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Original Article

Investigating factors affecting the development of contract farming. Case study: tomatoes in Kermanshah Province

Investigando fatores que afetam o desenvolvimento da agricultura contratual. Estudo de caso: tomates na Província de Kermanshah

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Abstract

The escalating demands of a growing population and rising living standards strain the efficiency of traditional agricultural methods in fulfilling consumer nutritional needs. Technological advancements, particularly the introduction of contract farming models, offer a potential path towards addressing these challenges. However, in Iran, contract farming remains an underdeveloped and under-researched agricultural practice. This study delves into the factors influencing the development of contract farming in Iran. Employing a two-level multinomial logit model and data collected through 380 questionnaires administered to farmers in the Kermanshah region, the research reveals income (measured by the number of employed household members) as the primary driver of contract farming adoption. Additionally, factors such as reduced agricultural risk, higher education levels among farmers, improved product sales prices, and proximity to processing facilities positively impact the expansion of contract farming. Interestingly, "push factors" like land scarcity significantly influence non-contract farming participation, with 30.8% of surveyed households relying on these alternative methods. Geographical factors also contribute, explaining 23% of the observed variance in farming activity choices. These findings inform key policy interventions for sustainable contract farming development in Iran: robust legal frameworks and transparent contracts, contract-specific insurance schemes, training for agricultural extension workers, and farmer awareness campaigns.

Keywords: contract farming, tomato, two-level multinomial logit model.

Resumo

A escalada de exigências de uma população crescente e o aumento dos padrões de vida desafiam a eficiência dos métodos agrícolas tradicionais na satisfação das necessidades nutricionais dos consumidores. Os avanços tecnológicos, particularmente a introdução de modelos de agricultura contratual, oferecem um caminho potencial para enfrentar estes desafios. No entanto, no Irã, a agricultura contratual continua a ser uma prática agrícola subdesenvolvida e pouco investigada. Este estudo investiga os fatores que influenciam o desenvolvimento da agricultura contratual no Irã. Empregando um modelo logit multinomial de dois níveis e dados recolhidos através de 380 questionários aplicados a agricultores na região de Kermanshah, a investigação revela o rendimento (medido pelo número de membros do agregado familiar empregados) como o principal impulsionador da adoção da agricultura contratual. Além disso, fatores, como a redução do risco agrícola, os níveis de educação mais elevados dos agricultores, a melhoria dos preços de venda dos produtos e a proximidade das instalações de processamento, têm um impacto positivo na expansão da agricultura contratual. Curiosamente, "fatores de impulso", como a escassez de terras, influenciam significativamente a participação na agricultura não contratual, com 30,8% dos agregados familiares inquiridos demonstrando confiança nestes métodos alternativos. Os fatores geográficos também contribuem, explicando 23% da variação observada nas escolhas das atividades agrícolas. Estas conclusões podem embasar as principais intervenções políticas para o desenvolvimento sustentável da agricultura contratual no Irã: quadros jurídicos robustos e contratos transparentes, regimes de seguros específicos para contratos, formação para extensionistas agrícolas e campanhas de sensibilização dos agricultores.

Palavras-chave: agricultura por contrato, tomate, modelo logit multinomial de dois níveis.

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1. Introduction

The escalating demands of a growing global population and rising living standards necessitate a surge in food production. Meeting consumer expectations under traditional agricultural strategies has become increasingly challenging amidst recent transformations in food and agricultural systems. These transformations have driven structural and technological advancements, leading to shifts in market demand and the performance of raw material supply chains. Food markets have become more competitive, with consumers demanding food products that are not only safe for consumption but also produced in a manner that benefits not only the environment but also the farmers and laborers involved in their production. Therefore, adopting new agricultural production methods based on novel production systems and emphasizing consumer demand is an imperative of the present era (FAO, 2022)

In recent years, contract farming has gained popularity, particularly in developing countries (FAO, 2022). Recognizing the significance of contract farming within international communities, the Food and Agriculture Organization of the United Nations (FAO, 2001), as the primary authority on agriculture worldwide, addressed the importance, effects, and types of contract farming in developed and developing countries through the publication of the book "Contract farming, Partnerships for growth." According to the FAO (2001), contract farming organizes commercial agricultural production, both on small and large scales, reduces the cost of crop production, and facilitates the commercialization of production in small farms.

Various methods exist within the food supply chain for the exchange of agricultural products through agreements between farmers and processing companies acting as sponsor companies, with contracts being concluded before production (MacDonald and Korb, 2012). Contract farming involves establishing production relationships between at least two parties (farmers and sponsors) through verbal or written agreements for a specific period (Forrest Zhang, 2012). The core of contract farming lies in the agreement between farmers and sponsors, where both parties determine the terms and conditions for producing and marketingagricultural products. In a general definition, contract farming refers to "agricultural production carried out based on an agreement between farmers and a sponsor company, creating conditions for crop production and marketing (FAO, 2001). Farmers' perception of contract farming varies across cultures, reflecting their relationships with sponsor companies (Asano-Tamanoi, 1988).

