

1 **ACCEPTED ARTICLE**

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3 **Assessment of sustainability trend of the apicultural industry: Evidence from**
4 **Beekeepers in Iran**

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5
6 **Abstract**

7 This study is designed to analyze the sustainability trend of the apicultural industry. The present
8 investigation has been conducted with a focus on quantitative aspects and employed the
9 methodology of quantitative-qualitative trend analysis. The statistical population consists of all
10 beekeepers in Iran. Using multi-stage random sampling method, 453 beekeepers were selected and
11 studied as a sample. The primary instrument employed to gather data is a questionnaire developed
12 by the researcher. The sustainability of Iran's apiculture industry has been evaluated based on four
13 environmental, economic, social and institutional dimensions; the evaluation of the beekeeping
14 industry's sustainability in terms of the environmental aspect involved the assessment of eleven
15 criteria across two categories, both of which exhibited a declining trend. Sustainability was
16 evaluated in the form of 24 criteria and 5 categories in the economic aspect, of which two
17 categories had a negative trend and three categories had a positive trend. The assessment of the
18 social aspect's sustainability was conducted through an examination of 19 criteria organized into
19 three distinct categories. These categories represented different trends: one with a negative trend
20 category, another with a stable trend category, and the third with a positive trend category. Finally,
21 the sustainability of the institutional dimension was evaluated by 16 criteria in the form of 3
22 categories, and all three categories had a negative trend. Therefore, reforming the process of
23 environmental and institutional criteria shall be of priority for the planners and policy makers of
24 Iran's apiculture industry. The results of this study can be used as basic information in the foresight

25 of the beekeeping industry, the preparation of the vision document, as well as the strategic planning
26 of the development of this industry.

27 **Key words:** beekeeping industry, sustainability trend analysis, evaluation, foresight.

28

29 1. Introduction

30 According to the historical evidence, the honey bee has lived on the planet for about 50 million
31 years; however, less than 2 million years have passed since the human species, as we know it
32 today, commenced its dispersion across the planet. Indeed, it is estimated that honey has been part
33 of the human diet from the beginning (Jones, 2009). Beekeeping is a time-honored occupation, as
34 evidenced by the historical records of ancient civilizations such as Egypt, Greece and Rome which
35 contain a wealth of information and expertise on the subject of bees (Pocol *et al.*, 2021). The
36 relationship between mankind and honey bees (bee-keeping) in Asia, dates back to 2000 years ago
37 (Patel *et al.*, 2021). In Iran, since the Achaemenid period (330-550 BC), beekeeping has been
38 popular and honey has been used instead of sugar. The discovery of a bronze bee-shaped dagger
39 in Lorestan, which belongs to 1200 BC and is now kept in Brussels museum, shows the ancient
40 familiarity of Iranians with this useful insect (Komeili, 1990; Shahrestani, 2006). In conclusion,
41 beekeeping holds significant economic potential as a lucrative occupation for both rural villagers
42 and urban residents, without any limitations based on age or gender; Moreover, it contributes to
43 the growth of employment opportunities while also fostering additional value through the creation
44 of high-quality products. This, in turn, facilitates sustainable development in both rural and urban
45 areas, encompassing various aspects. (Pocol *et al.*, 2021; Altunel and Olmez, 2019; Panta, 2020;
46 Vrabcova, 2020). The global honey production has witnessed a significant increase in recent years,
47 nearly doubling in a span of sixty years. From approximately about 700,000 tons in 1961, the
48 production of honey has risen to about 1,852,000 tons in 2019, marking a growth of almost two
49 and a half times. This trend in Iran has also been remarkably upward, so that with the growth of
50 almost thirty times, the amount of Iranian honey production has reached from 2,450 tons in 1961
51 to about 75,000 tons in 2019. China, Turkey, Canada, Argentina and Iran emerged as the top five
52 honey producing nations in the world in 2019 (FAOSTAT, 2021).

53 Beekeeping possesses a distinct capacity that can significantly contribute to the accomplishment
54 of 15 out of the 17 goals outlined by the United Nations' Sustainable Development (Patel *et al.*,
55 2021). Despite the longstanding connection between human being and bee throughout the history,

56 as well as researchers' emphasis on the high capacity of the beekeeping industry in achieving
57 sustainable development, the investigations into the sustainability assessment of this industry from
58 various sources reveal the challenges faced by researchers in evaluating its sustainability.
59 Kouchner et al., (2019) have highlighted that the apicultural industry is often undervalued and less
60 studied as a professional agricultural activity. while researchers have attempted to employ
61 sustainability assessment tools utilized in other agricultural sectors, their feedback indicates that
62 these tools lack the necessary efficacy to achieve the desired goal (Kouchner *et al.*, 2019). Mogni
63 et al. found that when assessing the indicators of sustainable development in the beekeeping
64 industry in Argentina, the commonly used indicators for evaluating agricultural sustainability were
65 either not utilized or exhibited significant variations when applied to the beekeeping industry.
66 (Mogni *et al.*, 2009).

67 Understanding this necessity, Rahimi et al. (2021) in a study identified the sustainability criteria
68 of the apicultural industry in Iran based on economic, social, environmental and institutional
69 dimensions. In this study, 70 special criteria, which were categorized into 13 general criteria, have
70 been proposed to assess the sustainability of the beekeeping industry. Each of these general criteria
71 include some special criteria. These criteria, as all of them can be calculated and assessed in the
72 beekeeping industry, have been identified in a qualitative research and with the consensus of a
73 group of experts in Iran's apiculture industry and in accordance with sustainability studies,. So in
74 this study, the sustainability of the apicultural industry in Iran was evaluated via the indicators
75 identified by Rahimi et al. (2021). Since the assessment of sustainability in the world's apicultural
76 industry is rarely done, the most important innovation aspect of this study would be the
77 comprehensive review of the sustainability of this industry. One of the notable innovations of this
78 study involves utilizing the trend analysis approach to evaluate ten-year time periods and forecast
79 the future development of this industry over the next decade.

