of farms varied from 0.28 to 0.59, and the average score was 0.44 at sampled farms. The composite hazelnut sustainability index was at an unsatisfactory level. The social and economic sustainability index value of farms was equal, and they were higher than the environmental index value. While the economic sustainability index score of full-time farms was higher than that of part-time farms, and part-time farms had higher environmental sustainability index scores than that of full-time farms.

Dubo (2003) evaluated the effects of energy subsidies and inputs of agricultural inputs in Zimbabwe and concluded that the energy expense of families who used wood and kerosene was 20.8% higher than that of the families who used subsidized electricity.

Mutuku and Dana (2008) explored the production structure of Kenyan farms using the duality theory in production and cost and used the translog cost function to obtain the demand function of inputs. Based on the results, the production structure was suitable and the production inputs were found to be substitutes for one another. They recommended that the use of production inputs with the existing composition would preserve the current level of production.

Alkharabsheh et al. (2021) evaluated Urban Public Transportation Systems by using the analytic hierarchy process (AHP) grey values to overcome the limitations of the uncertainty in the classical AHP approach. The presented Grey-AHP model assumes an efficient contrivance to facilitate the public transport system's supply quality evaluation, especially when respondents are non-experts. Finally, we estimate and rank the public transport system's supply quality criteria by adopting the proposed model for a real-world case study (Amman city, Jordan). The study's outcome shows the effectiveness and the applicability of the developed approach for enhancing the quality of the public transport system.

Becker (2010) evaluated energy substitutability in the agricultural sector of the US using the translog cost function and the price elasticity of energy substitutions over 1992-3007 and concluded that price elasticities were negligible between energy and other production inputs.

The next section describes multi-attribute decision-making (MADM) models and the gray technique (GRA) used for modeling in this research.

As it is clear from the research records, the factors affecting the price of inputs have been of great interest to researchers in the agricultural sector. This issue becomes more important according to sustainability indicators. Therefore, in this research, the economic and environmental evaluation of input prices in Sistan and Baluchestan province has been considered. This goal has been modeled for the first time through the gray technique according to sustainability indicators.

Materials and Methods

Grey relational analysis (GRA) technique

A grey system is described by grey numbers, grey equations, and grey matrices. Grey numbers are like the atoms and cells of the system. A grey number can define a number that is subject to uncertainty. For example, criteria in decision-making can be expressed by lingual variables that can be put in numerical intervals. These intervals will contain uncertain information. In 1982, Deng Julong published his first paper "Control Problem of Grey Systems" on grey concepts and theory in *Control & Systems* (Deng, 1989). Deng performed extensive research on the prediction and control of economic systems and fuzzy systems. He faced highly uncertain systems. The indicators of these systems could hardly be described by fuzzy mathematics or statistics and probabilities.

In general, fuzzy mathematics deals with problems in which uncertainty can be expressed by experts with discrete/continuous membership functions. Statistics and probabilities need distribution functions and high sampling to achieve the required validity. Grey systems are named after the color of the studied topics. One of the best examples is *Black Box*, which refers to a piece in which all internal structures and relationships are fully encoded and unknown. Here, the term *Black* refers to fully unknown information, *White* refers to fully known information, and *Grey* refers to information that is partially known and partially unknown. Accordingly, systems with fully known information are called "white systems", systems with fully unknown or missing information are called "black systems", and systems with partially known and partially unknown information are called "grey systems". Figure 1 depicts a schematic view of the grey theory (Taghavifard and Malek, 2011).

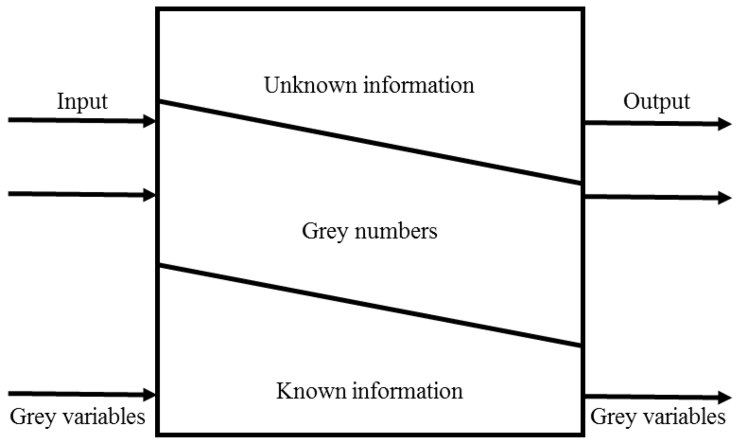

Figure 1. A schematic view of a grey system

Steps of GRA

- Step 1. Assigning weights to effective components

  It is assumed that there are k decision-makers, so the component weights Q_j can be calculated by

