

The Effect of Contract Farming on the Sustainability of Wheat Production in Iran (Study Case of Golestan Province)

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Abstract

The Ministry of Agriculture Jihad in Iran implemented contract farming (CF) for wheat in 2021 to address marketing issues. This study compares agricultural sustainability for farmers participating in and not participating in CF. Agricultural sustainability was assessed by applying a combined index approach that considers economic, social, and environmental dimensions. The required data came from 620 wheat farmers in Golestan province, sampled using the multi-stage randomization technique. The data were evaluated using exploratory factor analysis (EFA) and clustering methods. The findings indicated a significant difference in the performance of economic and environmental sustainability dimensions between two groups of wheat farmers. For the participants, 14.2% were deemed unsustainable, 47.7% were considered partially sustainable, and 38.1% were classified as sustainable. For non-participants, the figures were 38.7%, 47.7%, and 13.5%, respectively. Therefore, it is suggested to provide more opportunities for participation in this program and expand it to other key crops. Additionally, authorities should provide more information about the benefits of the CF plan.

Keywords: Composite index approach, Dimensions of sustainability, Exploratory factor analysis, Sustainable agriculture.

INTRODUCTION

The Sustainable Development Goals (SDGs) serve as a "blueprint for achieving a better and more sustainable future for all" by 2030. They integrate sustainability into production, distribution, and consumption. The goals aim to ensure increased agricultural productivity through sustainable and resilient practices (United Nations, 2021). Achieving the goals relies on global agricultural sustainability. This meets society's long-term needs for food and fiber while protecting ecosystems (Suresh et al., 2022). The agricultural sustainability system is a complex concept that involves agricultural production and is guided by three fundamental principles: "Healthy environment," "economic viability," and "social acceptability" (Velten,

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32 2015). As the primary participants in the food value chain, farmers play a crucial role in
33 promoting agricultural sustainability development (Liu et al., 2020; Chèze et al., 2020).

34 Today, agricultural contracts play a crucial role in most countries as a significant tool in
35 managing risks, instilling confidence in farmers, and ensuring stable crop prices. The
36 application of these contracts is increasing in developing countries (Gatto et al., 2017;
37 Ntukamazina et al., 2017; Shahnavazi., 2022). The Food and Agriculture Organization (FAO)
38 (2017) defines CF as bilateral agreements between farmers and companies to produce and
39 supply crops under prior agreements, often at set prices. In general, CF involves agreements
40 between farmers and buyers regarding production. Based on this agreement, smallholders gain
41 access to inputs, assistance, and markets (Ragasa et al., 2018; Pouliot and Wang, 2018) through
42 integration, which helps them cope with price changes and lower transaction costs (Guo et al.,
43 2007; Li et al., 2016; Soullier and Moustier, 2018). This enhances efficiency and boosts
44 farmers' incomes (Gulati et al., 2007; Miyata et al., 2009; Bellemare and Bloem, 2018; Khan
45 et al., 2019). Therefore, CF must balance the goals of ensuring food/farmer welfare with
46 protecting nature from degradation (Jianping et al., 2014; Knickel et al., 2017; Sharma et al.,
47 2018; Kleemann and Abdulai, 2013).

48 This is important because market-based developments, such as CF can fuel the expansion of
49 arable land to increase contract crop productivity (Evans et al., 2015; Vanderhaegen et al.,
50 2018). Heavy chemical use threatens ecosystems through landscape changes, water pollution,
51 and reduced soil biodiversity (Foley et al., 2011; Laurance et al., 2014; Sharma et al., 2018).
52 CF helps farmers, especially poor ones, purchase fertilizers and pesticides under quality control
53 (Gramzow et al., 2018). CF offers economic benefits such as price stability and market access,
54 which shield farmers from the risks associated with price drops and seasonal fluctuations (Guo
55 et al., 2007; Soullier and Moustier, 2018). Past research shows positive impacts of CF on farmer
56 income (Bellemare and Bloem, 2018; Dargah., 2017; Dube et al., 2017). Sustainable
57 production is often more expensive due to the higher costs of inputs such as labor, seeds, and
58 organic fertilizers (Maggio et al., 2008; Wang et al., 2018).