Contract farming can be seen as an organizational innovation and institutional arrangement that reduces transaction costs by connecting smallholders to the market, enabling sponsor companies to participate in the production process and exercise control without owning or exploiting the fields (Key and Runsten, 1999; Baumann, 2000; Mishra et al., 2016; Patel, 2022). Timely and reliable access to high-quality production inputs is essential for the success of any agricultural firm, particularly in domestic and international markets. In this regard, modern agriculture is shifting towards contract and specialized farming (Singh, 2002).

The agricultural sector remains a crucial part of Iran's economy due to its vital role in food provision, ensuring food security, conserving natural resources, and creating employment opportunities. With a contribution of 17.7% to employment (Statistical Centre of Iran, 2020), 8% to the GDP (CBI, 2020), and 5.3% to non-oil exports (IRICA, 2020), the agricultural sector holds significant potential for the development of Iran's economy. However, it requires the attention of policymakers and macroeconomic planners. Several factors pose severe challenges to agricultural production in terms of providing food security, including limited access to capital, the underutilization of new technologies and advanced machinery and equipment, low productivity of production factors, small and fragmented land holdings, a lack of integrated supply chains, imbalances in supply and demand, the presence of natural hazards, and inadequate consideration of consumers' demands (Bakhshaiesh et al., 2020).

Despite international recommendations for implementingcontract farming and its successful adoption in various countries, contract farming has not been widely practiced in Iran. Only a few researchers have examined, recommended, and promoted this concept to the extent that it became a subject of discussion by the Minister of Agriculture Jihad in 2021 (Fars News Agency, 2021). The lack of contract farming, scientific studies, and support for contract farming at the administrative and national development program levels has resulted in abandoning this globally recommended policy.

Numerous studies in the agricultural scientific literature have focused on contract farming worldwide. Afsari (2014) assessed the performance of conventional agriculture in Iran by employing statistical tests and the logit model with questionnaire data. Their findings indicated an average decrease of 29% in farmers' costs per hectare. Dargeh et al. (2021) conducted a study in Kermanshah province using questionnaires and data analysis to examine the extension of contract farming. Their results emphasized the importance of accurate contract design and the involvement of public organizations in this domain. In another study, Mahmoudi and Karbasi (2019) conducted field research in Kermanshah province to investigate the determinants of contract farming using the regression switching method. They found that various factors such as vehicle ownership, computer access to up-to-date communication tools, relative product share in the household, area of cultivation, participation in training, other crop production, affected farmers differently, and written contracts were more successful than verbal agreements

Bellemare (2021) conducted a thorough examination of contract farming in Asia. The study concluded that targeting contract farming as a primary national strategy would not be appropriate. Instead, it recommended implementing contract farming as a pilot project for specific products in vulnerable areas. If successful, the practice could then be expanded to encompass all regions.

In a study by Behera and Swain (2021), the researchers explored whether farmers engaged in contract farming were more productive than other farmers. The findings

revealed that farmers involved in medium-scale contract farming exhibited higher performance levels due to better tillage operations and the use of suitable seeds.

Shi and Wang (2023) investigated the correlation between production levels in supply chains of contract farming products. The results demonstrated that competition among farmers, uncertainty regarding yield, and farmers' risk aversion hurtfarm size and the usage of chemical fertilizers. However, yield insurance showed positive effects.

In a study by Singh (2012), the authors analyzed the allocation or non-allocation of lands for tomato cultivation in India. The researchers utilized ordinary least squares (OLS) regression and completed questionnaires from 327 farmers. The results highlighted the significant influence of tomato seed supply on the success of contract farming of tomatoes in India.

Simbila et al. (2022) investigated the compliance and effectiveness of contract farming among smallholders in Tanzania. The study collected data from 220 farmers, and the findings indicated that educating the farmers had the most significant impact on the acceptance and success of cotton contract farming in Tanzania.

While numerous studies have examined various aspects of agriculture globally, none of them have simultaneously explored farms, farmers, and regions. Recognizing the significance of contract farming and the requirements for its development in Iran, this research focuses onthe contract farming of tomatoes in Kermanshah province. Econometric models were employed to investigate the factors that increase farmers' willingness to engage in contract farming at both the farm and regional levels. The choice of this particular region and crop is explained as follows.