$$\otimes w_j = \frac{1}{k}\left[\otimes w_j^1 + \otimes w_j^2 + ... + \otimes w_j^k\right] \tag{6}$$

In which $\otimes w_j^k (j = 1, 2, ..., n)$ represents the weight of component j for the kth decision-maker and can be expressed by the grey number $\otimes w_j^k = \left[\underline{\alpha}_j^k \bar{\alpha}_j^k\right]$.

- Step 2. The use of lingual variables (e.g., very low, low, moderate, and very high) to specify the component values

  According to these variables, the component values can be estimated by

$$\otimes G_{ij} = \frac{1}{k}\left[\otimes G_{ij}^1 + \otimes G_{ij}^2 + ... + \otimes G_{ij}^k\right] \tag{7}$$

In which $\otimes G_{ij}^k (i = 1, 2, ..., n; j = 1, 2, ..., n)$ is the value of component ij for the kth decision-maker and can be represented by the grey number $\otimes G_{ij}^k = \left[\underline{\alpha}_{ij}^k \bar{\alpha}_{ij}^k\right]$.

- Step 3. Building a grey decision matrix

$$D = \begin{bmatrix} \otimes G_{11} & \otimes G_{12} & \cdots & \otimes G_{1n} \\ \otimes G_{21} & \otimes G_{22} & \cdots & \otimes G_{2n} \\ . & . & \cdots & . \\ . & . & \cdots & . \\ . & . & \cdots & . \\ \otimes G_{m1} & \otimes G_{m2} & \cdots & \otimes G_{mn} \end{bmatrix} \tag{8}$$

In which ⊗G's are the lingual variables converted into grey numbers.

- Step 4. Normalizing the grey decision matrix

$$D^* = \begin{bmatrix} \otimes G_{11}^* & \otimes G_{12}^* & \cdots & \otimes G_{1n}^* \\ \otimes G_{21}^* & \otimes G_{22}^* & \cdots & \otimes G_{2n}^* \\ . & . & \cdots & . \\ . & . & \cdots & . \\ . & . & \cdots & . \\ \otimes G_{m1}^* & \otimes G_{m2}^* & \cdots & \otimes G_{mn}^* \end{bmatrix} \tag{9}$$

In which $\otimes G_{ij}^*$ is represented as follows for the incremental components

$$\otimes G_{ij}^* = \left[\frac{\underline{\alpha}_{ij}}{G_j^{\max}} \frac{\bar{\alpha}_{ij}}{G_j^{\max}}\right] \tag{10}$$

$$\otimes G_j^{\max} = \max_{1 \le i \le m}\left\{\bar{\alpha}_{ij}\right\}$$

and $\otimes G_{ij}^{*}$ is represented as follows for the decremental components.

$$\otimes G_{ij}^{*} = \left[\frac{G_j^{\min}}{\bar{\alpha}_{ij}} \frac{G_j^{\min}}{\underline{\alpha}_{ij}} \right] \tag{11}$$

$$\otimes G_j^{\min} = \max_{1 \le i \le m} \left\{ \underline{\alpha}_{ij} \right\}$$

- Step 5. Building a normalized weighted decision matrix

  Assuming different significance of the component, the normalized weighted matrix is represented by

$$D^{*} = \begin{bmatrix} \otimes N_{11} & \otimes N_{12} & \cdots & \otimes N_{1n} \\ \otimes N_{21} & \otimes N_{22} & \cdots & \otimes N_{2n} \\ . & . & \cdots & . \\ . & . & \cdots & . \\ . & . & \cdots & . \\ \otimes N_{m1} & \otimes N_{m2} & \cdots & \otimes N_{mn} \end{bmatrix} \tag{12}$$

  In which $\otimes N_{ij} = \otimes G_{ij}^{*} \times \otimes w_j$ (Dong et al., 2006).

