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Analysis of stability and mechanization trends in small farms of Khuzestan Province

Saheb Mirpanahi[1], Morteza Almassi[2*], Arjang Javadi[2], Hossein Bakhoda[1]

[1] Department of Agricultural systems engineering, Science and Research Branch, Islamic Azad University, Tehran, Iran
[2] Agricultural Engineering Research Institute, Agricultural Research, Education and Extension Organization, Karaj, Iran

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Corresponding author:
m.almassi@srbiau.ac.ir

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Abstract

This study examines the stability and mechanization trends of small farms in Khuzestan Province, a region known for its varied agricultural practices and vital role in national food security. The research seeks to evaluate the current mechanization status of these farms and identify the factors that impact their stability and productivity. Utilizing a mixed-methods approach, data were gathered through field surveys, interviews with local farmers, and analysis of agricultural output. Key factors assessed included equipment availability, farm size, crop types, and management practices. Statistical analyses were conducted to explore the relationship between levels of mechanization and farm stability, with a focus on economic viability, resilience to external shocks, and sustainable practices. The findings indicate a diverse landscape of mechanization, with larger farms exhibiting higher levels of mechanization compared to smaller ones. Critical factors influencing the adoption of mechanization included access to credit, training in modern agricultural techniques, and collaboration among farmers. The study also emphasizes the impact of local policies on the facilitation or obstruction of mechanization efforts. The results highlight the necessity of a customized approach to mechanization that addresses the specific needs and capabilities of smallholder farms. Recommendations for policymakers include enhancing access to machinery, fostering cooperative farming structures, and improving educational programs for farmers. This study enhances the understanding of agricultural mechanization in Khuzestan and lays the groundwork for future research aimed at boosting the stability and productivity of small-scale farming systems in the region.

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Introduction

Mechanization plays a crucial and essential role in optimizing agricultural production, enhancing human labor capacity, and improving productivity through better utilization of inputs such as fertilizers, seeds, and pesticides. In the realm of agriculture, mechanization is a key factor in achieving food production and ensuring food security for society (Ray et al., 2018). Tackling agricultural and demographic challenges can only be achieved through the advancement of mechanization and the adoption of appropriate tools, equipment, and technologies. Therefore, planners and policymakers should prioritize the provision of essential mechanization tools, which include a variety of machines, implements, and agricultural equipment, as a fundamental requirement. In the current landscape, sustainable agricultural development is crucial. To achieve this goal, it is important to highlight this focus in the country's five-year development plans, which act as essential guides for progress. Successful implementation of these initiatives requires a strong emphasis on the objectives outlined in these five-year plans (Paudel et al., 2019).

Agriculture is a vital sector for economic development, particularly in regions like Khuzestan Province, Iran, where the landscape is characterized by diverse climatic conditions and rich agricultural resources. Small farms play a crucial role in the local economy, contributing to food security and the livelihoods of rural households (Johansen et al., 2012). However, the challenges of increasing productivity, sustainability, and resilience against environmental changes necessitate a thorough understanding of farming practices, particularly in terms of stability and mechanization (Li et al., 2017). A stability study in agriculture refers to the examination of how farming systems can maintain productivity and resilience over time, especially under varying climatic and economic conditions (Cho et al., 2020;ó a. Kaab et al., 2023). Moreover, the determination of mechanization patterns is critical for enhancing agricultural efficiency and productivity. Mechanization can vary significantly based on farm size, crop type, and local resources. For small farms in Khuzestan, understanding the current mechanization patterns-such as the use of tractors, irrigation systems, and harvesting machinery is essential for promoting sustainable farming practices (Streimikiene, 2021).