80

81 **2- Materials and methods**

82 The current investigation adopts a quantitative approach from paradigm perspective, it is applied
83 in terms of purpose, and employs an analytical technique in terms of research type. The statistical
84 population of the research consists of all beekeepers who possess over 100 honey bee colonies¹

¹ The minimum number of the required colonies to separate the ordinary beekeepers from professional beekeepers is 100 colonies.

85 who possess at least 10 years of experience in this sector (with the aim of comparing the
86 sustainability trend of the beekeeping industry compared to the last decade). In order to determine
87 the statistical sample, multi-stage random sampling method was used. Iran is divided into 5
88 geographical regions of north, south, east, west and center, and from each section based on the
89 census of apiaries in the year 2018, the province with the largest number of honey bee colonies
90 was selected. Iran has a substantial population of 85,273 dedicated individuals who engage in
91 beekeeping. These skilled beekeepers collectively nurture 8,434,808 bee colonies. (Ebadzadeh *et*
92 *al.*, 2019). The sample size was determined 384 beekeepers, which was increased to 453
93 beekeepers for increasing the confidence coefficient using the Krejcie and Morgan's table. This
94 sample size was distributed among the selected provinces with proportional allocation, and
95 accordingly, 91 samples were studied in Mazandaran, 42 samples in Khuzestan, 39 samples in
96 Razavi Khorasan, 221 samples in East Azerbaijan, and 60 samples in Isfahan province. The
97 researcher-designed survey served as the tool for gathering data, and its credibility was affirmed
98 by a group of university professors and experts in extension and education of agriculture and
99 beekeeping. the reliability of the survey was verified using Cronbach's alpha coefficient which was
100 estimated as 0.78 from a subset of 35 beekeepers within the statistical sample.

101 Using the sustainability criteria of the beekeeping industry identified by Rahimi *et al.* (Rahimi *et*
102 *al.*, 2021), in this article, a questionnaire with 70 items was prepared and given to the statistical
103 sample, and they were asked to give their opinion about the level of sustainability of Iran's
104 beekeeping industry at two periods of time, the past 10 years and now, in the form of a five-point
105 Likert scale. The evaluation at two periods of time is the criterion for analyzing the changes in the
106 sustainability status of this industry over the past years and will provide basic information for the
107 analysis of future trends. Trends are key clues that can be used to identify changes in the
108 environment and an image of the future. In this method, we can evaluate issues and trends and
109 have a full understanding of the environment, infer future potential capacities, and by drawing a
110 vision, make strategic planning while preparing to encounter opportunities and threats (Singh,
111 2019; Rohrbeck, 2013; Gordon *et al.*, 2020). Since the Likert scale used to determine the current
112 situation compared to the last 10 years has five options and option 3 means no change, in order to
113 check the significance of the difference between the current situation compared to the previous 10
114 years, the One-way t-test was used and the average scores assigned to each factor were compared
115 to the number 3. Therefore, the test hypothesis is defined as follows: the current situation of Iran's

116 beekeeping industry has not changed significantly in the four dimensions of sustainability
 117 compared to the last 10 years (H_0 : Mean=3; H_1 : Mean \neq 3). Different methods are used to analyze
 118 the trend of time series. In this research, regression has been used to determine the slope of the line
 119 and the future trend of the time series. When linear regression is used to analyze time series data,
 120 the data is entered into the formula $y = mx + b$, where "m" represents the slope of the line/rate of
 121 change and "b" represents the width from the origin of the line (Sharad and Kumar, 2012;
 122 Kivikunnas, 1998). Based on this, the results of the analysis of the sustainability trend of Iran's
 123 beekeeping industry in each of the four dimensions of sustainability are shown in detail in the form
 124 of different diagrams.

125 3- Results

126 3-1- Descriptive and demographic statistics of the beekeepers

127 Based on the information obtained from the descriptive statistics of the interviewees, over half of
 128 the participants fell within the age bracket of 30-40 years and 62% of them kept fewer than 200
 129 bee colonies. Among the beekeepers surveyed, it was found that 38% of beekeepers had a diploma,
 130 while 36% held a bachelor's degree. 47% of the respondents were single-occupant beekeepers,
 131 whereas the remaining 53% had other jobs alongside beekeeping. Table 1 presents detailed
 132 descriptive statistics of the beekeepers.

Table 1. Descriptive and demographic statistics of the respondents (n=453)

	Variable	Frequency	Percent	Cumulative percent
Age	30 >	71	16	16
	30-40	241	53	69
	41-50	85	19	88
	50 <	56	12	100
Number of Colony	100-200	280	62	62
	201-300	43	10	72
	301-400	29	6	78
	401-500	51	11	89
	500 <	50	11	100
Level of education	Less than a Diploma	42	9	9
	Diploma	170	38	47
	B.Sc. / B.A.	163	36	83
	M.Sc. / M.A. and upper	78	17	100
Other occupations Besides beekeeping	Yes	241	53	
	No	212	47	

133

134 3-2- Environmental sustainability trend of the apicultural industry

135 The environmental sustainability assessment of the beekeeping industry has been performed in the
 136 form of two categories and 11 criteria. As shown in Table 2, the average difference between the

137 current situation and ten years ago is negative and significant in 4 cases and positive and significant
 138 in 7 cases. This indicates that the average sustainability indexes pertaining to this particular aspect
 139 are displaying a negative trend. Also, the analysis of the future trend of this industry in the
 140 environmental dimension shows that if the current conditions do not change and the trend of the
 141 last ten years continues in 7 indexes, the situation of the Iran's apiculture industry is far from the
 142 desired situation.