- Step 6. Selecting the best alternative

  The best possible alternative $C = \left\{ C_1, C_2, \ldots, C_m \right\}$ for m different criteria $M^{\max} \left\{ \otimes G_1^{\max}, \otimes G_2^{\max}, \ldots, \otimes G_n^{\max} \right\}$ can be estimated by

$$M^{\max} = \left\{ \left[\max_{1 \le i \le m} \underline{\alpha}_{i1} \max_{1 \le i \le m} \bar{\alpha}_{i1} \right] \left[\max_{1 \le i \le m} \underline{\alpha}_{i2} \max_{1 \le i \le m} \bar{\alpha}_{i2} \right] \cdots \left[\max_{1 \le i \le m} \underline{\alpha}_{in} \max_{1 \le i \le m} \bar{\alpha}_{in} \right] \right\} \tag{13}$$

- Step 7. Calculating the grey possibility degree

  It is represented by Eq. (14) for different alternatives:

$$P\left\{ M_i \le M^{\max} \right\} = \frac{1}{n} \sum_{j=1}^{n} P\left\{ \otimes N_{ij} \le \otimes G_j^{\max} \right\} \tag{14}$$

- Step 8. Ranking different alternatives

  The lower the grey possibility degree of an alternative, the higher its rank (Dong et al., 2006).

Criteria and alternatives studied in the research

Tables 1 and 2 show the indicators and options under consideration. According to the model used in this research, these indicators and options have been obtained from library studies, related research records, and also by completing a questionnaire from experts. Based on this, 3 main criteria and 23 options were defined based on the research objectives.

To achieve the research goals, we used the gray relational analysis (GRA). This technique collects the opinions of users and experts in several steps to collect the required information. So, we first developed a self-designed questionnaire in several steps to derive criteria and subcriteria based on the opinions of experts. Eventually, relevant information was collected from 50 experts in two categories of farmers and experts. Data were analyzed using the MCDM_{SOLVER} (ver. 2018) and MATLAB software packages.

Table 1. The criteria used in the research

Criterion	Symbol
Economic sustainability	Criterion 1
Social sustainability	Criterion 2
Environmental sustainability	Criterion 3

Table 2. The alternatives used in the research

Alternative	Symbol
Total costs of the production factors	Alternative 1
Crop price fluctuations	Alternative 2
Exchange rate variations	Alternative 3
The inflation rate of agricultural inputs	Alternative 4
Weather constraints and climate change	Alternative 5
Availability of target markets for crops	Alternative 6
Credit facilities	Alternative 7
Agricultural land rent	Alternative 8
Guaranteed purchase of crops	Alternative 9
Crop insurance	Alternative 10
The subsidy of production factors per unit area	Alternative 11
Machinery used per unit area	Alternative 12
Labor per unit area	Alternative 13
Gross return per unit of water consumption	Alternative 14
Water consumption rate per unit area	Alternative 15
Electrical energy consumption	Alternative 16
Diesel energy consumption	Alternative 17
Chemical fertilizer consumption	Alternative 18
Manure consumption	Alternative 19
Herbicide consumption	Alternative 20
Fungicide consumption	Alternative 21
Insecticide consumption	Alternative 22
Gross return of the agricultural unit	Alternative 23

Results and Discussion

Results based on experts' approach

Based on the results derived from the category of experts, alternative 1 in the decision matrix gained values of 10, 8, and 7 for the three criteria, respectively. The values of alternative 2 for the three criteria were 10, 8, and 6, respectively (Table 3).

Similar results were obtained for alternative 3 whose values for the three criteria were found to be 9, 7, and 5, respectively. Also, the results revealed that alternative 4 had the highest value among the three criteria for criterion 3, which was 7. The other results are evident in table 4. The results of the dimensionless or normalized matrix in the category of experts show that alternative 1 gained a value of 1 for the three criteria. Alternative 2 gained a value of 1 for criteria 1 and 2 and 0.833 for criterion 3.