Currently, about 18.7 million ha are in use for agricultural production, which has seen significant annual growth in recent decades, fueled by urbanization. The urban population has surged from 6 million (28% of the total population) to 48 million (70%) over the last few decades, leading to an increase in the number of cities from 500 to around 1,200. In the past 16 years, nearly 100,000 hectares of agricultural land have been altered-both legally and illegally-and removed from production (Farooq et al., 2019). This figure does not account for the land lost to urban expansion during this period. The demands of industrial development and the growing need for housing and recreational areas have exerted considerable pressure on agricultural land, often resulting in its conversion to urban spaces, services, and villas (Paolotti et al., 2016). Consequently, the essential requirements of urban growth and tourism development have increasingly been met by repurposing agricultural lands. This trend poses a serious challenge to food security and raises significant concerns about the future sustainability of the 14.8 million hectares of agricultural land remaining in the country (Mohammadi et al., 2010). The limited size of cultivated land is a significant characteristic of the agricultural sector in Iran and globally. This challenge hinders progress toward sustainable development goals in both agricultural and rural development. Without an appropriate model, the small size of agricultural plots complicates the adoption of new and suitable technologies across various fields, both technically and economically (Jamali et al., 2021). This often results in reduced yields per unit area, higher production costs, and lower income for farmers due to decreased agricultural productivity. Additionally, land fragmentation is a notable consequence of the country's traditional agricultural framework (Rasoolizadeh et al., 2022).

This type of territorial organization is not exclusive to Iran; it exists to varying extents in numerous countries. Today, researchers, experts, and agricultural policymakers acknowledge that the fragmentation and widespread distribution of agricultural lands present considerable obstacles to the progress of agricultural mechanization, especially in light of recent changes in land use systems (Elhami et al., 2019; Tohidyan Far and Rezaei-Moghaddam, 2019). Issues arising from small-scale farming systems include a lack of economic incentives for adopting new technologies at the production stage, minimal investment motivation, low production efficiency, and reduced economic profit (Kaab et al., 2023; Pahlavan et al., 2011).

Despite comprehensive efforts made during Iran's five-year development programs from 1990 to 2005 to reform agricultural exploitation structures and establish various optimal and efficient operational systems suited to the socio-economic conditions and agricultural capacities of different regions, the agricultural sector continues to grapple with these developmental challenges (Houshyar, 2017). The fragmentation of agricultural land remains a primary barrier to sustainable agricultural development. Efficient and effective management of land, water, labor, inputs, mechanization, innovative practices, precision agriculture, and various factors that influence agricultural production are significantly hindered by persistent issues such as small landownership and land fragmentation (Saber et al., 2021). Several factors contribute to this situation, including socio-family factors (such as the benefits of awareness, participation, bias, family dynamics), cultural and communication factors (such as access to communication centers, interests in group work, interaction with agricultural service centers, traditional beliefs), educational and technical aspects (such as access to technical guidance, availability of experts, presence of machinery, workshop facilitation), legal practices (including endowment, inheritance laws, partnership participation, and land division strategies), and economic factors (such as price disparities, adverse economic conditions, machinery costs, and banking facilities). These factors collectively hinder the development of agricultural mechanization in the country (Ghasemi-Mobtaker et al., 2010).

The repercussions of these challenges include decreased productivity, increased costs, inefficient farm management, ineffective adoption of new technologies, reduced agricultural investment, intensified land-use changes, exclusion of small plots from active production, inadequate access to financial resources, and diminished income. Consequently, rural migration, hidden unemployment, underutilization of agricultural mechanization, inefficient water resource management, and wasteful production practices ultimately contribute to a decline in agricultural productivity, reflective of underdevelopment (Devendra and Leng, 2011).

This study aims to assess the stability of small farm operations in Khuzestan, examining the interplay between agricultural practices, environmental conditions, and economic viability. Additionally, it will explore the existing mechanization patterns, identifying opportunities for improvement and adaptation. By integrating these elements, the study seeks to provide a comprehensive framework that supports small farmers in enhancing productivity while ensuring sustainability and resilience in the face of evolving challenges.

Materials and methods

The location of the study area

Khuzestan Province is located in southwestern Iran, bordering Iraq to the west and the Persian Gulf to the south. It is one of the largest provinces in Iran, covering an area of 63,238 km^2. The capital of Khuzestan Province is Ahvaz, which is also the largest city in the province and serves as an important economic and cultural center (Ministry of Jihad-e-Agriculture of Iran, 2022) (Figure 1).