1.1. The importance of tomato production and export in Kermanshah province and Iran

Tomato production plays a crucial role in Iran, particularly in Kermanshah province. In the 2018-2019 season, Iran harvested approximately 7 million tons of tomatoes, accounting for 9.3% of the country's total irrigated crop production, which stood at 75 million tons (Jihad, 2020). Regarding foreign exchange, tomato, and tomato paste exports reached a total value of around $386 million in 2018, constituting 6.13% of agricultural product exports. Notably, in the same year, Iran exported 61.5% of its tomato paste and 73% of its tomatoes to Iraq (ITC, 2020). Due to their production volume and economic significance, tomatoes hold a unique position in household consumption and agricultural income generationin Iran, both in terms of Rials and U.S Dollars. Kermanshah province alone contributed 476,000 tons of tomatoes to Iran's production during the 2018-2019 season, representing 7% of the country's total tomato production (Iranian Agricultural Statistics, 2020). Given the province's shared border with Iraq, a significant export destination for more than 70% of Iran's tomato and tomato paste products, investigating contract farming in the region becomes paramount.

1.2. Contract farming of tomatoes in Kermanshah province

RojinTaak Complex has led in implementing contract farming for tomatoes in Kermanshah province. The complex has collaborated with 3,600 trained farmers across 411 villages, utilizing 5,000 hectares of land. As a result, the processing capacity has grown to accommodate 4,200 tons of tomatoes per day. To facilitate this initiative, RojinTaak Complex established Dasht Sabz GharbAgro-Industrial Company, which enters into contracts with farmers, providing them with support and training throughout the cultivation process. The average farm size is 1.2 hectares, and small parcels of land have been integrated without altering their ownership. Consequently, the farmers retain ownership of their lands, and their rights are respected. In contrast to previous agro-industrial companies, where farmers were mere employees, RojinTaak Complex ensures that farmers maintain their motivation to produce and work.

During the harvest season, approximately 2,600 seasonal workers are employed in the fields associated with this company. The crop distribution is divided equally between domestic use and export, with 50% allocated for each purpose. The company produces 40 million cans, 8-10 tons annually, then exports in aseptic forms. In 2020 alone, the company exported crops worth $23 million to 15 countries, including Canada, China, Italy, Russia, the UK, Ghana, UAE, Iraq, and Kurdistan. To facilitate distribution, the company has established a distribution office in Canada (Research Findings). The company has recentlyventured into manufacturing apple and peach purees through contract farming and primarily exports these products in aseptic forms to Russia. Additionally, the company is expanding its production to include various sauces, pickles, and other food items produced through contract farming in collaboration with farmers.

1.3. Type of contract farming of tomatoes in the region

The supporting company (DashtSabzGharb Agro-Industrial Company) provides educational services and inputs for farmers. The inputs (e.g., seedlings, seeds, pesticides, and fertilizers) are tested before being presented to farmers and then used in research fields. If their environmental efficiency has reached the commercial stage and is compatible with the region's soil, sun, water, and air, they are given to farmers. The updated scientific and research findings conducted in the institute are regularly provided to the farmers face-to-face or through short message panels and virtual social networks. The company provides all extension and educational activities, as well as farm examinations,to farmers for free. Furthermore, the cost of physical inputs is eliminated, and the rest is paid to farmers for supporting them during the threshing and delivery of tomatoes to the factory when the tomato cost is going to be paid.

Despite national statistics from the Agriculture Jihad Organization in 2020 indicating an average tomato yield of 42.5 tons per hectare (t/ha), Rojin farms using standard (OP) and non-hybrid seeds achieve a significantly higher average yield of 70 t/ha. Farms employing hybrid Canadian and Californian seeds reach an even greater average yield of 101.7 t/ha, exceeding the average yield of Californian farmers by roughly one ton per hectare. 250 liters of water is used to produce each kilogram of tomatoes in Iran. This consumption has decreased to 137 liters in farms

with standard (OP) and non-hybrid Rojin seeds and 97 L/kg in hybrid seed farms of this variety. Per capita, water consumption (standard seed cultivation) is 9590 m^3/ha with contract farming and 10700 m^3/ha without contract cultivation. The contracted farmers have drip irrigation systems. Being equipped with a drip irrigation system is, in fact, a prerequisite for the contract, except for those farmers who are unable to build the equipment owing to natural disasters. A farmer in Bazvash Village in Kamyaran has a record yield of 254.6 tons/ha. Table 1 presents the tomato crop, yield, and irrigation water information.

This study investigates the structure of contract farming in both urban and rural households, with a specific focus on Kermanshah, Iran. It expands upon existing research by examining the factors that influence the development of contract farming among farmers in this region. The study addresses three key research questions:

- Probability of Participation: What is the likelihood of an agricultural household engaging in contract farming arrangements (either having a contract, not having a contract, or both)?
- Spatial Variation: Does the probability of participation in either contractual group (contracted or non-contracted) vary across different villages?
- Determinants of Participation: How do individual characteristics of farmers, household attributes, farm-level factors, and regional characteristics influence the probability of participation in each of the contractual groups (contracted and non-contracted)?