The results were similar for alternative 3. It gained a value of 0.875 for criterion 1, 0.833 for criterion 2, and 0.666 for criterion 3. It was found that alternative 4 gained values of 0.5, 0.66, and 1 for the three criteria, respectively. The results for the other alternatives can be seen in table 5.

Table 3. The decision matrix based on the experts' approach

Matrix	Criterion 1	Criterion 2	Criterion 3
Alternative 1	10	8	7
Alternative 2	10	8	6
Alternative 3	9	7	5
Alternative 4	6	6	7
Alternative 5	6	5	3
Alternative 6	7	6	6
Alternative 7	7	5	4
Alternative 8	6	5	4
Alternative 9	8	7	5
Alternative 10	7	7	4
Alternative 11	7	7	6
Alternative 12	5	5	3
Alternative 13	5	4	3
Alternative 14	8	7	7
Alternative 15	6	6	6
Alternative 16	7	6	5
Alternative 17	6	5	4
Alternative 18	3	3	3
Alternative 19	3	3	3
Alternative 20	2	2	1
Alternative 21	2	2	1
Alternative 22	2	2	2
Alternative 23	6	5	4
Criterion direction	The higher, the better	The higher, the better	The higher, the better
Criterion weight	0.34	0.27	0.38

Table 4. Normalization based on the experts' approach

Dimensionless matrix	Criterion 1	Criterion 2	Criterion 3
Alternative 1	1	1	1
Alternative 2	1	1	0.83
Alternative 3	0.87	0.83	0.66
Alternative 4	0.5	0.66	1
Alternative 5	0.5	0.5	0.33
Alternative 6	0.62	0.66	0.83
Alternative 7	0.62	0.5	0.5
Alternative 8	0.5	0.5	0.5
Alternative 9	0.75	0.83	0.66
Alternative 10	0.62	0.83	0.5
Alternative 11	0.62	0.83	0.83
Alternative 12	0.37	0.5	0.33
Alternative 13	0.37	0.33	0.33
Alternative 14	0.75	0.83	1
Alternative 15	0.5	0.66	0.83
Alternative 16	0.62	0.66	0.66
Alternative 17	0.5	0.5	0.5
Alternative 18	0.12	0.16	0.33
Alternative 19	0.12	0.16	0.33
Alternative 20	0	0	0
Alternative 21	0	0	0
Alternative 22	0	0	0.16
Alternative 23	0.5	0.5	0.5

Table 5. The reference sequence definition based on the experts' approach

Reference target series	Criterion 1	Criterion 2	Criterion 3
Alternative 1	0	0	0
Alternative 2	0	0	0.16
Alternative 3	0.12	0.16	0.33
Alternative 4	0.5	0.33	0
Alternative 5	0.5	0.5	0.66
Alternative 6	0.37	0.33	0.16
Alternative 7	0.37	0.5	0.5
Alternative 8	0.5	0.5	0.5
Alternative 9	0.25	0.16	0.33
Alternative 10	0.37	0.16	0.5
Alternative 11	0.37	0.16	0.16
Alternative 12	0.62	0.5	0.66
Alternative 13	0.62	0.66	0.66
Alternative 14	0.25	0.16	0
Alternative 15	0.5	0.33	0.16
Alternative 16	0.37	0.33	0.33
Alternative 17	0.5	0.5	0.5
Alternative 18	0.87	0.83	0.66
Alternative 19	0.87	0.83	0.66
Alternative 20	1	1	1
Alternative 21	1	1	1
Alternative 22	1	1	0.83
Alternative 23	0.5	0.5	0.5

According to the results for defining the reference target series, alternatives 1 and 2 gained values of 0 for criteria 1 and 2. The value of alternative 1 for criterion 3 was calculated at 0. However, the value of alternative 2 for criterion 3 was 0.166. Also, the values of alternative 3 for criteria 1, 2, and 3 were 0.125, 0.166, and 0.333, respectively. The results also revealed that alternatives 20 and 21 gained values of 1 for all three criteria. Also, alternative 22 gained a value of 1 for criteria 1 and 2 and a value of 0.833 for criterion 3 whereas the value of alternative 23 for all three criteria was 0.5. The results for the effect of the GRA coefficient showed (Table 6) that it was 1 for alternatives 1 and 2 for criteria 1 and 1. But, their coefficients for criterion 3 were 1 and 0.70, respectively.