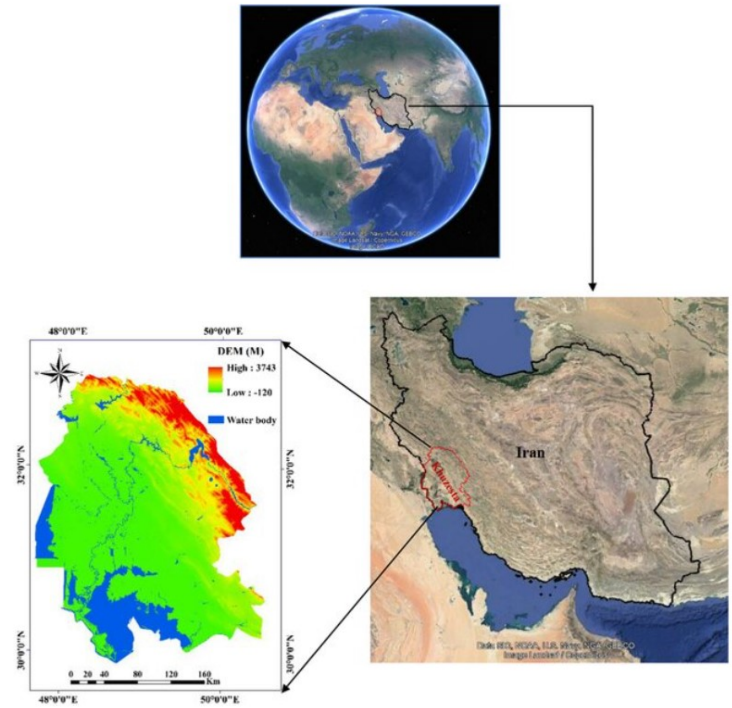

Figure 1. The location of the study area in Khuzestan Province of Iran.

Data collection and sample size

In this study, we employed a simple random sampling method, which offers reliable results that can be generalized to the entire population when the principles of sampling are adhered to. This method was chosen not only for its reliability but also for its alignment with the sampling strategies used by the Iranian Statistics Center and the Statistics Management and Planning Organization of Iran. Under this approach, every unit in the population has an equal probability of being selected at each stage. Given the significant variability in both the number and size of plots of land across various villages and regions, we aimed to select a larger number of farmers from those areas. Subsequently, we utilized random sampling to proportionately distribute and collect the questionnaires. To determine the appropriate sample size (Eq 1), we applied Cochran's statistical formula, which is designed to calculate the necessary sample size for random sampling (Cochran, 1977; Ghasemi-Mobtaker et al., 2020):

$$n = \frac{Nt^2S^2}{Nd^2 + t^2S^2} \quad (1)$$

The present study is an applied research effort employing a descriptive-analytical methodology combined with a survey approach. The target population comprised small-scale farmers and operators, specifically those managing farms of less than 5 ha. This population was identified through a sample selection process focused on Khuzestan Province, with 48 farmers selected from the two southern counties of Karoon and Behbahan.

The method of evaluating the impact of mechanization on production stability

Sustainability assessment is defined as a process through which the concept of sustainability is estimated in an innovative way and through which decision makers and policy makers can be helped on what other sustainable measures should be taken into account (Singh et al., 2015). The number of tools that can be claimed to be used to assess sustainable development is expanding every day. So far, there have been many classifications of methods and tools for sustainability evaluation and measurement, which can be classified into three general categories: sustainability based on indicators, production-oriented sustainability, and integrated sustainability evaluation (Farahnaki et al., 2019).

This study utilized a sustainability evaluation method grounded in indicators, which encompass multiple dimensions of economic, environmental, and social aspects. These indicators can be effectively integrated into a composite index. Once all relevant information is collected through these indicators, a sustainability index enables a comprehensive assessment of a system's sustainability. While numerous indicators have been created, they do not capture every facet of sustainability. Furthermore, due to variations in biological and socio-economic conditions, indicators that are applicable in one country may not be suitable for use in another (Rasul and Thapa, 2004). Munda and Nardo (2005) suggest a number of alternative methods for constructing a composite index, which are: principal components analysis; hierarchical analysis; And Multivariate method based on the distance from the ideal point. In this research, the principal component analysis method will be used to construct a composite index.