2. Material and Methods

Situated within Kermanshah Province, Iran, Kermanshah County holds significant regional importance. In 2016, the county's population reached 1,083,833 inhabitants, with 31% residing in rural areas. Kermanshah County's geographical borders encompass Kurdistan Province and Ravansar County to the north, Dalaho and Islam Abad Gharb Counties to the west, Ilam Province to the south, Sahneh and Harsin Counties to the east, and Sanqar and Kolyai County to the northeast. The selection of Kermanshah County for this study stemmed from its thriving contract farming activities, serving as a unique and successful model within the nation. Data collection employed a three-stage stratified sampling approach. Initially, the four constituent regions of Kermanshah were identified. Villages within these regions were then randomly chosen, followed by the random selection of agricultural households within each village. A total of 380 questionnaires were distributed across the designated area, with 305 completed by farmers engaged in contractual agreements and 75 by those not involved in such arrangements. STATA15 software was utilized to estimate a two-level multinomial logit model using the gsem command.

In order to investigate the factors affecting the participation of urban and rural households in contract farming, the dependent variable or response variable in the present study has three groups: households with contract farming (reference group (group=1)), households without contract farming (group=2), and households with both (group=3) (households with both contract and non-contract farming).

The independent variables of the model include the individual and personal characteristics of the household head (such as age, gender, migration status, education (number of years of schooling), marital status, degree of risk aversion (index from one to five)); household characteristics (number of household members, average household education and an index of household assets (vehicle value), receipt of loan, number of employed household members, household income), agricultural characteristics (farm size, number of livestock, value of agricultural assets (water + machinery), ownership of agricultural land)) and regional

Table 1. Contract Farming Information.

Variables	Unit	Contract Farming
Total Cultivation Area	ha	4571
Average Cultivation Area	ha	1.2
Number of Contracts	No.	2501
Tomato production	1000 t	252.8
Average Yield per Hectare (Standard Seed, OP)	t	70
Average Yield (per ha of Hybrid Seed)	t	101.7
Water Consumption per Capita (Standard Seed Cultivation)	m^3/ha	9590
Water Consumption per Capita (Hybrid Seed Cultivation)	m^3/ha	9865
The use ofPressurized Irrigation	%	95
Price of Tomato	Rials	20000
Average Cost of Production per Hectare	Billion rials	1
Average Income per Hectare	Billion rials	2.034
Average Profit per Hectare	Billion rials	1.034

Source: Research findings.

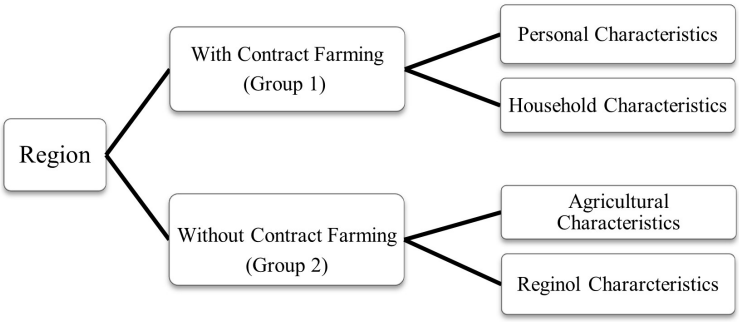

Figure 1. Visualization of the Two-Level Multinomial Logit Model Structure.

characteristics (such as population and distance from the county center (Kermanshah)). The levels examined in the structure of the two-level multinomial logit model are the household and regional levels (Figure 1).

The multilevel multinomial logit model is a mixed generalized linear model (McCullagh and Nelder, 1989) with linear predictors. According to Wright and Sparks (1994); Skrondal and Rabe-Hesketh (2003); Hedeker (2003); and Grilli and Rampichini (2007), the two-level multinomial logit model with width from random origin will be as follows (Equation 1):

$$\eta_{ij}^{(m)} = \alpha_{00}{}^{(m)} + \beta_1{}^{(m)} x_{ij} + \xi_{0j}^{(m)} + \delta_{ij}^{(m)} \quad (1)$$

The above relationship in combination with the multinomial logit:

$$P\left(Y_{ij} = m | x_{ij}, \xi_j, \delta_{ij}\right) = \frac{exp\left\{\eta_{ij}^{(m)}\right\}}{1 + \sum_{l=2}^{M} exp\left\{\eta_{ij}^{(l)}\right\}} \quad (2)$$

In this Equation 2:
m =1,2, ..., M: represents the grouping of the dependent variable (contractual farming level).
j =1,2, ..., J: represents the levels or clusters (region).
i =1,2, ..., n_j:represents the observation at the first level (household).
$\xi_j^{(m)}$: is the variance of the disturbance components at the district level.
$\delta_{ij}^{(m)}$: is the error variance at the first level (household).