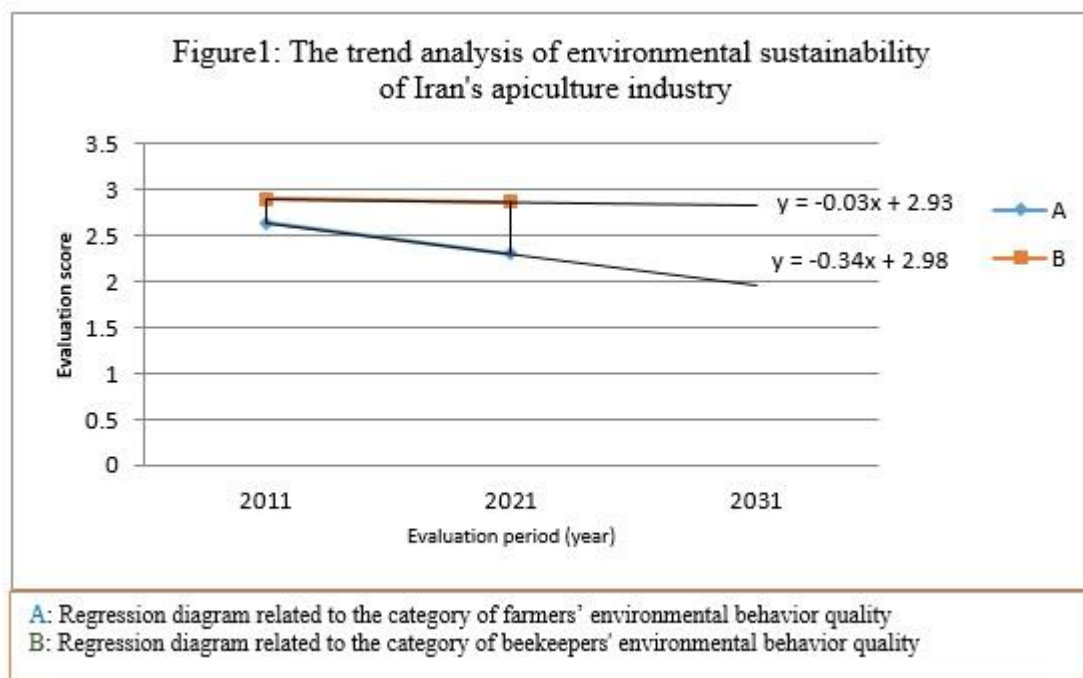
143 According to the assessment of farmers' environmental behavior, based on five criteria, it is evident
 144 that four of these criteria have witnessed a decline in the past decade. The difference between the
 145 current situation and those of the previous ten years has been significant in three specific criteria.
 146 Only in the criterion of " the rate of use of biological pesticides and managerial methods instead
 147 of conventional and chemical pesticides in farms and gardens", this trend was increasing, the
 148 difference between the current situation and the situation of the past ten years is not significant in
 149 this criterion too. The second category of the environmental dimension is the environmental
 150 behavior category of beekeepers, which has been evaluated using six criteria. In this category,
 151 compared to the last ten years, two criteria have a negative trend and four criteria have a positive
 152 trend, and the difference in the situation in three criteria is significant.

Table 2. The trend of environmental sustainability of Iran's apiculture industry.

Category	Environmental sustainability criteria	Situation of 2011 compared to the desired situation	Situation of 2021 compared to the desired situation	Mean differences	t	Sig.	Trend analysis in 2031
Farmers' environmental behavior quality	1. The rate of use of safe or low-risk vegetal pesticides for pollinators	2.83	2.30	-0.53	-5.56	0.00	1.77
	2. The rate of notifications about farm and garden spraying time to beekeepers to reduce honey bee colonies mortality	2.33	2.30	-0.03	-0.40	0.69	2.27
	3. The rate of use of dangerous chemical pesticides for pollinators by farmers	2.54	2.10	-0.44	-4.95	0.00	1.66
	4. The rate of contamination of current and groundwater by spraying and use of fertilizers by farmers	3.31	2.50	-0.81	-8.31	0.00	1.69
	5. The rate of use of biological pesticides and managerial methods instead of conventional and chemical pesticides in farms and gardens	2.16	2.30	0.14	1.59	0.11	2.44
Total		2.64	2.30	-0.34			1.96
Bee kee	1. The rate of reduction of pesticides and drugs against honeybee colony diseases	2.66	2.80	0.14	1.21	0.23	2.94

2. The rate of use of non-chemical pesticides and managerial methods in apiaries	1.33	2.30	0.97	10.49	0.00	3.27
3. The rate of environmental pollution around the apiaries, with waste, chemicals and non-renewables by beekeepers	2.31	2.80	0.49	4.38	0.00	3.29
4. The rate of prevalence of pests and diseases in apiaries in Iran	4.28	3.00	-1.28	-17.88	0.00	1.73
5. Environmental crime rate of beekeepers (illegal hunting, destruction of natural resources, etc.)	2.77	3.50	0.74	5.33	0.00	4.24
6. Genetic diversity of honeybee species in Iran	4.06	2.80	-1.26	-12.75	0.00	1.54
Total	2.90	2.87	-0.03			2.83

153
 154 The Figure 1 show the trend of each of the two sustainability categories of Iran's apiculture industry
 155 in the environmental dimension compared to the last ten years and future ten years. In this graph,
 156 the X-axis represents the years of environmental sustainability investigation, namely 2011 and
 157 2021, while presenting a projection for the following decade (2031). The Y-axis denotes the
 158 timeline, while the Y-axis corresponds to the scores obtained by various categories in different
 159 year



160
 161 As shown in Figure 1, if the current trend continues and there are no significant changes in the
 162 factors affecting each criterion, the average score of the criteria of the "farmers' environmental

163 behavior (A category)”, without considering the possible future changes, in the next ten years
 164 would be estimated as 1.96. The “B category: environmental behavior of beekeepers”, as shown
 165 in Figure 1, has a positive and mild slope compared to the last ten years, and in case of the
 166 continuance of the existing trend and the lack of tangible changes in the factors affecting each
 167 criterion, the average score of the criteria of this category would be estimated as 2.83 in next ten
 168 year.