Alternatives 3-7 gained values of 0.76, 0.44, 0.44, 0.51, and 0.51 for criterion 1 whereas their values for criterion 2 were 0.70, 0.54, 0.44, 0.54, and 0.44, respectively. The results for the GRA rank (Table 7) showed that the GRA ranks of alternatives 1-5 were 0.38, 0.26, 0.20, 0.38, and 0.143 for criterion 3, respectively. They were 0.27, 0.27, 0.19, 0.15, and 0.12 for criterion 2, respectively. It was found that the GRA ranks of alternatives 20-23 for criterion 1 were 0.09, 0.09, 0.09, and 0.15, respectively.

The results for the category of experts (Table 8) showed that alternative 1 (total costs of the production factors) was ranked first in terms of the GRA rank with a score of 1. The second and third ranks were assigned to alternative 2 (crop price fluctuations) and alternative 14 (gross return per unit of water consumption) with scores of 0.88 and 0.78, respectively. Alternatives 4 (the inflation rate of agricultural inputs), 3 (exchange rate variations), and 11 (the subsidy of production factors per unit area) were put in the next ranks with scores of 0.68, 0.66, and 0.64, respectively. The last ranks were for alternatives 18 (chemical fertilizer consumption), 19 (manure consumption), 22 (insecticide consumption), 20 (herbicide consumption), and 21 (fungicide consumption) with GRA scores of 0.34, 0.34, 0.30, 0.28, and 0.28, respectively.

Table 6. The effect of the GRA coefficient based on the experts' approach

Coefficient impact	Criterion 1	Criterion 2	Criterion 3
Alternative 1	1	1	1
Alternative 2	1	1	0.70
Alternative 3	0.76	0.70	0.54
Alternative 4	0.44	0.54	1
Alternative 5	0.44	0.44	0.37
Alternative 6	0.51	0.54	0.70
Alternative 7	0.51	0.44	0.44
Alternative 8	0.44	0.44	0.44
Alternative 9	0.61	0.70	0.54
Alternative 10	0.51	0.70	0.44
Alternative 11	0.51	0.70	0.70
Alternative 12	0.39	0.44	0.37
Alternative 13	0.39	0.375	0.37
Alternative 14	0.61	0.70	1
Alternative 15	0.44	0.54	0.70
Alternative 16	0.51	0.54	0.54
Alternative 17	0.44	0.44	0.44
Alternative 18	0.31	0.32	0.37
Alternative 19	0.31	0.32	0.37
Alternative 20	0.28	0.28	0.28
Alternative 21	0.28	0.28	0.28
Alternative 22	0.28	0.28	0.32
Alternative 23	0.44	0.44	0.44

Table 7. The GRA rank based on the experts' approach

Rank	Criterion 1	Criterion 2	Criterion 3
Alternative 1	0.34	0.27	0.38
Alternative 2	0.34	0.27	0.26
Alternative 3	0.25	0.19	0.20
Alternative 4	0.15	0.15	0.38
Alternative 5	0.15	0.12	0.14
Alternative 6	0.17	0.15	0.26
Alternative 7	0.17	0.12	0.16
Alternative 8	0.15	0.12	0.16
Alternative 9	0.20	0.19	0.20
Alternative 10	0.17	0.19	0.16
Alternative 11	0.17	0.19	0.26
Alternative 12	0.13	0.12	0.14
Alternative 13	0.13	0.10	0.14
Alternative 14	0.20	0.19	0.38
Alternative 15	0.15	0.15	0.26
Alternative 16	0.17	0.15	0.20
Alternative 17	0.15	0.12	0.16
Alternative 18	0.10	0.08	0.14
Alternative 19	0.10	0.08	0.14
Alternative 20	0.09	0.07	0.10
Alternative 21	0.09	0.07	0.10
Alternative 22	0.09	0.07	0.12
Alternative 23	0.15	0.12	0.16