The dependent variable Y_{ij} (conditional on random effects) has a multinomial distribution that takes values related to the set of groups m=1,2, ..., M, where m=1 is the reference group. The conditional probability of Y_{ij}=1 is obtained based on Equation 3.

$$1 / \left(1 + \sum_{l=2}^{M} exp\left[\eta_{ij}^{(l)}\right]\right) \quad (3)$$

The statistic of interest in multilevel models is the Intraclass Correlation Coefficient (ICC), which is calculated for the multilevel logit model from Relation 4 (Grilli and Rampichini, 2007):

$$ICC^{(m)} = \frac{\mathrm{Var}\left(\xi_j^{(m)}\right)}{\mathrm{Var}\left(\xi_j^{(m)}\right) + \frac{\pi^2}{3}} \quad (4)$$

Also, to select the best model in multi-level patterns, deviance index or -2loglikelihood (-2LL) is used, the lower this statistic, the better. Of course, this index should be statistically significant according to the LR test.

3. Results and Discussion

The target population for this study consists of all tomato growers in Kermanshah province. Using Cochran's formula with the parameters explained [previously/in the methodology section], the sample size was determined to be 380 individuals. Table 1 presents the demographic and social characteristics of the tomato growers included in the study.

According to the above table, 40.8% of the 380 participants in the experimental group are under 30 years old and 59.2% are over 30 years old. In general, the experimental group under study has a good average age in terms of learning conditions and favorable work potential. In terms of education, according to the statistical data, 52.5% of the participants have a middle school education or higher. However, 47.5% are illiterate, which can be an effective factor in reducing the rate of technical education and acceptance of new thoughts and ideas among these farmers. The study of the household size shows that 42.5% of the research subjects have households with a size of more than four people. The cultivated area of 58.3% of the research cases is less than three hectares. Land ownership was also evaluated in two levels: renting and being the owner of the user, based on the data studied, more than 14.17% of people are owners. To check the economic status of households, more than 66.67% of people have the only source of income through agriculture, and 33.33% of people have other sources of income other than agriculture.

Table 2 presents a further breakdown of the study sample, disaggregating the individual, household, and agricultural characteristics by the three activity groups: (1) contract farming only, (2) non-contract farming only, and (3) both contract and non-contract farming. The overall

Table 2. Demographic and Social Characteristics of the Experimental Group.

Variable	Description	Percentage
Age	Under 30 years	40.8
	Over 30years	59.2
EducationLevel	Illiterate	47.5
	Primary and Secondary School	19.5
	High School and Higher	23
	Academic	10
Household Size	Less than 4	42.5
	More than 4	57.5
Harvest Level	Less than 3 ha	58.33
	More than 3 ha	41.67
Ownership	Owner	85.83
	Tenant	14.17
Income Source	Farming+Non-farming	33.33
	Farming	66.67

sample consisted of 356 households headed by males, with 17 households headed by females. Marital status data reveals that 352 household heads were married, while 21 were single. In terms of migration history, 53 households reported prior migration experiences. Finally, land ownership data shows that 180 households owned the land they farmed.

Table 3 presents a detailed breakdown of the sample characteristics by contract farming participation status. Notably, households without a history of contract farming had the lowest mean household head age (36.4 years) and the highest education level (9 years). The average household size in this group was 3.5 people, which was lower than the other two groups. Additionally, the mean vehicle value (10.2 million IRR) was higher in this group compared to the other two. For households that previously engaged in contract farming but are not currently involved, the mean number of employed household members was 1.2 people, and the mean loan amount received was 7.5 million IRR. In contrast, the mean cultivated land area (14.9 hectares) and the value of agricultural assets (50.9 million IRR) were higher in households that currently engage in contract farming compared to the other two groups.

Table 3 further indicates that households without contract farming experience had less land available for cultivation. This suggests that access to agricultural resources, such as adequate land area, livestock, and agricultural assets, was a key factor in determining contract farming participation in the region. Therefore, it appears that push factors, such as resource constraints, were more significant than pull factors in driving contract farming adoption among households in Kermanshah County.

Table 4 presents the different scenarios for estimating the probability of contract farming participation using a two-level multinomial logit model, and Table 5 shows the estimation results for these scenarios.

Selecting the best model among the estimated ones requires considering not only the deviance statistic but also the value of the random error variance. If adding new variables reduces the random error variance, it indicates that those variables were appropriate for explaining the model. Therefore, based on the value and significance of the deviance statistic and the reduction in the random error component, Model 4, which includes individual, household, agricultural, and regional variables, is the best model.