59 While the CF and economic and welfare effects of carbon footprint are extensively studied,
60 sustainability impacts receive little attention. For example, Soullier and Moustier (2018) found
61 that there was no significant difference in the use of chemical fertilizers and weeding for
62 marketing contracts. Mishra et al. (2018) showed that farmers with access to irrigation water
63 were more likely to participate in CF. Increasing land and water use potentially leads to

64 biodiversity degradation and loss, as discussed by Singh (2002), Bijman (2008), and Vicol
65 (2017). All of them have raised concerns about environmental degradation due to CF and have
66 claimed that CF can have negative effects on sustainable land management. However, in some
67 cases, participation in CF can have positive effects on agricultural sustainability (Minten et al.,
68 2007; Wollni et al., 2010; Dedehouanou et al., 2013; Kathage et al., 2016). Khan et al. (2019)
69 and Wu et al. (2020) found that participation in a CF scheme increased producers' income and
70 CF may positively impact skilled labor. Olounlade et al. (2020) reported CF negatively
71 impacted the rice income. Hoang (2021), Dubbert et al. (2021) and Ren et al. (2021)
72 investigated CF's small positive effect of sustainable technology.

73 Iranian farmers have been struggling to source inputs, sell crops, or channel them to industries
74 without finding any solutions in recent years. The Ministry of Agriculture Jihad believes that
75 CF can solve these issues by preventing corruption and farmers' losses, addressing brokering
76 and middlemen, and increasing farmers' income. In CF, the private sector takes over
77 government purchases and support, privatizing agriculture according to Act 44. In Iran, CF is
78 based on agreements between farmers and companies.

79 Agriculture's importance in Iran's economic, social, political, and other fields cannot be
80 denied due to its role in providing basic resources and fostering sustainable development
81 through their utilization.

82 Considering the importance of wheat as Iran's main food source, sustainable production and
83 reducing the need for imports have always been agricultural goals. Despite land allocation and
84 efforts, Iran's low wheat yield compared to other countries places it in an unfavorable position
85 among producers. Self-sufficiency has long been an official goal, but imports have risen
86 recently due to threats such as drought, lack of training on pests for farmers, credit issues, and
87 poor farmer support policies. Thus, the Ministry of Agricultural Jihad emphasized, within a
88 resilient economy framework, initiatives such as CF to attain sustainable self-sufficiency in
89 wheat.

90 Wheat grows across Iran under irrigation and rain in all provinces. Golestan was chosen for
91 ranking first in quality and third in quantity of wheat nationally. It supplies over ten provinces.
92 Over 1600 Golestan farmers, representing leading producers, participated in the CF plan.
93 Significant funds and time were invested in the implementation of the plan there.

94 Iran's wheat CF plan began in 2021. The State Trading Company was tasked with signing
95 farmer contracts, ensuring crops, supplying inputs, and settling accounts when buying harvest.

96 In 2022, over 250,000 hectares of wheat land were covered by the plan, with 2 million hectares
97 expected next year (Ministry of Jihad Agriculture, 2022). Despite Iran's CF plan, no study has
98 examined its impact on sustainability. Additionally, there is a lack of research by PCA and
99 EFA methodology for CF. This research utilized a composite index to examine the impact of
100 CF on agricultural sustainability, focusing on ecological security, economic efficiency, and
101 social equality. A survey of Golestan wheat farmers for the 2020-21 season, both those
102 participating and not participating in CF, assessed the adoption of sustainable practices. This
103 research addressed the following questions:

- 104 · What is the status of agricultural sustainability among wheat farmers who are participating
105 in the CF plan and those who are not participating in the plan in Golestan province?
- 106 · What is the status of the combined index of agricultural sustainability among wheat farmers
107 participating in the CF plan and those not participating in the plan in Golestan province?