169
 170 **3-3- Economic sustainability trend of the apicultural industry**

171 The economic sustainability dimension of the beekeeping industry was assessed by considering 24
 172 factors across five distinct categories. Table 3 reveals that within the realm of product marketing
 173 and sales, three out of the four criteria assessed exhibited positive trend over the past decade, with
 174 two of them being notably significant. To evaluate the category of productivity and production
 175 performance, six criteria were considered. Among these three criteria had a positive and significant
 176 trend while the remaining three criteria had a negative and significant trend compared to the
 177 previous ten years.

178 Five criteria were used to evaluate the category of the amount of monetization from pollinations'
 179 right, and all five criteria had a negative trend in the past ten years, and in four criteria this negative
 180 trend was significant. In the category of the amount of monetization of byproducts and value-added
 181 products, all four given criteria had a positive and significant trend. According to the parameters
 182 of the job creation and sustainable employment category, it can be observed that among the five
 183 criteria associated with this category, three criteria exhibited a noteworthy and unfavorable
 184 tendency, while two criteria displayed a favorable and substantial trend over the past decade.

Table 3. The trend of economic sustainability of Iran's apiculture industry.

Category	Economic sustainability criteria	Situation of 2011 compared to the desired situation	Situation of 2021 compared to the desired situation	Mean differences		Sig.	Trend analysis in 2031
The quality of marketing and sales of honey	1.The rate of direct sales and without intermediary sales products produced by beekeepers	3.14	3.30	0.17	1.24	0.21	3.47
	2.Export rate of honey to different countries	2.01	1.80	-0.21	-2.47	0.01	1.50
	3.Usage rate of honey quality control laboratories by beekeepers	1.98	3.00	1.02	10.82	0.00	4.02
	4.The amount of per capita consumption of honey in Iran	1.75	3.10	1.35	16.10	0.00	4.45

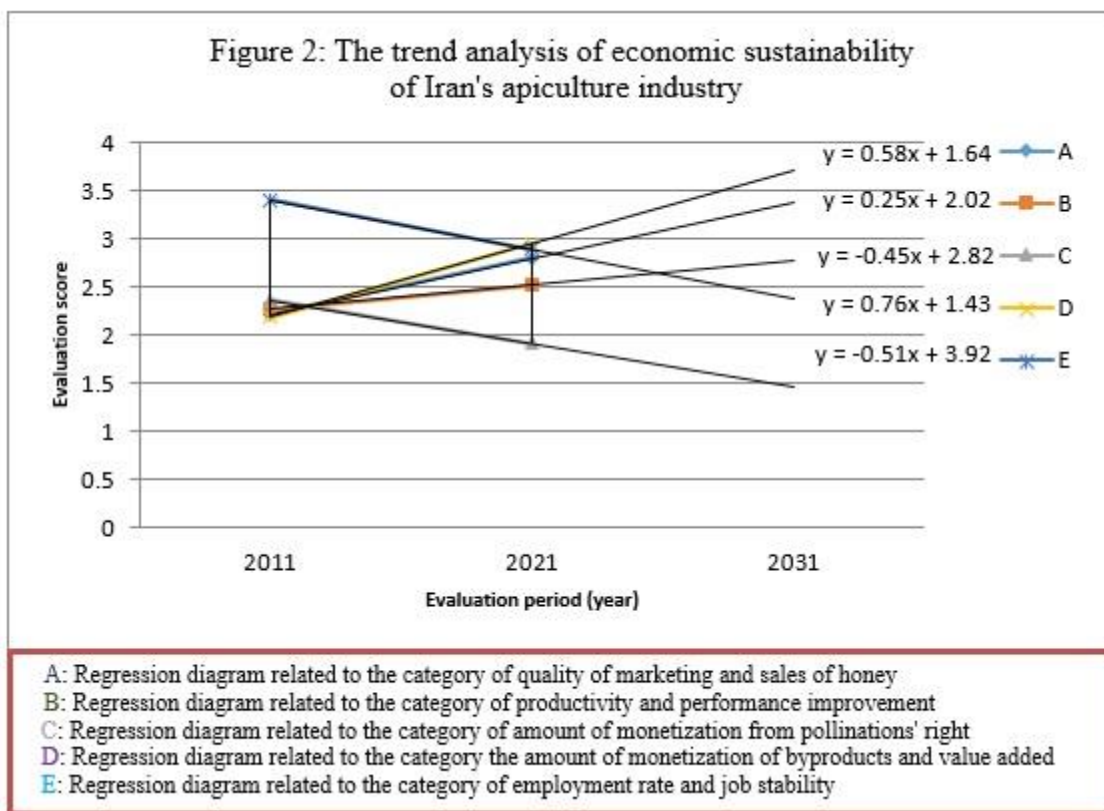
	Total	2.22	2.80	0.58			3.38
Productivity and performance improvement	1. Average profitability of the beekeeping industry compared to production costs	2.85	2.00	-0.85	-9.94	0.00	1.15
	2. Average yield per colony in honey production	3.09	2.30	-0.79	2.69	0.01	1.51
	3. Average yield per colony in production of other beekeeping products	1.06	2.50	1.44	21.30	0.00	3.94
	4. The application of world-class knowledge and technologies in the farm management of apiaries	1.26	3.00	1.74	15.79	0.00	4.74
	5. Timely access of beekeepers to various inputs and equipment required	2.82	2.30	-0.52	-5.64	0.00	1.78
	6. Mortality rate due to poor management of apiaries	2.52	3.00	0.48	3.85	0.00	3.48
	Total	2.27	2.52	0.25			2.77
Amount of monetization from pollinations' right	1. Quality of planning about migration of apiaries for maximum utilization of pollen and nectar resources of farms, gardens and pastures by relevant institutions	2.84	2.00	-0.84	-12.22	0.00	1.16
	2. Cooperation and assistance of farmers, gardeners and rangeland owners in deployment of bee colonies in the vicinity of their farms, gardens and pastures	2.01	1.80	-0.21	-3.12	0.00	1.59
	3. Quality of specific agricultural products development programs using pollination (such as canola)	3.69	3.00	-0.69	-7.17	0.00	2.31
	4. Level of activity and influence of pollination workgroup at different organizational levels	1.56	1.50	-0.06	-0.87	0.39	1.44
	5. The amount of beekeepers' income due pollination	1.75	1.30	-0.45	-9.75	0.00	0.85
	Total	2.37	1.92	-0.45			1.47
The amount of monetization of byproducts and value	1. The amount of per capita consumption of other beekeeping products	1.79	3.00	1.22	14.19	0.00	4.22
	2. Export rate of other beekeeping products to different countries	1.82	2.30	0.48	5.29	0.00	2.78
	3. The rate of packaged and branded products produced in Iranian beekeeping industry	2.63	3.50	0.88	6.18	0.00	4.38
	4. The rate of beekeeping products, purchased by companies producing value added products (such as cosmetics, hygiene, etc.)	2.52	3.00	0.48	4.17	0.00	3.48
	Total	2.19	2.95	0.76			3.71
Employment rate and job stability	1. The employment rate of the beekeeping industry compared to the investment made	2.21	2.50	0.29	2.52	0.01	2.79
	2. The proportion of bee colonies in each region relative to the capacity of pastures in that region	4.73	3.50	-1.23	31.56	0.00	2.28
	3. The rate of professional beekeepers (single-occupant beekeepers) compared to the total beekeepers in Iran	2.00	3.30	1.30	9.00	0.00	4.60