To answer the first research question, which is the probability of a farming household being in each of the contract farming groups, we use the fixed effects estimates presented in Model (1) of Table 5, which are log odds. These probabilities are calculated as follows, considering the overall mean of the variables (model intercept and without considering the explanatory variables):

$$p = \frac{1}{1+\sum e^{\alpha_{ij}}} = \frac{1}{1+e^{-0.28}+e^{-0.42}} = \frac{1}{1+0.755+0.656} = 0.414 \quad \text{(Group 1)}$$

$$p = \frac{1}{1+\sum e^{\alpha_{ij}}} = \frac{e^{-0.28}}{1+e^{-0.28}+e^{-0.42}} = \frac{0.755}{1+0.755+0.656} = 0.313 \quad \text{(Group 2)}$$

$$p = \frac{1}{1+\sum e^{\alpha_{ij}}} = \frac{e^{-0.42}}{1+e^{-0.28}+e^{-0.42}} = \frac{0.656}{1+0.755+0.656} = 0.272 \quad \text{(Group 3)}$$

The probability of a household engaging solely in contract farming, irrespective of its characteristics, is 41%. Similarly, the probability of engaging in non-contract farming is 31%, and the probability of engaging in both contract and non-contract farming is 27%.

To address the second research question, the ICC statistic was calculated based on Equation 5. This statistic, in addition to confirming the presence of a hierarchical structure in the data, indicates that 23% of the total variance of the dependent variable (activity in different agricultural groups) is attributed to the second level, i.e., regions. Therefore, 87% of the variance is explained by the level-one variables, namely individual, household, and agricultural characteristics.

$$\text{ICC} = = \frac{0.97}{0.97+3.29} = 0.23 \quad (5)$$

To examine the impact of each explanatory variable on the probability of participation in each farming group, we focus on the coefficients presented in Model 4. Since the coefficients of the presented variables are log odd values, only the significance and direction of the variables' effects can be interpreted. As can be seen from the table, the variables of household head's education, number of employees, agricultural asset value, farmer's risk tolerance, and product selling price have a significant effect on log odd in the second group (non-contract farming). Additionally, the variables of household head's education, number of employees, agricultural land area, land ownership, regional population, distance to the factory, risk tolerance, and product selling price have a significant effect on log odd in the third group (both contract and non-contract farming). Moreover, the direction of the effect of these variables (positive or negative) is also in line with expectations.

Table 3. Personal, household, agricultural and regional characteristics by contract groups.

Dependent Variables/Variables		Group 1		Group 2		Group 3	
		Contract farming only		Non-Contract farming only		Both Contract and Non-Contract farming	
Variables		Mean	standard deviation	Mean	standard deviation	Mean	standard deviation
household head characteristics	Age (year)	44.87	12.95	37.52	9.89	40.91	11.82
	Education (year)	6.14	3.77	8.75	3.68	8.53	4.29
Household characteristics	Size (Person)	3.58	1.19	3.4	1.11	3.78	1.16
	Labor Force (Person)	1.01	0.11	1.1	0.33	1.21	0.43
	loan amount (million IRR)	49.3	127	53.9	88.6	75.5	131.2
	Household savings (million IRR)	59.6	101.7	99	247.9	97.8	113.9
agricultural characteristics	cultivated land (ha)	1.68	2.66	0.87	6.88	0.9	1.18
	Value of Agricultural Assets (Water and Machinery) (million IRR)	509.0	730.1	8.7	65.6	374.8	668.4
regional characteristics	Population (Person)	1094.6	651.3	1547.7	873.23	1408.3	765.7
	Distance to processing facility (km)	28.45	31.84	20.19	25.21	26.98	29.55

Source: Research findings.

Table 4. The various model building scenarios.

Model 1 (Baseline Model)	Model 2	Model 3	Model 4
Baseline Model with no explanatory variables and considering only the random regional effects	Model 1 + First-Level Variables (Household Characteristics)	Model 2 + First-Level Variables (agricultural Characteristics)	Model 3 + Regional-level variables
Results are presented to illustrate the percentage of fluctuations in the level of contract farming explained by level-two units (region).	The results demonstrate the relationship between Level 1 variables (household characteristics) and participation in contract farming.	The results indicate that the model's performance improves with the inclusion of agricultural characteristics	The results suggest that the model improves when second-level (region) variables are included.

For better interpretation of the results, the relative-risk ratio (RRR) is calculated and presented in Table 6.

The RRR values for statistically significant variables in Group 2 indicate that a one-year increase in the household head's education level is associated with a 1.19 increase in the relative risk of engaging in non-contract farming compared to contract farming, holding other variables constant. This suggests a worsening of the situation. Similarly, a one-unit increase in the number of household workers is expected to increase the relative risk of non-contract farming by 3.94 units, holding other variables constant. In contrast, a one-unit increase in agricultural assets is associated with a 0.95-unit decrease in the relative risk of non-contract farming compared to contract farming, holding other variables constant.

For Group 3, a one-unit increase in the household head's education level is expected to increase the relative risk of engaging in this group compared to contract farming by 1.18 units, holding other conditions constant. Additionally, a one-unit increase in the number of household workers is expected to increase the relative risk of Group 3 compared to the base group by 2.17 units. Among the significant variables in this group is the area of agricultural land. The relative risk ratio for this variable indicates that a one-unit increase in the area of agricultural land is expected to reduce the relative risk of both contract and non-contract farming compared to contract farming by 0.61 units. However, land ownership increases this risk. Specifically, owning land, compared to not owning land, increases the

Table 5. The results of the two-level multinomial logit model estimation for the contract farming groups.