108

109 METHODOLOGY

110 This survey was conducted in Golestan province. The statistical population included all wheat
111 farmers in this province. A multi-stage random sampling method was used to select the research
112 area and farmers. In this research, after selecting the district, villages in each district, and
113 farmers in each village were randomly chosen. The sample size was determined using
114 Cochran's formula (Eq. 1). The data were collected from wheat farmers who participated in the
115 CF plan during the crop year 2020-21 using a questionnaire that was validated by agricultural
116 experts. SPSS statistical software (V.16) was utilized to analyze the data (IBM SPSS Statistics,
117 2023).

$$n = \frac{\frac{Z^2 pq}{d^2}}{1 + \frac{1}{N} \left(\frac{Z^2 pq}{d^2} - 1 \right)} \quad [1]$$

118 In equation 1 (Cochran, 1977), n is the sample size, p is the estimated proportion of the
119 statistical population that participated in the CF plan, q is equal to $(1 - p)$, that is, the
120 proportion of the population that did not participate in the CF plan, d is the degrees of
121 confidence (0.05), $Z = 1.96$ is the percentage error of acceptable confidence coefficient (α
122 level of error (0.05), and N the size of the statistical population of wheat farmers in this
123 province. Then the KMO and Bartlett's Test of Sphericity are estimated to determine if the
124 sample size is adequate. Another method to calculate the sample size is by using Morgan's
125 table. According to Morgan's table, an additional 310 samples should be included.

126 In this research, sampling has been conducted in 7 counties of Golestan Province that have a
 127 higher percentage of participation in CF. The statistical population size in the rural areas of
 128 Golestan province that participated in the CF plan was 1613 households, with 310 farmers
 129 sampled, and 310 questionnaires was collected from farmers who did not participate in CF.

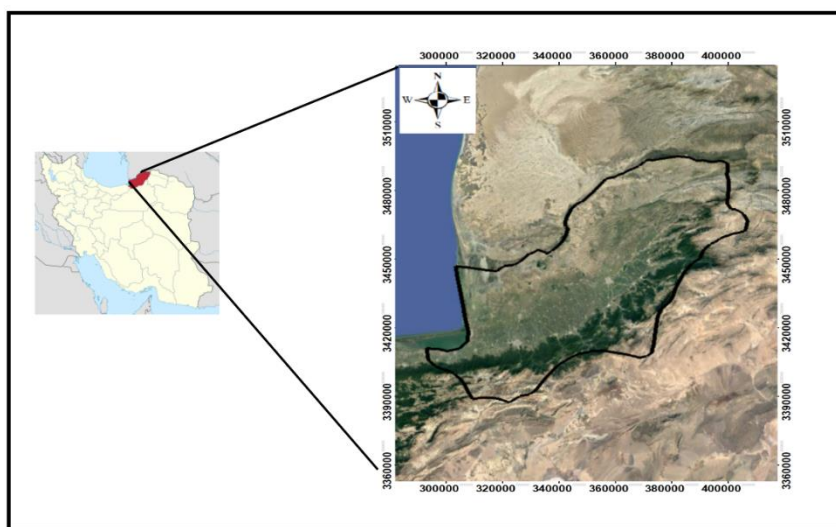
130 Table 1 shows the counties of Golestan province, the number of farmers participating in the
 131 CF plan, and the number sampled in each county.

132 **Table 1.** The population of farmers participating in the CF plan in Golestan province.

Counties	The number of farmers participating in the CF plan (persons)	The ratio of participants to total farmers (%)
Gonbad-e Qabus	150	29
Agh Qala	300	58
Kalaleh	192	37
Aliabad	319	61
Minodasht	295	56
Galikesh	115	22
Gorgan	242	47
Total	1613	310

133 Source: Agricultural Jihad Organization of Golestan Province, 2020.

134 The location of Golestan Province is shown on the map of Iran in Fig. 1.



135 **Fig. 1.** Location of the studied area on the map of Iran.

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 137
 138 The research examined the agricultural sustainability of two groups of farmers: those who
 139 participated in the CF plan and those who did not, using survey data. The study recorded the
 140 characteristics of each group for analysis. To accurately measure the sustainability of
 141 agriculture, the study identified important indicators of agricultural sustainability from the
 142 perspective of agricultural experts. The criteria included 32 indicators, which were measured
 143 on a five-point Likert scale ranging from very low sustainability to very high sustainability.
 144 Table 2 presents the agricultural sustainability indicators among farmers who participated in

145 the CF plan and those who did not, separated by dimensions. The comprehensive calculation
 146 of sustainability enabled the determination of the overall level of agricultural sustainability in
 147 Golestan province. This was based on available information and a review of studies conducted
 148 in Iran and other countries (Durán Gabela et al., 2022; Ataei et al., 2022; Benitez- Altuna et
 149 al., 2023).