Weighing each of the indicators with the help of principal components analysis

Once the discrepancies in scale among the indicators have been addressed, the next critical task is to assign appropriate weights to the chosen indicators. There are various approaches to determining these weights to manage the differences between variables. One effective method is Principal Component Analysis (PCA), which aims to maximize the sum of squared correlations. This technique enables researchers to derive a vector representing the first principal component, which is linearly related to the primary variables and shows the highest sum of squared correlation with them. The specific vector corresponding to the largest eigenvalue of the correlation matrix provides the desired weights. To apply these weights, the values of this vector should be multiplied by those of the standardized matrix (Kalantari-Dahaghi, 2010).

Given the numerous variables involved and the consideration of the three dimensions of sustainability; economic, environmental, and social; by the research team, an alternative approach for analysing the main components is to categorize the selected indicators into subgroups. This method is particularly advisable when there is a significant internal correlation within each subgroup, while the correlation between different groups is lower. In these situations, principal component analysis (PCA) is performed for each subgroup, and the resulting composite indices can then be treated as new variables for calculating the overall composite index. Furthermore, the weights assigned to the indicators in the initial factor analysis are influenced by the correlation between the variables; thus, a variable that exhibits a stronger correlation with others will receive a higher weight (Kalantari-Dahaghi, 2010). In this study, the factor analysis method was employed to classify the indicators into three categories: natural sustainability, economic sustainability, and social sustainability. The factor load for each index was multiplied by its corresponding column, and the indicators associated with each sustainability dimension were summed to compute the composite index for each category (Table 1). In the subsequent step, we conducted a factor analysis to calculate the factor loadings for each of the three dimensions. These loadings were then multiplied by their respective dimensions. By integrating these three dimensions, we derived the composite index of stability. The results of the factor analysis also indicated the significance of each factor, as shown in Table 2. After multiplying the relevant coefficients for each index, the three indices were combined, resulting in the final composite sustainability index presented in Table 3.

Table 1. Analysis of factors affecting sustainability.

Agent name	Special amount	Factor load	Cumulative factor load
Natural sustainability	5.63	42.12	40.05
Economic sustainability	5.02	10.64	52.33
Social sustainability	4.81	8.04	60.24

Table 2. Analysis of factors affecting sustainability.

Agent name	Special amount	Factor load
Sustainability	1.15	38.71

Table 3. The amount of factor load explained by each factor.

Agent name	Agent name	Factor load
Sustainability	Natural sustainability	0.542
	Economic sustainability	0.521
	Social sustainability	0.301

Evaluation method

The present study is an applied research project that employed a descriptive-analytical method with a survey approach. The research focused on a statistical population comprising farmers and operators with both small farms (under 5 ha) and larger farms (over 5 ha). A sample of 48 farmers residing in the rural areas of two southern Khuzestan cities, Karoon and Behbahan, was selected (Table 4). Data analysis was conducted using SPSS and Excel software. In this research, the sustainable development of mechanization was treated as the dependent variable. To assess the level of sustainable development in mechanization, various indicators were evaluated, including the number of agricultural plots owned by users, savings on inputs (such as water, seeds, fertilizers, and labor), increases in production and farmers' income, reductions in production costs, and the extent of new technology adoption on farms.

Table 4. Cronbach's alpha calculated for research indicators.