	Model 1	Model 2		Model 3		Model 4
Fixed Effects						
constant term- Group 1	(0.23)-0.23	(1.43)-2.06		(2.78)-0.91		(2.91)-8.94
constant term- Group 2	(0.24)-0.43	(1.76)-6.77		(2.05)-8.26		(2.09)-8.94
Variables	**Group 2**	**Group 3**	**Group2**	**Group3**	**Group2**	**Group 3**
Gender	-1.43**	0.85	-0.65	-8.34*	-0.23	0.74
	(0.67)	(1.17)	(2.83)	(2.06)	(1.45)	(1.17)
Age	-0.05*	-0.02	-0.01	-0.01	-0.02	-0.03
	(0.02)	(0.02)	(0.04)	(0.02)	(0.04)	(0.02)
Education	0.18*	0.2*	0.22***	0.23*	0.18	0.17*
	(0.05)	(0.05)	(0.12)	(0.06)	(0.12)	(0.06)
Household size	-0.1	0.05	0.06	0.12	-0.1	0.002
	(0.14)	(0.15)	(0.42)	0.16	(0.42)	(0.16)
Farmer's Degree of Risk Aversion	-23.15	-0.25	-28.73	0.13	-29.5	0.31
	(78.00)	(0.31)	(67.02)	(0.36)	(63.4)	(0.34)
Loan	-0.04**	-0.03***	0.01	-0.01	0.01	-0.02
	(0.02)	(0.01)	(0.07)	(0.02)	(0.08)	(0.02)
Household asset value	0.02	0.08	0.05	0.02	0.05	0.02
	(0.01)	(0.01)	(0.05)	(0.02)	(0.05)	0.02
Household Labor Force	3.93	4.24	2.91	4.99	3.43	5.66
	(0.98)	(0.97)	(1.53)	(1.18)	(1.65)	(1.31)
Price of Selling Goods	2.58**	2.85*	2.56**	3.01*	2.21***	2.76**
	(1.02)	(0.99)	(1.08)	(1.01)	(1.05)	(1.2)
Cultivated land area	-	-	-204.3	-0.41*	-232.08	-0.49*
			(358.46)	(0.14)	(706.45)	(0.14)
Land ownership	-	-	-10.68	0.67	-10.37	0.58
			(309.3)	(0.4)	(446.12)	(0.38)
Agricultural asset	-	-	-0.05*	-0.005***	-0.05**	-0.005
			(0.02)	(0.003)	(0.02)	(0.003)
population of the region	-	-	-	-	0.0005	0.001*
					(0.0005)	(0.003)
Distance to processing facility	-	-	-	-	0.04	0.02*
					(0.03)	(0.007)
Random error variance						
	0.99**	1.08*		0.58		0.01
	(0.42)	(0.49)		(0.39)		(0.17)
goodness of fit						
-2LL	789.5	693.62		314.92		298.74
LR test	67.59	95.89		378.71		298.74
	(p<0.0005)	(p<0.00)		(p<0.000)		(p<0.002)

The numbers in parentheses are standard errors. *, **, and *** indicate significance at the 1%, 5%, and 10% levels, respectively.
Source: Research findings.

Table 6. Relative Risk Ratio (RRR).

Variables	Group 2 compared to Group 1	Group 3 compared to Group 1
constant term	0.15	0.001
Gender	1.26	2.09
Age	0.98	0.97
Education	1.19	1.18
Household size	0.91	1.02
Household Labor Force	3.94	2.17
Farmer's Degree of Risk Aversion	0.68	0.98
Price of Selling Goods	0.95	1.10
Loan	1.01	0.98
Household asset value	1.05	1.02
Cultivated land area	1.4	0.61
Land ownership	0.03	1.78
Agricultural asset	0.95	0.99
population of the region	1.005	1.001
Distance to processing facility	1.04	1.02

Source: Research findings.

expected risk of both contract and non-contract farming by 1.78 units, holding other variables constant.

The population of the region and distance to the factory also have a positive effect on the relative probability (log odd) for Group 3. A one-unit increase in the population of the region and distance to the factory is expected to increase the relative risk of both contract and non-contract farming compared to contract farming by 1 unit and 1.02 units, respectively, holding other variables constant.

4. Conclusion and Suggestions

This study employed a two-level multinomial logit model to investigate the factors influencing the expansion of tomato contract farming in Kermanshah province, Iran. The findings demonstrate the positive impacts of contract farming on tomato yields and farmer well-being, aligning with previous research (Tripathi et al., 2005; Hobbs and Young, 1999; Wang et al., 2011; Morrison Paul et al., 2004). Additionally, contract farming enhanced access to inputs, markets, and labor, fostering employment opportunities and potentially mitigating seasonal migration from the region.