150 **Table 2.** Agricultural sustainability indicators and their dimensions.

Sustainability dimensions	Indicators
Economic	Access to various chemical fertilizers
	Access to agricultural machinery
	Access to crop markets
	Access to warehouses, cold storage, and silos
	Access to a variety of seeds
	Investment in agriculture
	Easy access to loans and bank credits
	The quality of chemical fertilizers used
	The existence of sufficient agricultural infrastructure in terms of irrigation facilities
	Environmental
The extent of using fallow (land fallow)	
Cultivation of other crops to implement crop rotation	
Using the forest-agriculture method	
Not burning the straw and stubble left over from harvesting the crop	
Adjusting planting and harvesting time to fight pests	
The use of integrated pest management	
The use of animal manure to strengthen the soil	
Consumption of micronutrient fertilizers	
Planting green manure to strengthen and increase soil fertility	
Correct and accurate use of fertilizers recommended by agricultural experts	
Minimal use of chemical fertilizers and pesticides	
Better water quality and quantity protection (consumption savings)	
Social	Satisfaction with farming job
	Satisfaction with future career
	No feeling of deprivation
	The amount of social participation in village activities
	The extent of using communication networks
	The degree of willingness to insure land
	The level of satisfaction with agricultural officials and workers
	The amount of participation in educational and promotional classes
	Access to the nearest primary health care centers
Access to safe drinking water in the household	

151 Source: Dubbert et al. (2021); Ren et al. (2021); Khan et al. (2019); Liu et al. (2020); Guo et al., (2019); Dubbert,
 152 2019; Dubbert and Abdulai, (2021); Peng and Pang (2019); Nguyen et al. (2015); Minot and Sawyer (2016).

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 154 The research questionnaire included questions on household characteristics, environment,
 155 economy, and society. Questions on household profiles covered demographics such as age,
 156 gender, marital status, education, family size, residence, land size, income, livestock
 157 ownership, and farm tools. To assess agricultural sustainability and its environmental,
 158 economic, and social dimensions, indicators from selected regions and farmer data were

159 collected. Questions on CF and its effects arose from ministry instructions and expert opinions
160 on wheat contract farming. To measure sustainability using composite indexes, factor analysis
161 summarized the indicators in each dimension into factors. The factors were then combined in
162 cluster analysis to determine farmers' status regarding adherence to sustainable agriculture
163 principles in three categories: sustainable, partially sustainable, and unsustainable.

164 Normally, there are two problems in determining and measuring sustainability through a set
165 of variables: a) the interdependence of the selected indicators, and b) the lack of consideration
166 for the importance coefficient (weight) of each indicator. We used Exploratory Factor Analysis
167 (EFA) to address these two problems. EFA is the most common method in factor analysis. The
168 factor is a new variable estimated through the linear combination of the main variables as per
169 Eq. 2 (Wold et al, 1987).

$$F_j = \sum_{i=1}^p A_{ji} X_i = A_{j1}X_1 + A_{j2}X_2 + \dots + A_{jp}X_p \quad [2]$$

170 The objective of this method is to find combinations of variable P ($X_1 + X_2 + \dots + X_p$) to
171 create independent and uncorrelated variables ($F_1 + F_2 + \dots + F_j$). These new variables
172 contain different variables, and the duplicate information is removed. In Eq. (2), A represents
173 factor score coefficients and P represents the number of variables. In EFA-based research,
174 determining the sample size and correlations between variables is essential. The sample size
175 determines the correct clustering in EFA. The Kaiser-Meyer-Olkin (KMO) and Bartlett's tests
176 ensure an adequate sample size and variable sphericity before conducting EFA. According to
177 these interpretations, to measure agricultural sustainability, the factor analysis method was first
178 used through the following steps: (1) preparing the standard matrix, (2) calculating the matrix
179 of correlation coefficients, (3) extracting the factors, (4) rotating the factors, and (5) calculating
180 factor scores. Other studies utilised instrumental variables and regressions to estimate the
181 impact of CF on agricultural production and sustainability. (Soullier & Moustier, 2018; Mishra
182 et al, 2018; Ren et al, 2021).