Table 8. The final scores for the GRA rank based on the experts' approach

Result	Rank
Alternative 1	1
Alternative 2	0.88
Alternative 14	0.78
Alternative 4	0.68
Alternative 3	0.66
Alternative 11	0.64
Alternative 9	0.61
Alternative 6	0.59
Alternative 15	0.57
Alternative 10	0.54
Alternative 16	0.53
Alternative 7	0.46
Alternative 8	0.44
Alternative 17	0.44
Alternative 23	0.44
Alternative 5	0.41
Alternative 12	0.39
Alternative 13	0.38
Alternative 18	0.34
Alternative 19	0.34
Alternative 22	0.30
Alternative 20	0.28
Alternative 21	0.28

Results based on farmers' approach

Based on the results derived from the farmers' approach, in building the decision matrix, alternatives 1-5 gained values of 7, 8, 6, 7, and 5 under criterion 1 while their values under criterion 2 were 6, 7, 5, 6, and 4, respectively. Their scores under criterion 3 were 5, 6, 4, 5, and 3, respectively. The values for alternatives 19-23 were 3, 3, 4, 3, and 6 under criterion 1, 3, 3, 3, 2, and 5 under criterion 2, and 3, 3, 2, 3, and 4 under criterion 3, respectively.

The results of the normalization matrix can be summarized as follows (Tables 9 and 10). Alternatives 1 and 2 gained values of 0.8 and 1 for criteria 1 and 2, respectively. The score of alternative 3 was 0.6 for criteria 1 and 2 and 0.428 for criterion 3. Also, alternatives 4-8 gained values 0.8, 0.4, 0.8, 0.6, and 0.2 for criterion 1, respectively.

Based on the definition of the reference series for the category of experts, alternatives 1 and 2 gained values 0.2 and 0 for criteria 1 and 2, respectively. But, its values were 0.428 and 0.285 for criteria 3, respectively. For criterion 3, alternative 4 gained a value of 0.428, alternative 5 gained a value of 0.714, alternative 6 gained a value of 0.428, alternative 7 gained a value of 0.285, and alternative 8 gained a value of 0.714. Other results are available in Table 9.

The effect of the GRA coefficient based on criteria 1, 2, and 3 was 0.66, 0.6, and 0.48 for alternative 1, respectively. It was 1, 1, and 0.58 for alternative 2, respectively (Table 11 and 12). The results for the score of alternative 3 for the GRA coefficient were 0.5, 0.5, and 0.411 under three criteria, respectively.

Similar results were obtained for alternatives 20-23 whose GRA coefficients were 0.28, 0.33, 0.28, and 0.5, respectively whereas it was 0.33, 0.33, 0.28, and 0.5 for criterion 2, respectively. The results of these alternatives under criterion 3 showed the values of 0.35, 0.318, 0.35, and 0.41 for the GRA coefficient, respectively.

Table 9. The decision matrix based on the farmers' approach

Matrix	Criterion 1	Criterion 2	Criterion 3
Alternative 1	7	6	5
Alternative 2	8	7	6
Alternative 3	6	5	4
Alternative 4	7	6	5
Alternative 5	5	4	3
Alternative 6	7	6	5
Alternative 7	6	6	6
Alternative 8	4	3	3
Alternative 9	8	7	8
Alternative 10	6	5	4
Alternative 11	7	6	5
Alternative 12	3	3	3
Alternative 13	3	2	2
Alternative 14	4	5	6
Alternative 15	5	4	3
Alternative 16	3	3	3
Alternative 17	3	2	1
Alternative 18	4	3	2
Alternative 19	3	3	3
Alternative 20	3	3	3
Alternative 21	4	3	2
Alternative 22	3	2	3
Alternative 23	6	5	4
Criterion direction	The higher, the better	The higher, the better	The higher, the better
Criterion weight	0.27	0.32	0.39