4.1. Key drivers and deterrents of contract farming expansion

Farmer income and tomato yield level exhibited positive and significant effects on farmers' willingness to adopt contract farming, corroborating the findings of Miyata et al. (2009), Gatto et al. (2017), and Schipmann and Qaim (2011). Conversely, agricultural risk, age, household size (White, 1997), and risk aversion of contract farmers (Wang et al., 2014; Hueth and Hennessy, 2002) had significant negative effects on the willingness to expand contract farming.

4.2. Land scarcity and participation in non-contract farming

An analysis of the agricultural structure in Kermanshah county revealed that "push factors," such as land scarcity for agriculture, were more important than "pull factors" in driving the participation of agricultural households in non-contract farming. Among the 380 households surveyed, 30.8% were involved exclusively in non-contract agricultural activities, primarily comprising households with no land for farming. Households engaged in both contract and non-contract farming constituted a smaller share (26.8%) of the total.

4.3. Geographical influence and individual characteristics

The results of the two-level multinomial logit model suggested that geographical factors and location of residence influenced the likelihood of agricultural household participation in non-contract farming activities. According to the intraclass correlation coefficient, 23% of the total variance in activity across groups (contract farming, non-contract farming, and both) was attributed to the regional level (i.e., location). The remaining 87% of the variance was explained by individual, household, and agricultural characteristics.

4.4. Probability of participation across farming activities

The study's findings also indicated that, irrespective of the independent variables, the probability of an agricultural household participating in contract farming was 41%, in non-contract farming was 31%, and in both activities was 27%. Individual and household characteristics further influenced participation decisions. Household head's education level and number of employed individuals positively affected the relative probability of agricultural household participation in

non-contract farming activities. In contrast, owning agricultural assets (water and agricultural machinery) and agricultural land increased the probability of participation in contract farming. Among the regional characteristics, population size and distance to the processing plant had a positive effect on the relative probability of being in the first and third groups (contract farming and both activities, respectively)

4.5. Policy recommendations

Based on the findings of this study and the challenges identified, the following policy recommendations are proposed to promote sustainable contract farming development in Kermanshah province and potentially throughout Iran.

4.5.1. Strengthening the legal framework

A robust legal framework is crucial to address potential breaches of contract farming agreements. This framework should clearly define the rights and responsibilities of both farmers and contracting companies, providing security and fostering trust within the system.

4.5.2. Enhancing regional support

Currently, regional agricultural organizations lack sufficient familiarity with contract farming principles. Capacity building programs and training initiatives are essential to equip these organizations with the knowledge and expertise to provide context-specific recommendations to farmers. This would enable them to better promote contract farming and address the unique challenges faced by local agricultural communities.

4.5.3. Diversifying collateral options

Land scarcity is a major barrier for some farmers to participate in contract farming. The legal system should be reformed to support the use of a wider variety of collateral options beyond land ownership. This could include equipment, livestock, or even group guarantees from farmer cooperatives. This would allow more farmers, particularly landless households, to participate in contract farming arrangements.

4.5.4. Risk mitigation strategies

Agricultural risk and risk aversion were identified as significant deterrents to contract farming expansion. Encouraging the incorporation of risk mitigation strategies, such as insurance, into contract farming agreements would significantly reduce risks for farmers. Government subsidies or public-private partnerships could be explored to make these risk mitigation tools more accessible and affordable for farmers.

4.5.5. Supporting contracting companies

Collaboration between policymakers and contracting companies can further incentivize contract farming growth. Policy initiatives could support contracting companies in diversifying their collateral options, potentially through loan guarantees or tax breaks. This would allow them to engage with a wider pool of farmers and expand their operations.

4.6. Future research directions

This study provides valuable insights into the factors influencing contract farming in Kermanshah province. However, further research is needed to gain a more comprehensive understanding of contract farming dynamics in a broader context. Here are some potential areas for future exploration:

4.6.1. The role of contracting company characteristics

This study focused on farmer-level factors. Future research could examine the characteristics of contracting companies and their influence on contract farming success. Aspects such as company size, reputation, and the terms offered in contracts could be explored.

4.6.2. Contract farming models for resource-constrained farmers

Land scarcity and limited assets pose significant challenges for some farmers. Research is needed to develop and evaluate contract farming models specifically tailored for resource-constrained farmers. These models could focus on alternative collateral options, risk-sharing mechanisms, and innovative production methods suitable for smaller landholdings.

By implementing these policy recommendations and pursuing further research along the suggested directions, stakeholders can create a more robust and equitable contract farming system that benefits both farmers and contracting companies, ultimately contributing to the development of a sustainable and thriving agricultural sector.

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