183 Factor analysis summarizes the collinearity among indicators and groups them into factors,
184 each assigned an appropriate weight. The factor score sum thus represents indicators well. The
185 sum of average factor scores can indicate compliance with agricultural sustainability principles
186 and levels of enjoyment. Cluster analysis classified sustainability levels, enabling researchers
187 to group studied cases based on their existing homogeneity, and subsequently interpret and
188 explain them. Researchers first calculated a composite index using principal component

189 analysis and indicator weighting. The composite index obtained then served as the basis for
190 cluster analysis, which was analyzed hierarchically. This research utilized factor analysis to
191 streamline the indicators of sustainability dimensions, building on the studies by Dovbischuk
192 (2023), Saygili et al. (2023), Das et al. (2023), and Blay Jnr et al. (2022).

193

194 RESULTS AND DISCUSSION

195 To assess wheat farmers' compliance with sustainability principles in Golestan, the
196 questionnaire's reliability was tested through a pre-test involving 30 individuals from the
197 population. Cronbach's alpha was 0.77 for economic, 0.65 for social, and 0.64 for
198 environmental dimensions, indicating reliable measurement. Agricultural sustainability
199 dimensions were evaluated by the EFA. KMO (It should be more than 0.6) and Bartlett tests
200 (The significant level should be less than 0.05) were conducted to assess the suitability of the
201 data for factor analysis. The results in Table 3 confirmed that the variable correlations were
202 suitable for factor analysis.

203 **Table 3.** The results of KMO's and Bartlett's tests.

Sustainability dimensions	KMO stat value	Bartlett's value	DF	Significance level
Economic	0.726	2162	36	0.000
Social	0.722	1885	28	0.000
Environmental	0.716	2201	45	0.000

204 Source: Research Findings.

205 Table 4 presents the extracted factors, along with their eigenvalues and the variance they
206 account for after Varimax rotation. The results show that when the eigenvalue was greater than
207 one, two factors were extracted for the economic dimension. The first factor was the most
208 significant, with an eigenvalue of 3.218, accounting for 35.760% of the variance in the factors
209 that determine the economic dimension of agricultural sustainability. It was named Access to
210 Agricultural Inputs and Equipment, according to the five indicators included in this factor
211 (access to various chemical fertilizers, agricultural machinery, crop markets, warehouses, cold
212 storage, silos, and a variety of seeds). The second factor with an eigenvalue of 2.020 is loaded
213 by investment in agriculture, facilitating access to loans and bank credits, the quality of
214 chemical fertilizers used, and the existence of sufficient agricultural infrastructure for
215 irrigation. This factor could capture 22.440% of the total variance. It was named Investment
216 Possibilities, Infrastructure, and Quality of Inputs.

217 In the social dimension of sustainability, three factors were identified. In this study, two
218 indicators (the willingness to invest in land and the satisfaction level with agricultural officials

219 and workers) were excluded from the analysis because they did not show significant
220 correlations with other indicators in the factor analysis. The first factor with an eigenvalue of
221 2.466 accounted for 30.820% of the variance in the factors determining this dimension. It was
222 named "Job Satisfaction" based on the three indicators included in this factor: satisfaction with
223 the farming job, satisfaction with the future career, and absence of feelings of deprivation. The
224 second factor, with an eigenvalue of 2.110, included three indicators: the level of social
225 participation in village activities, the extent of using communication networks, and the degree
226 of participation in educational and promotional classes. The study was titled "The Extent of
227 Social, Communicational, and Educational Participation." The third factor from the social
228 dimension was loaded with two indicators: access to the nearest primary health care centers
229 and access to safe drinking water in the household. It was named "Access to Safe Drinking
230 Water and Sanitary Facilities."