Table 10. Normalization based on the farmers' approach

Dimensionless matrix	Criterion 1	Criterion 2	Criterion 3
Alternative 1	0.8	0.8	0.57
Alternative 2	1	1	0.71
Alternative 3	0.6	0.6	0.42
Alternative 4	0.8	0.8	0.57
Alternative 5	0.4	0.4	0.28
Alternative 6	0.8	0.8	0.57
Alternative 7	0.6	0.8	0.71
Alternative 8	0.2	0.2	0.28
Alternative 9	1	1	1
Alternative 10	0.6	0.6	0.42
Alternative 11	0.8	0.8	0.57
Alternative 12	0	0.2	0.28
Alternative 13	0	0	0.14
Alternative 14	0.2	0.6	0.71
Alternative 15	0.4	0.4	0.28
Alternative 16	0	0.2	0.28
Alternative 17	0	0	0
Alternative 18	0.2	0.2	0.14
Alternative 19	0	0.2	0.28
Alternative 20	0	0.2	0.28
Alternative 21	0.2	0.2	0.14
Alternative 22	0	0	0.28
Alternative 23	0.6	0.6	0.42

Table 11. The definition of the reference target series based on the farmers' approach

Reference target series	Criterion 1	Criterion 2	Criterion 3
Alternative 1	0.2	0.2	0.42
Alternative 2	0	0	0.28
Alternative 3	0.4	0.4	0.57
Alternative 4	0.2	0.2	0.42
Alternative 5	0.6	0.6	0.71
Alternative 6	0.2	0.2	0.42
Alternative 7	0.4	0.2	0.28
Alternative 8	0.8	0.8	0.71
Alternative 9	0	0	0
Alternative 10	0.4	0.4	0.57
Alternative 11	0.2	0.2	0.42
Alternative 12	1	0.8	0.71
Alternative 13	1	1	0.85
Alternative 14	0.8	0.4	0.28
Alternative 15	0.6	0.6	0.71
Alternative 16	1	0.8	0.71
Alternative 17	1	1	1
Alternative 18	0.8	0.8	0.85
Alternative 19	1	0.8	0.71
Alternative 20	1	0.8	0.71
Alternative 21	0.8	0.8	0.85
Alternative 22	1	1	0.71
Alternative 23	0.4	0.4	0.57

Table 12. The effect of the GRA coefficient based on the farmers' approach

Coefficient effect	Criterion 1	Criterion 2	Criterion 3
Alternative 1	0.66	0.66	0.48
Alternative 2	1	1	0.58
Alternative 3	0.5	0.5	0.41
Alternative 4	0.66	0.66	0.48
Alternative 5	0.4	0.4	0.35
Alternative 6	0.66	0.66	0.48
Alternative 7	0.5	0.66	0.58
Alternative 8	0.33	0.33	0.35
Alternative 9	1	1	1
Alternative 10	0.5	0.5	0.41
Alternative 11	0.66	0.66	0.48
Alternative 12	0.28	0.33	0.35
Alternative 13	0.28	0.28	0.31
Alternative 14	0.33	0.5	0.58
Alternative 15	0.4	0.4	0.35
Alternative 16	0.28	0.33	0.35
Alternative 17	0.28	0.28	0.28
Alternative 18	0.33	0.33	0.31
Alternative 19	0.28	0.33	0.35
Alternative 20	0.28	0.33	0.35
Alternative 21	0.33	0.33	0.31
Alternative 22	0.28	0.28	0.35
Alternative 23	0.5	0.5	0.41

The results for the GRA rank (Table 13) showed that alternatives 1-5 gained values of 0.18, 0.27, 0.13, 0.18, and 0.11 under criterion 1 while their values were 0.21, 0.32, 0.16, 0.21, and 0.12 for criterion 2, respectively.

The GRA rank values of 0.07, 0.09, 0.07, and 0.13 were recorded for alternatives 20-23 under criteria whereas their values under criterion 2 were 0.10, 0.10, 0.09, and 0.16, respectively.

Eventually, the final score for the GRA rank (Table 14) based on the farmers' approach put alternative 9 (guaranteed purchase of crops) with a GRA rank of 1 in the first rank.

The results of this research confirm the results of Kiani Ghalehsard et al. (2021) research. The next ranks were assigned to alternative 2 (crop price fluctuations) with a GRA rank score of 0.8, alternative 1 (total costs of the production factors) with a GRA rank score of 0.59, and alternative 4 (the inflation rate of agricultural inputs) with a GRA rank score of 0.58.