4. The amount of loans granted to renovate beekeeping equipment	3.98	2.50	-1.48	-19.33	0.00	1.03
5. The amount of loans granted to provide beekeepers annual cash requirement	4.12	2.70	-1.42	-17.20	0.00	1.28
Total	3.41	2.90	-0.51			2.39

185

186 Figure 2 illustrates that if the current trend continues and there are no significant changes in the
187 factors affecting each criterion the average score of the “A category: quality of marketing and sales
188 of products’ (without considering possible future changes) is estimated to be 3.83 in the next
189 decade (above average) showing a positive upward trend in the sustainability of this category. The
190 average score of the “B category: productivity and production performance” (without considering
191 possible future changes) is estimated to be 2.77 (less than average) in the next ten years with a
192 very slight positive slope. The average score of the “C category: amount of monetization from
193 pollinations' right” (without considering future changes) over the next decade is estimated to be
194 1.47 indicating a very weak performance with a declining trend All the criteria within this category
195 are exhibiting an unfavorable trend, indicating the need for serious consideration and rectification
196 of the current process. The average score of the "D category: mount of monetization of byproducts
197 and value-added products" (without considering possible future changes) in the next ten years is
198 estimated to be 3.71 (almost good) with a positive slope. Considering the positive trend of the
199 criteria of this category, paying attention to the strengths of these criteria and attempting to
200 continue this trend can have a significant effect on increasing the economic sustainability of Iran's
201 apiculture industry. The average score of the “E category: amount of employment generation and
202 sustainable employment creation" (without considering possible future changes) is estimated to be
203 2.39 (almost weak) with a negative slope in the next ten years. Considering the negative trend of
204 the criteria of this category, it would be necessary to pay special attention to these criteria, which
205 have a direct relationship with the future job of the human resources working in this industry.

206



207

208 **3-4- Assessment of the social sustainability of the apicultural industry**

209 For the sustainability assessment of Iran's apiculture industry in the social dimension, 19 criteria

210 were used in the form of three categories, the results of which are depicted in Table 4. As shown,

211 in the category of the level of social development of stakeholders, two criteria out of the five

212 criteria assessed had a positive trend during the last decade, one of which was significant. Also,

213 the sustainability of the criterion of beekeepers' trust in different organizations of the beekeeping

214 sector had a fixed trend.

215 As shown in the continuance of Table 4, there are seven criteria employed to assess the

216 stakeholders' cultural development. Over the course of the last decade three of these criteria

217 exhibited a notable and unfavorable trend, while three others demonstrated a positive and

218 significant trend.

219 In the continuation of Table 4, seven criteria of the category of providing education and extension

220 and education new sciences and technologies to stakeholders can be observed. Four criteria, out of

221 the seven criteria assessed in this category had a positive and significant trend and three criteria

222 had a negative trend. the trend of two criteria was significant, during the last ten years.

Table 4. The trend of social sustainability of Iran's apiculture industry.