231 In the environmental dimension, three indicators (adjusting planting and harvesting time to
232 combat pests, implementing integrated pest management, and utilizing micronutrient
233 fertilizers) were excluded because they did not correlate with other indicators in the factor
234 analysis. The first factor from the environmental dimension of sustainability included five
235 indicators: utilizing the integrated method of livestock and plants, the amount of fallow
236 application, cultivation of other crops to implement crop rotation, using the forest-agriculture
237 method, and not burning the straw and stubble left over from harvesting the crop. It had an
238 eigenvalue of 3.631 and accounted for 36.315% of the variance in the determining factors of
239 this dimension. Adherence to Cultivation Principles The second factor included two indicators:
240 the use of animal manure to enhance the soil and planting green manure to improve soil fertility.
241 This factor was named "The Application of Organic Fertilizers." Finally, the third factor from
242 the environmental dimension was loaded with three indicators: correct and accurate use of
243 fertilizers recommended by agricultural experts, minimal use of chemical fertilizers and
244 pesticides, and better protection of water quality and quantity. This factor was named "The
245 Correct Use of Agricultural Inputs."

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251 **Table 4.** The factor matrix rotated by the Varimax method.

Sustainability dimensions	Factor loading	Variables	Factor name
Economic	0.848	Access to various chemical fertilizers	Access to agricultural inputs and equipment (eigenvalue:3.218) (variance percentage:35.760)
	0.815	Access to agricultural machinery	
	0.814	Access to crop markets	
	0.827	Access to the warehouses, cold storage, and silos	
	0.554	Access to a variety of seeds	Investment possibilities, infrastructure, and quality of inputs (eigenvalue:2.020) (variance percentage:22.440)
	0.599	Investment in agriculture	
	0.789	Facilitating access to loans and bank credits	
	0.548	The quality of chemical fertilizers used	
Social	0.820	The existence of sufficient agricultural infrastructure for irrigation	Job satisfaction (eigenvalue:2.466) (variance percentage:30.820)
	0.815	Satisfaction with farming job	
	0.872	Satisfaction with future career	
	-0.610	No feeling of deprivation	The extent of social, communicational, and educational participation (eigenvalue:2.110) (variance percentage:26.374)
	0.728	The extent of social participation in village activities	
	0.890	The extent of using communication networks	
Environmental	0.794	The extent of participating in educational and promotional classes	Access to safe drinking water and sanitary facilities (eigenvalue:1.366) (variance percentage:17.075)
	0.861	Access to the nearest primary healthcare centers	
	0.610	Access to safe drinking water in the household	Adherence to cultivation principles (eigenvalue:3.631) (variance percentage:36.315)
	0.864	Utilizing the integrated method of livestock and plants	
	0.930	The amount of the application of fallow (land fallow)	
	0.529	Cultivation of other crops to implement crop rotation	
0.864	using the forest-agriculture method		
0.930	Not burning the straw and stubble left over from harvesting the crop		
Environmental	0.764	The use of animal manure to strengthen the soil	The application of organic fertilizers (eigenvalue:1.960) (variance percentage:19.604)
	0.857	Planting green manure to strengthen and increase soil fertility	
	0.774	Correct and accurate use of fertilizers recommended by agricultural experts	The correct use of agricultural inputs (eigenvalue:1.587) (variance percentage:15.866)
	0.796	Minimal use of chemical fertilizers and pesticides	
	0.782	Better water quality and quantity protection	

Source: research findings

252
 253 In this section, Friedman's variance analysis was utilized to determine the relative importance
 254 of each factor based on their factor scores. As evident in Table 5, there were significant
 255 differences in the relative importance of sustainability components. The components of social,

256 communicational, and educational participation, as well as the consumption of organic
257 fertilizers, had ranks higher than the average.

258 **Table 5.** Friedman analysis test results.

Sustainability dimensions	Factors	Rank average	Factors rank
Economic	Access to agricultural inputs and equipment	4.29	8
	Investment possibilities, infrastructure, and quality of inputs	4.52	4
Social	Job satisfaction	4.31	7
	The extent of social, communicational, and educational participation	4.93	1
	Access to safe drinking water and sanitary facilities	4.33	6
Environmental	Adherence to cultivation principles	4.54	3
	Consumption of organic fertilizers	4.73	2
	Correct use of agricultural inputs	4.35	5
Friedman's test statistic value=38.002		DF=7	Significance level= 0.000

Source: research findings

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260 The results of the differences in sustainability dimensions between the group of wheat farmers
261 participating in the CF plan and those not participating in this plan are presented in Table 6.