Scale	The number of objects	Cronbach's alpha
Farmers' attitude toards sustainable agriculture	24	0.76
Farmers' knowledge about sustainable agriculture	13	0.93
Using sustainable agricultural methods	13	0.76
Social capital	20	0.80
Job satisfaction	6	0.84
Human capital	50	0.86
Sustainability	43	0.71

Results

Results of the effect of mechanization on production stability

Personal characteristics of users

The farmers participating in this study have an average age of 47.3 years, with an average of 24 years of experience in agricultural activities. Literacy levels among the farmers are concerning, as only about 32% possess a diploma or higher qualifications, reflecting a low educational attainment in the region. Regarding land ownership, 135 farmers, or 79%, own the land they cultivate. The findings from the attitude scale reveal that 30 farmers exhibit a "very unfavorable" attitude towards the adoption of appropriate mechanization in small farms, while 60% have an "unfavorable" outlook, and 32 farmers maintain an "average" attitude. In contrast, 48 farmers demonstrate a "favorable" attitude towards the potential for mechanization in their operations. In assessing farmers' knowledge of sustainable agriculture, approximately 26% are characterized by very limited knowledge, and 26.5% have a low understanding. Furthermore, 21.3% display an average awareness, while 26.3% indicate a substantial knowledge of sustainable practices. When examining job satisfaction, results show that 25.9% of farmers report "very little" job satisfaction, and 24.6% express a "low" level of satisfaction. Additionally, 25.8% have a "moderate" sense of job satisfaction, whereas only 23.8% report having "high" job satisfaction. The evaluation of the use of sustainable farming methods indicates that 53.8% of the surveyed farmers employ "very little" or "little" suitable mechanization techniques on small farms, while 29.8% utilize "moderate" methods. A mere 16.3% apply appropriate mechanization techniques to a "high" extent. Overall, it would be beneficial to present these results graphically to better illustrate their significance. Additionally, it is crucial to analyze the relationships between these variables, such as whether age or literacy correlates with farmers' attitudes. The current presentation primarily reports findings without a thorough scientific interpretation.

Social characteristics

The research findings indicate that in Khuzestan Province, 94.3% of users have access to health houses. However, only 65.5% of users in Khuzestan report access to health services, with 44.2% in Khuzestan also having access to these facilities. Critically, the research revealed that none of the beneficiaries had access to a hospital, private clinic, pharmacy, or maternity hospital in their villages, highlighting a concerning health situation in the areas studied. Regarding farmers' membership in agricultural or rural organizations, only 8.3% of farmers in the Islamic Council of Khuzestan. Conversely, 72.3% of farmers in Khuzestan belong to rural cooperatives. Alarmingly, just 0.1% of respondents reported having access to cold storage for their agricultural products. Consequently, 18.5% of users in Khuzestan utilize silos, while 38.3% in Khuzestan have access to a rural cooperative. Additionally, 14.2% of beneficiaries in Khuzestan have access to specialized agricultural repair centers in their villages.

Economic characteristics

In the analyzed sample, the highest number of farmers (68) cultivate less than 1 hectare of land. Following this, 55 farmers manage between 1 and 3 hectares, while 47 farmers work on plots ranging from 3 to 5 hectares. Data gathered from farmers in the studied villages reveal that the average number of land plots per farmer is 2.3, with most farmers operating on 3 to 4 parcels of land. In the current crop year, 62% of the farmers have utilized bank loans, whereas 38% have not sought bank loans to address their financial needs at the beginning of the growing season and during various agricultural activities. Additionally, 35 respondents are involved in non-agricultural activities, which do not provide a stable income. These activities include driving, transporting, and selling agricultural products in nearby cities; however, the farmers state that these jobs do not sufficiently cover their financial requirements. Furthermore, 135 farmers, or 75%, rely on family labor for their operations, while 25% do not employ non-family labor in their farming activities.

Agricultural characteristics

In Khuzestan, 42 respondents reported that the majority of their cultivated land is flat, while only 6 mentioned usage of sloped areas, which they described as dense and swampy. Nearly half of the farmers in Khuzestan (55.2%) depend on river water for their agricultural operations. Moreover, 9% of farmers in the region use biological control methods for pest management. Additionally, 55% of farmers indicated that they incorporate weeds in some or all of their fields to help suppress unwanted vegetation. Out of the 170 farmers surveyed, only 12 reported using windbreaks, all of which were located around their gardens, and a mere 8% had utilized them in the preceding cropping season. Some portions of their farms have also undergone testing.