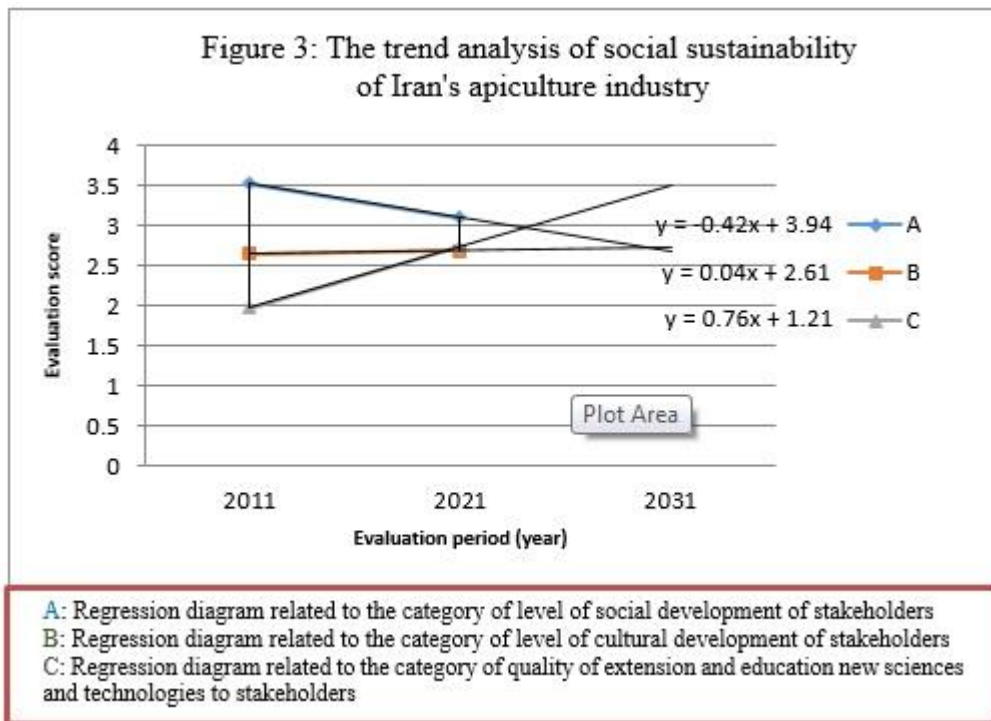
Category	Social sustainability criteria	Situation of 2011 compared to the desired situation	Situation of 2021 compared to the desired situation	Mean differences	t	Sig.	Trend analysis in 2031
The level of social development of stakeholders	1. The level of social justice for all beekeepers to have equal access to information, facilities etc.	3.97	2.70	-1.27	-13.08	0.00	1.43
	2. The rate of participation of beekeepers in elections and decisions related to the beekeeping industry	4.70	3.30	-1.40	-11.09	0.00	1.90
	3. The level of trust of beekeepers to different beekeeping organizations	3.50	3.50	0.00	0.21	0.83	3.50
	4. The level of mutual confidence and cohesion of beekeepers to each other in common activities	2.92	3.50	0.58	3.76	0.00	4.08
	5. Mutual trust in social relationships between beekeepers and different groups of farmers (gardeners, farmers and rangeland owners)	2.49	2.50	0.01	0.00	0.01	2.51
	Total	3.52	3.10	-0.42			2.68
The level of cultural development of stakeholders	1. The degree of cohesion and empathy between organizations and institutions related to the beekeeping industry	3.04	2.50	-0.54	-5.44	0.00	1.96
	2. The quality of farmers' attitudes about the privileged role of bees' pollination in quantitative and qualitative improvement of varieties of agricultural and pasture products	1.65	2.00	0.35	4.55	0.00	2.35
	3. Attitudes of different sections of society about the privileged role of beekeeping industry products in nutrition, public health and treatment of diseases	3.08	4.00	0.92	9.10	0.00	4.92
	4. Attitudes of authorities and policy makers about the privileged role of beekeeping industry products in nutrition, public health and treatment of diseases	3.57	3.00	-0.57	-5.39	0.00	2.43
	5. Attitudes of authorities and policy makers about the privileged role of bees' pollination in quantitative and qualitative improvement of varieties of agricultural and pasture products	2.52	2.00	-0.52	-7.64	0.00	1.48
	6. Attitudes of students about the privileged role of bees' pollination in quantitative and qualitative improvement of varieties of agricultural and pasture products	2.78	3.00	0.23	1.62	0.11	3.23
	7. The quality of farmers' attitudes about using organic pesticides and fertilizers instead of chemicals	1.89	2.30	0.41	4.20	0.00	2.71
Total	2.65	2.69	0.04			2.73	

The quality of extension and education new sciences and technologies to stakeholders	1. Average education level of professional beekeepers	2.00	4.00	2.00	17.76	0.00	5.00
	2. The amount of training courses provided to different groups of farmers to develop the use of bees in pollination of farms	2.25	2.00	-0.25	-6.36	0.00	1.75
	3. The number of skilled trainers that familiar with the latest apiculture technologies for training beekeepers	1.61	2.50	0.89	9.47	0.00	3.39
	4. The amount of pollination related courses in different fields of agriculture in Iranian universities	2.43	2.30	-0.13	-1.68	0.90	2.17
	5. The amount of training courses offered to retrain and enhance the knowledge and skills of beekeepers to modern science and technology	1.53	3.00	1.47	13.05	0.00	4.47
	6. The amount of training courses for beekeepers about production of lateral products of beekeeping	1.63	3.30	1.67	16.31	0.00	4.97
	7. The amount of training courses for farmers on how prevent damage of spraying and other agricultural activities to pollinators	2.35	2.00	-0.35	-5.22	0.00	1.65
Total	1.97	2.73	0.76			3.34	

223

224 Figure 3 shows trend analysis of social sustainability of Iran's apiculture industry. A category
 225 shows the sustainability trend of the social development level of stakeholders of beekeeping
 226 industry. Based on the current trajectory and in the absence of any significant alterations to the
 227 factors impacting each criterion, it is projected that the average score of the social development
 228 category for stakeholders (without taking into account potential future changes) will be
 229 approximately 2.68. This score falls below the average and demonstrates a negative trend.
 230 Therefore, it would be necessary to pay serious attention to the criteria of this category and correct
 231 the existing process. B category shows future trend of the cultural development of stakeholders. If
 232 the current trend continues and there are no tangible changes in the factors affecting each criterion,
 233 the average score of the criteria of this category (without considering possible future changes)
 234 would be estimated as 2.73 (about average) with a constant slope in the next decade. C category,
 235 indicates the sustainability trend of the category of providing education and extension and
 236 education new sciences and technologies to stakeholders of the beekeeping industry. As shown,
 237 assuming that the ongoing pattern persists and no significant alterations occur in the factors
 238 impacting each criterion, the projected average score for the criteria within this category would
 239 averagely amount to 3.34 (without considering possible future changes) with a positive slope in

240 the next ten years. Therefore, the stability of beekeeping industry in Iran in this category has a
 241 positive trend, and by removing the shortcomings and deficiencies in some criteria, the slope of
 242 the category's sustainability trend can be increased.