262 **Table 6.** The difference in sustainability dimensions between the group of wheat farmers participating in the CF
263 plan and those not participating in this plan.

Sustainability dimensions	Mann-Whitney test statistic	Wilcoxon test statistic	Z test statistic	Significance level
Economic	2.982E4	7.803E4	-8.179	0.000
Social	4.565E4	9.385E4	-1.078	0.281
Environmental	3.791E4	8.611E4	-4.549	0.000
Total sustainability index	2.948E4	7.768E4	-8.325	0.000

Source: research findings

The distribution of the three dimensions of stability and the total sustainability index is non-normal, so the Mann-Whitney test can be used.

264
265 As seen in Table 6, the wheat farmers in two groups of participants and non-participants in
266 the CF project differed significantly ($P < 0.01$) in terms of economic and environmental
267 sustainability, as indicated by the reported statistics. Also, based on the total sustainability
268 index, there was a significant difference between the two groups. The wheat farmers were
269 separated into three groups based on the composite index of sustainability through cluster
270 analysis. The results of the classification of the composite sustainability index are presented in
271 Fig. 2. These results indicate that the number of farmers in the sustainable group exceeded the
272 number in the other groups. Based on the total sustainability index, 25.8% of the farmers were
273 at the sustainable level.

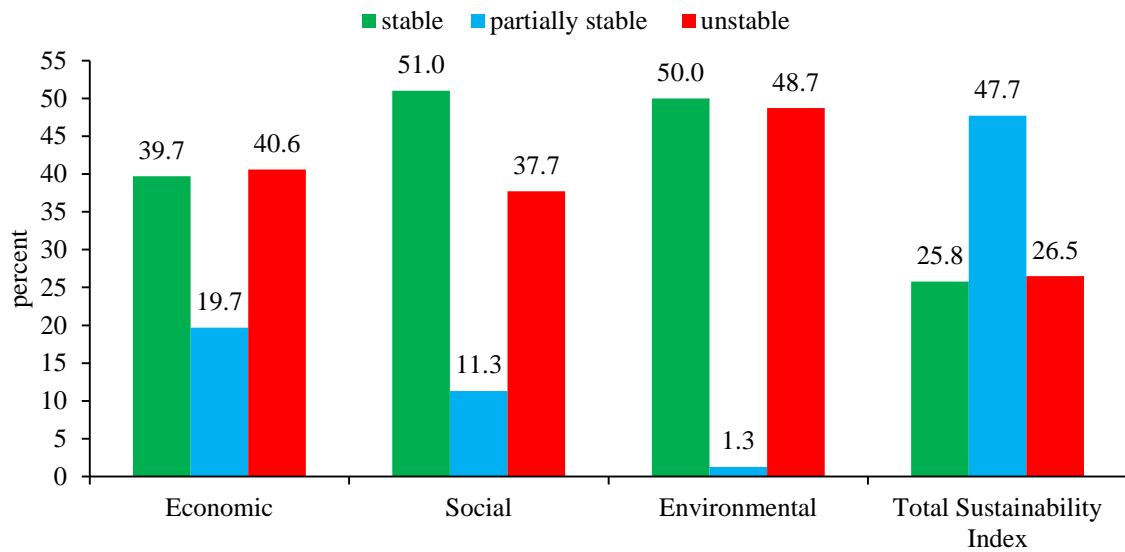


Fig. 2. Agricultural sustainability status of all wheat farmers investigated in Golestan province (Source: research findings).