Sustainability

The assessment of the composite sustainability index among farmers in Behbahan and Karun cities (located in Khuzestan province) revealed that 75.7% fall into the "very low" sustainability category, while 16.9% are categorized as "low," 3% as "medium," and a mere 0.5% are classified as "high" sustainability. The average sustainability score for the sample analyzed is 18.09, with a minimum score of 7.98 and a maximum score of 79.89.

Discussion

Sustainable agriculture is increasingly recognized worldwide as a vital pathway to achieving sustainable development goals. Evaluating agricultural sustainability can inform the creation of more effective policies and strategies that promote sustainable practices. This study introduces new composite indices designed to assess agricultural sustainability at both regional and national levels over time, employing a four-stage methodology. The individual indicators reflect the current status of resources utilized in the agricultural sector, while the composite indices serve as valuable tools for policymakers and planners. They can help identify strengths and weaknesses in agricultural practices, facilitate comparisons between regions regarding sustainability, assess changes over time, and guide agricultural policy decisions. The empirical analysis revealed varying sustainability statuses across Iranian provinces, with trends showing irregular patterns (with exceptions noted for the economic index in Kohgiluyeh and Boyer-Ahmad province and the social index in Hamedan and Gilan) throughout the study period. By implementing consistent and effective policies, it is possible to enhance agricultural sustainability in Iran (Abdar et al., 2022).

Khouzestan is facing a critical challenge with declining farm labor and insufficient investment in agricultural operations, which have contributed to shortage of domestic wheat yields. Cultural and economic barriers have limited the adoption of more expensive precision agriculture technologies, such as zero-till farming, that could enhance labor efficiency and optimize farm inputs. To leverage the advantages of precision application while accommodating the existing semi-mechanized seedbed preparation and tillage systems, we introduced a low-cost, chest-mounted seed and fertilizer applicator. Our findings revealed that this simple mechanization significantly improved yield efficiencies for nitrogen and phosphate. Additionally, seed rates using this method were positively correlated with seedling density, resulting in more predictable yields and profits for farmers. In contrast, hand-applied inputs led to a disconnect between the inputs used and the final yield at the end of the season, introducing considerable risk into their farming operations (Park et al., 2018).

The United States is facing a persistent shortage of agricultural labor. While growers are increasingly relying on guest-worker programs to fulfill their labor demands, many do not see immigrant workers as a sustainable long-term solution. Instead, producers of labor-intensive crops are turning to mechanization as a preferred long-term strategy. However, the slow adoption of mechanized harvesting equipment in the US presents a puzzling scenario. In this article, we argue that wage-setting farmers have an incentive to "over-mechanize," utilizing more capital than is cost-effective when capital and labor can substitute for each other. Conversely, they tend to "under-mechanize" when labor and capital are complementary. This tendency may perpetuate labor issues in agriculture where complementarity exists. To investigate the potential impact of underinvestment in labor-augmenting capital, we analyze labor market results following the introduction of non-autonomous harvesting aids on a large strawberry farm in Central California. We construct an econometric model that accounts for the influence of peer performance among farm workers in crews. Our findings indicate that mechanical aids enhance labor productivity in strawberry production, helping to clarify the slow uptake of mechanized harvesting in this sector, and contributing to the ongoing productivity disparities within agricultural industries. Furthermore, we explore the broader implications of our theory regarding the slow adoption of mechanical harvesting technologies in US agriculture by comparing wage trends across various labor-intensive and non-labor-intensive sectors in California (Hamilton et al., 2022).

The discussion regarding the effects of mechanization on production stability, particularly in the context of the personal, social, economic, agricultural characteristics, and sustainability of farmers in Khuzestan, reveals several critical insights. We will break down each section to examine the implications of these findings comprehensively. The demographic characteristics of the farmers indicate a relatively experienced group with an average age of 47.3 years and 24 years of agricultural experience. However, the concerning literacy level—where only 32% possess secondary or higher qualifications—may hinder the adoption of technological advancements, including mechanization. The attitudes towards mechanization were mixed: a significant portion exhibited unfavorable attitudes, which may correlate with their limited knowledge of sustainable agricultural practices (about 52.5% with limited to low awareness). This relationship suggests that enhancing education and training could be pivotal in improving attitudes towards mechanization. The job satisfaction rates are low, indicating potential discontent or challenges in the farming profession that could also influence their receptiveness to adopting mechanized methods.