243
 244
 245 **3-5- Institutional sustainability assessment of apicultural industry**
 246 The sustainability of beekeeping industry in Iran in the institutional dimension was evaluated by
 247 16 criteria in the form of three categories, the results of which are indicated in Table 4. As shown,
 248 in the category of the quality of rules and programs related to the beekeeping industry, all four
 249 criteria had a negative and significant trend during the last ten years. The current status of the
 250 criteria of this category is weak and the negative trend of their sustainability is concerning and
 251 needs more consideration. As demonstrated, six criteria have been employed to assess the quality
 252 category pertaining to the engagement of non-governmental stakeholders in role-playing activities.
 253 Out of these, five criteria have exhibited a notable and negative trend over the past decade, while
 254 one criterion also displayed a negative trend but without statistical significance. Given the overall
 255 negative trajectory observed across all criteria in this category, it becomes imperative for planners
 256 and policymakers to actively address and rectify the prevailing trend. The quality of role-playing
 257 of governmental institutions stakeholders was evaluated by six criteria. Four criteria, out of the six

258 criteria evaluated in this category had a negative and significant trend and one criterion had a
 259 positive and significant trend during the last ten years. Among the criteria of this category, the
 260 criterion of the amount of budget and credits allocated to the beekeeping sector compared to other
 261 sectors had the most negative slope, and the criterion of the amount and quality of research
 262 programs related to the beekeeping industry had the most positive slope. Thus, most of the criteria
 263 of this category also had an unstable trend.

Table 5. The trend of institutional sustainability of Iran's apiculture industry.

Category	Institutional sustainability criteria	Situation of 2011 compared to the desired situation	Situation of 2021 compared to the desired situation	Mean differences	t	Sig.	Trend analysis in 2031
Comprehensiveness of rules and programs	1. The comprehensive legislation in the fields that relate to the beekeeping industry	3.02	2.30	-0.72	-10.15	0.00	1.58
	2. The quality of law enforcement warranty in the fields that relate to the beekeeping industry	3.21	2.30	-0.91	-12.52	0.00	1.39
	3. The quality of instructions on how to work different organizations with beekeeping industry	3.20	2.50	-0.70	-8.46	0.00	1.80
	4. The quality of short-term and long-term designed plans for the development of the beekeeping industry	2.46	2.00	-0.46	-7.17	0.00	1.54
	Total	2.97	2.28	-0.70			1.58
The quality of the role-playing of non-governmental stakeholders	1. The transparency and non-overlapping degree of functions and authority of the beekeeping industry organizations	3.91	2.80	-1.11	-12.77	0.00	1.69
	2. The participation and cooperation degree of the beekeeping industry associations in matters related to this industry	3.81	2.80	-1.01	-11.49	0.00	1.79
	3. The influence and position degree of beekeeping organizations in policy and decision-making related to beekeeping industry	3.18	2.50	-0.68	-7.30	0.00	1.83
	4. The amount of capital and organizational strength of the Beekeepers' Union	2.66	2.50	-0.16	-1.55	0.12	2.34
	5. The membership rate of beekeepers in county beekeeping cooperatives	4.04	3.00	-1.04	-11.04	0.00	1.97
	6. The effectiveness and efficiency of beekeeping cooperatives in meeting the demands of stakeholders	3.59	3.00	-0.59	-4.66	0.00	2.42
Total	3.53	2.77	-0.76			2.00	

The quality of the role-playing of governmental institutions stakeholders	1. The amount of influence and organizational position of the beekeeping industry in the Ministry of Agriculture Jihad	2.94	2.50	-0.44	-4.68	0.00	2.06
	2. The extent of insurance support for bee colonies against all type of inflicted damages	2.75	1.80	-0.95	-16.68	0.00	0.85
	3. The usage rate of beekeeping society from beekeeping social insurance services	3.21	2.00	-1.21	-19.35	0.00	0.79
	4. The quality of research programs related to the beekeeping industry	2.02	2.80	0.78	4.44	0.00	3.58
	5. The amount of budget and credits allocated to the beekeeping sector compared to other sectors	3.96	2.30	-1.66	-26.69	0.00	0.64
	6. The number of active personnel in the public sector of the beekeeping industry compared to other sectors	3.36	2.50	-0.86	-8.56	0.00	1.64
Total	3.04	2.32	-0.72			1.59	

264

265 Figure 4 shows the trend of institutional sustainability of Iran's apiculture industry. As shown, at

266 "category A: quality of rules and programs related to Iran's apiculture industry", if the current

267 trend continues and no tangible changes are made in the factors affecting each criterion, the

268 average score of the criteria of the category of social development of stakeholders (without

269 considering possible future changes) is estimated 1.58 (below weak) with a negative slope in the

270 next ten years. Therefore, it is necessary to pay serious attention to the criteria of this category and

271 correct the existing process. Also, at "category B: quality of role-playing of non-governmental

272 stakeholders from Iran's apiary industry" the average score of the criteria of this category (without

273 considering possible future changes) is estimated 2.00 (weak) with a negative slope in the next ten

274 years. Given the downward trend and the projected subpar performance over the next decade in

275 this particular category, it is crucial for Iran's apiculture industry planners and policy makers to

276 place significant emphasis on rectifying the current process. In the following, category C shows

277 the quality of role-playing of the governmental institutions stakeholders in the beekeeping