The results of this research confirm the results of Ghaffari Moghadam et al. (2022) research. The final ranks were assigned to alternative 21 (fungicide consumption), alternative 22 (insecticide consumption), alternative 13 (labor per unit area), and alternative 17 (diesel energy consumption) with GRA rank scores of 0.32, 0.31, 0.29, and 0.28, respectively.

Table 13. The GRA rank based on the farmers' approach

Rank	Criterion 1	Criterion 2	Criterion 3
Alternative 1	0.18	0.21	0.19
Alternative 2	0.27	0.32	0.23
Alternative 3	0.13	0.16	0.16
Alternative 4	0.18	0.21	0.19
Alternative 5	0.11	0.12	0.14
Alternative 6	0.18	0.21	0.19
Alternative 7	0.13	0.21	0.23
Alternative 8	0.09	0.10	0.14
Alternative 9	0.27	0.32	0.39
Alternative 10	0.13	0.16	0.16
Alternative 11	0.18	0.21	0.19
Alternative 12	0.07	0.10	0.14
Alternative 13	0.07	0.09	0.12
Alternative 14	0.09	0.16	0.23
Alternative 15	0.11	0.12	0.14
Alternative 16	0.07	0.10	0.14
Alternative 17	0.07	0.09	0.11
Alternative 18	0.09	0.10	0.12
Alternative 19	0.07	0.10	0.14
Alternative 20	0.07	0.10	0.14
Alternative 21	0.09	0.10	0.12
Alternative 22	0.07	0.09	0.14
Alternative 23	0.13	0.16	0.16

Table 14. The final scores for the GRA rank based on the farmers' approach

Result	Score
Alternative 9	1
Alternative 2	0.83
Alternative 1	0.59
Alternative 4	0.58
Alternative 6	0.58
Alternative 11	0.57
Alternative 7	0.58
Alternative 14	0.48
Alternative 3	0.46
Alternative 10	0.45
Alternative 23	0.45
Alternative 5	0.38
Alternative 15	0.34
Alternative 8	0.34
Alternative 12	0.33
Alternative 16	0.32
Alternative 19	0.32
Alternative 20	0.32
Alternative 18	0.32
Alternative 21	0.32
Alternative 22	0.31
Alternative 13	0.29
Alternative 17	0.28

Conclusion

- Based on the results, the government is recommended to lay the ground for the crops market and input prices and interfere with the market to control price volatility.
- The Ministry of Agriculture is recommended to put a heavy emphasis on reducing the interest rates of bank facilities granted to the agricultural sector because if farmers can get cheap credits, they can purchase inputs at more appropriate prices and timing. As such, a part of the risk related to input costs is not transferred to crop prices.
- Foreign exchange control policies are crucial for crops and input prices. Given the influence of foreign exchange rate fluctuations on the instability of crop prices, the policies that aim to stabilize foreign exchange rates can be effective in partially alleviating price fluctuations.
- Farmers are faced with uncontrollable factors, e.g., adverse climatic conditions and the lack of infrastructure, which can aggravate price fluctuations. To cope with these factors, measures like providing such facilities as greenhouses for the production of vegetables and summer crops can be adopted. In this regard, it can be beneficial to provide farmers in Sistan-va-Baluchistan province with facilities and training.
- Including crops in the stock market can contribute to the efficiency and viability of the guaranteed purchase policy. The stock market uses various modern price tools to cope with price unreliability, e.g., futures contracts, option contracts, advance contracts, cash contracts, and credit contracts. Since all farmers cannot individually include their crops in this market, it is recommended to establish associations in the studied province, which has a very high capacity for garden crops. These associations can represent farmers in the stock market and supply their crops to it.

- Supporting producers is a basic program of the Ministry of Agriculture. Therefore, the policy of developing processing industries and export markets for surplus production can be a good policy for the partial control of input price volatilities for highly perishable crops like vegetables and summer crops. The government is recommended to help producers to detect target markets. It can also mediate surplus crop sale contracts for domestic consumption between farmers and buyers in this province.

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