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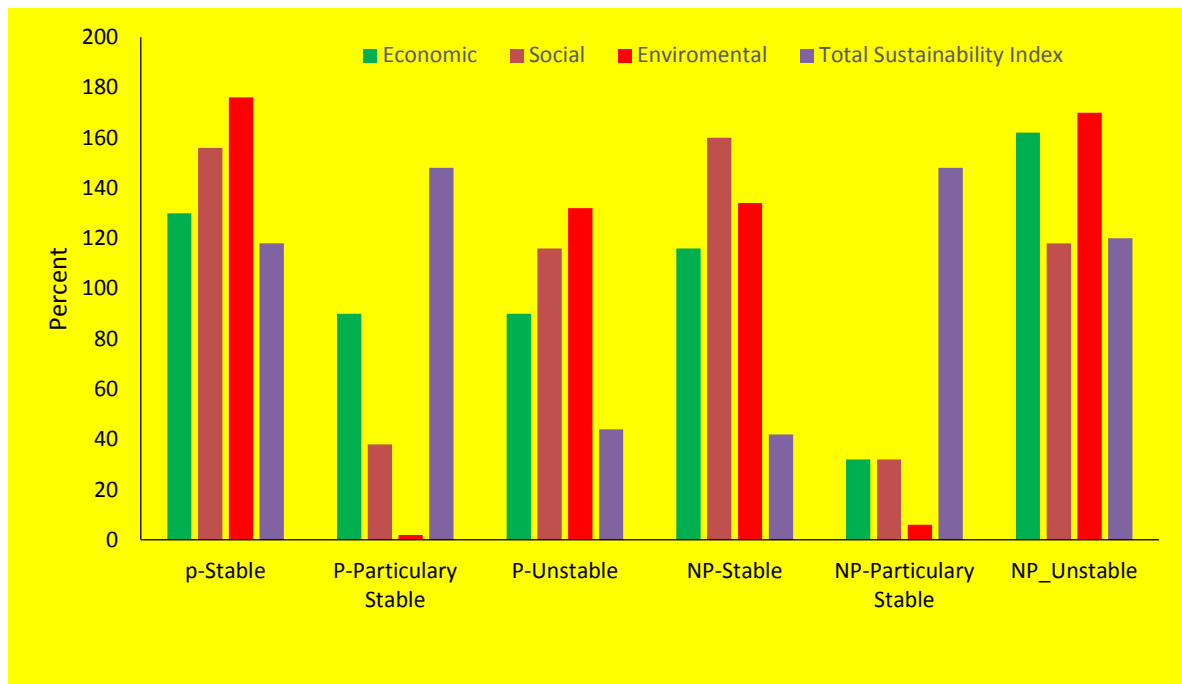


Fig. 3. Agricultural sustainability status among wheat farmers participating (P) and non-participating (NP) in the CF plan in Golestan province (Source: research findings).

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The analysis of sustainability levels between wheat farmers participating or not in CF showed that participation increased production sustainability in economic, social, and environmental dimensions (Figs. 2). Based on the total sustainability index, more participating wheat growers (38.1%) were in the sustainable cluster, indicating that CF successfully enhanced wheat grower sustainability across three dimensions.

287 As a result, the economic sustainability of CF farmers is higher than that of non-CF farmers
288 because they sell wheat at a higher price, assure the markets, and experience no fluctuations in
289 their wheat selling prices. Additionally, CF farmers are required to use a specified amount of
290 fertilizer and pesticide through contracting, making them more environmentally sustainable
291 than other farmers.

292

293 CONCLUSIONS

294 To measure CF's effect on agricultural sustainability, this study analyzed 32 rural social,
295 economic, and environmental indicators in Golestan province located in the northeast of Iran.
296 To address the question of sustainability status, three dimensions were evaluated. Economic
297 and environmental dimensions were more sustainable for wheat farmers participating in CF,
298 with no difference in the social dimension between groups. Results also showed an imbalance
299 between the sustainability levels of farmers participating or not in CF. Non-participants had
300 less favorable conditions. CF implementation has contributed to greater farmer sustainability
301 through support, contracts, advice, and monitoring. Authorities should inform farmers about
302 the benefits of CF, and facilitate broader participation to enhance production sustainability.
303 Additionally, they should consider extending the plan to other important crops. In this study,
304 like many studies in Iran, obtaining data from Agricultural Jihad of CF farmers posed
305 challenges for researchers. Researchers suggest conducting further research in other cities and
306 on different products to compare and understand the benefits of CF farming, in order to develop
307 it further and achieve more sustainability.

308

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312

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