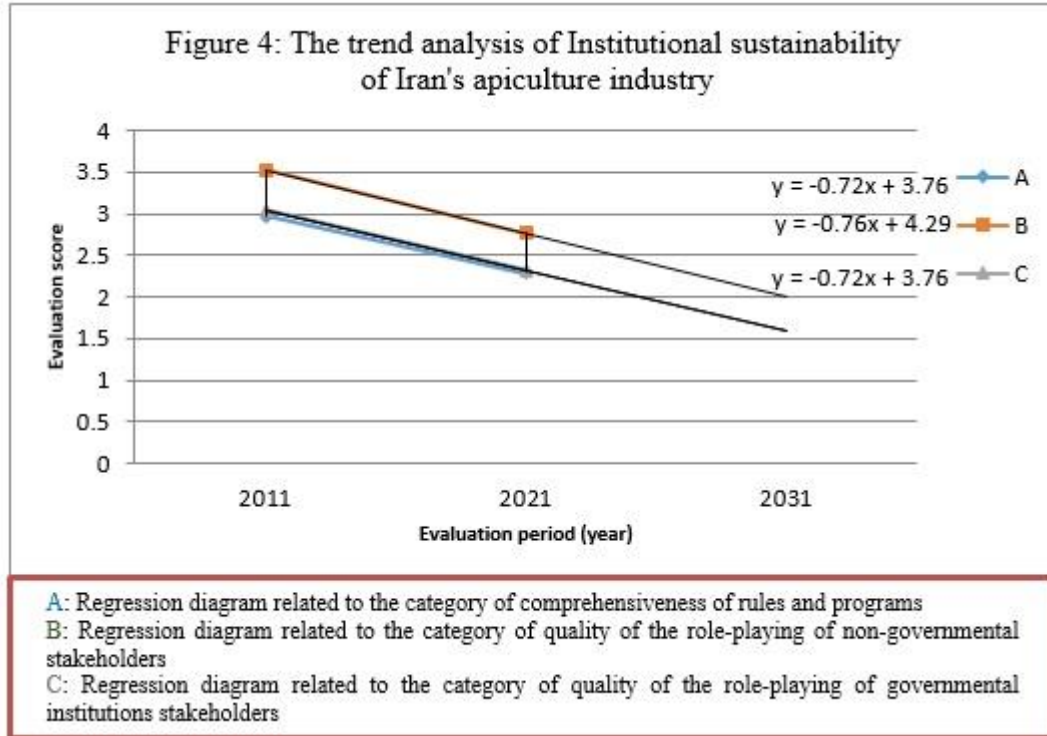
278 industry. As shown, the average score of the criteria of this category (without considering possible

279 future changes) is estimated 1.59 (below weak) with a negative slope in the next ten years.

280 Therefore, the sustainability of Iran's apiculture industry in this category has a negative trend, and

281 with the continuation of the current trend, the condition is estimated to be very unstable in the next

282 ten years.



283

284 4- Discussion, Conclusion and Recommendations

285 The present study aimed to evaluate and analyze the sustainability trend of Iran's apiculture
 286 industry. Considering that in the evaluation of the trend of the environmental dimension, both
 287 categories had a negative trend, and in the evaluation of the institutional dimension, all three
 288 categories had a negative trend, Therefore, it is recommended that the reform of the criteria of the
 289 environmental and institutional dimensions should be on the priority by the planners and policy
 290 makers of Iran's apiculture industry, and other dimensions should be reviewed and examined in
 291 more details.

292 When comparing with studies conducted worldwide, it can be inferred that the sustainability level
 293 of various aspects of beekeeping differs across regions based on their specific conditions.
 294 According to a study in Argentina, despite the high sustainability of the beekeeping industry in the
 295 environmental dimension, there are problems in the social and economic dimensions (Mogni *et*
 296 *al.*, 2009). Despite being economically profitable, the beekeeping industry in Romania has
 297 shortcomings in terms of commercialization and needs government support. In the environmental
 298 dimension, the beekeeping industry has not only negative consequences, but has many positive
 299 effects in the field of pollination and biodiversity conservation. Also, from the social aspect,
 300 beekeeping is recognized as a positive activity (Pocol *et al.*, 2012). The beekeeping sector in

301 Tanzania has faced various difficulties pertaining to its economic aspects, as well as marketing
302 and product packaging endeavors. Also, in the institutional dimension, Iran's apiculture industry
303 has encountered some shortcomings in the field of legal protection, educational services and
304 intersectional coordination (FAO (a), 2016; MNRT, 1998).

305 In general, it can be said that the results of this study can provide a deep insight into the situation
306 of the past decade, the current situation, and a perspective of the next ten years of Iran's apiculture
307 industry, and considering future influencing factors. Findings presented here offer valuable
308 insights for the planners, policy makers, researchers and involved in the management of
309 beekeeping in Iran with basic information. These insights are crucial for outlining a strategic plan
310 and designing the future trajectory of Iran's apiculture industry. It can also be a model for
311 beekeeping industry activists around the world, so that by using these results and their localization,
312 beekeeping development programs in all parts of the world can be used by a codified and organized
313 method. Indeed, this study has some limitations like other researches.

314 The most important limitation of this study was the impossibility of considering factors affecting
315 the future of beekeeping industry in Iran and presenting an in-depth and foresight-based research
316 at this stage. The current analysis of Iran's apiculture industry for the upcoming decade, based on
317 the employed methodology in this study, is straightforward and does not take into account future
318 influential factors. However, this simplified outlook can serve as a foundation for conducting more
319 comprehensive research in order to gain further insights into the future of the apiculture industry.
320 Also, it can contribute researchers in the future to present a more comprehensive vision of the
321 future of this industry by combining other quantitative and qualitative methods. In forthcoming
322 research investigations, it is advisable to utilize to use the results of this study to examine the
323 factors affecting the future of Iran's apiculture industry. Additionally, it is crucial potential
324 scenarios to identify for the future of this industry, allowing the results to serve as a comprehensive
325 guide in the strategic planning process. . Finally, it is suggested that in addition to removing the
326 economic obstacles in the categories that have a negative trend and hinder the economic stability
327 of the beekeeping industry, policy makers, by emphasizing on the institutional dimensions, shall
328 strengthen the infrastructure and institutional relations between the stakeholders of this industry.
329 Strengthening the institutional dimension, in addition to the sustainability of the beekeeping
330 industry in this dimension, might increase the sustainability of other dimensions as well.

331

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