The social context of the farmers, particularly regarding health services, is alarming. The data reveal that while many have access to nearby health facilities, the lack of access to hospitals or pharmacies in their villages is critical. This lack of basic health services not only affects the farmers' well-being but could also impact their productivity and willingness to invest in more advanced farming techniques. The low membership rate in agricultural organizations (8.3%) and the significantly higher percentage in rural cooperatives (72.3%) suggests that while there is some level of collective action, there is a need to strengthen networks that could facilitate knowledge sharing and improve the adoption of mechanization.

Economic factors play a significant role in the stability of production. A majority of farmers operate on small plots of land (68% under 1 hectare), which inherently limits the scale and efficiency of mechanization. The fact that 62% of farmers have utilized bank loans indicates a reliance on external financial support, possibly to invest in necessary equipment or inputs. However, the fact that 75% of farmers depend on family labor suggests a possible lack of capital for hiring skilled labor, which can further limit the effective use of mechanization. The involvement in non-agricultural activities, which are marginally productive, reflects the economic insecurity faced by these farmers.

The physical characteristics of the land and water availability significantly influence agricultural practices. The reliance on river water for irrigation indicates vulnerability to changes in water availability, which could impact production stability. The low usage of biological control methods for pests (only 9%) reflects a missed opportunity for sustainable practices, potentially limiting productivity and increasing susceptibility to pest damage. The low implementation of windbreaks and testing on farms also raises concerns about the adoption of practices that can lead to long-term sustainability.

The sustainability index findings are concerning, with a majority (75.7%) falling into the "very low" category. This low sustainability score indicates significant challenges in the agricultural practices adopted by farmers in Khuzestan, which likely correlates with inadequate mechanization, poor resource management, and a lack of adoption of sustainable practices. The average index score of 18.09 out of a possible maximum indicates that many are operating at a vastly inefficient level, which is detrimental to long-term agricultural viability.

The data highlights a need for targeted interventions focusing on:

1. Education and Training: Fostering improved literacy and agricultural training could enhance the adoption of mechanization and sustainable practices.
2. Health Services: Addressing the alarming lack of access to hospitals and pharmacies in rural areas will boost overall productivity and well-being of farmers.
3. Access to Financial Resources: Enhancing financial support systems might enable farmers to adopt mechanized methods more efficiently.
4. Cooperative Development: Strengthening agricultural organizations and rural

cooperatives can create synergies that promote knowledge sharing and resource pooling, increasing resilience and mechanization.

5. Promotion of Sustainable Practices: Initiatives to encourage the adoption of biological pest control and land management practices can improve sustainability and productivity.

Graphical representation of these findings could significantly enhance comprehension and highlight the relationships between these variables, facilitating a better understanding of the dynamics at play concerning mechanization and production stability.

Conclusions

The analysis of stability and mechanization trends in the small farms of Khuzestan province reveals significant insights into the farmers' characteristics and their operational practices. The data indicates that a majority of farmers (79%) are landowners, which suggests a level of investment in their agricultural activities. However, attitudes towards mechanization appear largely negative; with 30 farmers expressing a "very unfavorable" view and 60% holding an "unfavorable" attitude towards the potential benefits of mechanization. Only a minority (48 farmers) views mechanization favorably. Job satisfaction among farmers is also a concern, as a substantial portion (25.9% and 24.6%) reports very low to low levels of satisfaction. This could be indicative of greater challenges faced in small farms, possibly linked to limited mechanization and the associated impacts on productivity and working conditions. With the adoption of sustainable farming methods being reported as lacking, where 53.8% of farmers use little to no suitable mechanization techniques, it underscores a significant gap in the necessary technological advancements and support needed for improved farming practices. Overall, the findings highlight a critical need for intervention to enhance the understanding and adoption of mechanization and sustainable practices among small farmers in Khuzestan. Addressing their concerns and improving job satisfaction could be pivotal in promoting better operational efficiency and productivity in the agricultural sector.

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